Volume 20
Number 1
Jan. - June, 2014

ISSN 0972 – 6977

RNI No. UP - ENG/2001/6732

Journal of Farming Systems Research & Development

Farming Systems Research and Development Association
Modipuram, Meerut – 250 110

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Journal of Farming Systems Research and Development

Volume 20 **January - June 2014** **Number 1**

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J. Farming Systems Research & Development **20** (1) : 1-13 (2014)

EFFECT OF CROP ENVIRONMENTS ON ABOVE GROUND BIOMASS AND YIELD OF AROMATIC RICE UNDER MIDDLE GUJARAT AGRO CLIMATIC REGION

MOHAMMAD SHAMIM, A.M.SHEKH*, VYAS PANDEY*, SUNIL KUMAR AND VIPIN KUMAR

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ABSTRACT

A field experiment was conducted during *kharif* seasons of 2007 and 2008 on Silty Loam soils of Nawagam under middle Gujarat Agroclimatic region of India. Four aromatic cultivars of rice were transplanted on three dates at fortnight interval in order to determine above ground biomass and yieldto find out best cultivar and optimum date of transplanting.on the basis of the data of two crop season on yield and yield attributes it was ascertained through visual scrutiny that the second date of transplanting (D_2)among all three dates of transplanting for all the four cultivars and genotype GR-104 among all the four aromatic cultivars of rice. viz., Pankhali (P 203), Narmada (Ambica), GR 104 and Pusa Basmati-1 could be reckoned as the optimum condition and high yielding respectively.

Key words: aromatic rice, crop environment, above ground biomass, grain yield

Rice (*Oryza sativa*), one of the three most important food crops in the world, forms the staple diet of 2.7 billion people. Indian economy is mainly based on agriculture. Growth rate for overall GDP of India was 8.5% whereas for agriculture and allied sectors it was 10% (Anon., 2007). India is the largest growing country (8°N to 34°N latitude) of the rice under varying climatic conditions and it accounts for more than 40% of food grain production, providing direct employment to 70% people in rural areas. Being the staple food for more than 65% of the people, national food security hinges on growth and stability of its production (Anon., 2006a). The percentage share of export value of Basmati rice in the food grains export earnings was 76.10 per cent during 1993-94. India exported around 581791.0 metric tonnes of Basmati rice (Anon., 2004). Still there is vast scope for further expansion of Basmati rice export, provided we could supply to farmers high yielding Basmati varieties along with appropriate production technologies. Hence, to fill this gap between demand and supply, the present investigation was carried out for achieving this by selecting suitable aromatic cultivar and appropriate time of transplanting.

MATERIALS AND METHODS

A field experiment was conducted during *kharif* seasons of 2007 and 2008 at Nawagam under middle Gujarat Agroclimatic region. The farm is located at 22°48'N latitude, 71°43'E longitudes and at an altitude of 32.4 m above the mean sea level. The soil of the experimental field was medium black, deep to very deep, poorly drained and salt affected. The textural class of soil was Silty Loam having 38.1 % sand, 44.1 % silt and 20.8 % clay. The four different genotypes viz, V_1= Pankhali (P 203), V_2= Narmada (Ambica), V_3= GR- 104 and V_4= Pusa Basmati-1 were transplanted on

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three different dates viz, D_1: 8th July, D_2: 22nd July and D_3: 8th August.

The different phenological phases of plant development and the observations thereof were recorded by visiting the field frequently from raising of seedlings to harvesting. The whole life cycle of the rice crop from sowing to maturity was divided into six distinct phenophases are as follows: EM = Emergence, EJ = End of juvenile phase, PI = Panicle initiation, AN = Anthesis, BGF = Beginning of grain filling and PM = Physiological maturity. Leaf area indices were calculated by measuring their leaf area with leaf area meter (LI-COR 3100) at various phenophases. To assess the above ground biomass production the leaves, stem, and panicles were separated and initially shade dried. They were then dried in oven at 65°C for 72 hours till a constant weight was obtained and expressed in g $plant^{-1}$. Number of panicles per Sq. meter, numbers of grains per panicle, test weight, grain yield, straw yield and harvest index were calculated. It would be appropriate at this stage to state that the basic objective of conducting the field experiment was to characterize the micro environment involving a combination of the date of transplanting and various cultivars of rice crop that could contribute to high yield which could or could not necessarily be the highest on the basis of various possible combinations of these two parameters indirectly representing the environment.

Weather conditions during crop seasons *kharif* 2007 and 2008

The daily weather data of both the crop growth seasons were collected from the Agrometeorological Observatory, Main Rice Research Station, Nawagam. The average of ten days was worked out for temperatures, sunshine hours, wind speed, mean vapour pressure and ten days total rainfall for graphical presentation.

Air temperature

The range of daily mean temperature as obtained from the maximum and minimum temperatures of the pertinent day ranged from 24.6 to 34.4°C during the *kharif* season of 2007, while the corresponding range in the year 2008 was 25.4 to 31.7°C. The crop experienced higher average maximum temperature of 35.0°C (ranging between 30.2 to 40.4°C) during the nursery phase in D_1 transplanting of the year 2007 (Fig. 1a), while this was 35.2°C (ranging between 31.6 to 37.5°C) in the same period of the crop growing season of the year 2008 (Fig. 1d). However, germination was not affected in any of the two crop seasons on account of continuous wet condition of nursery after sowing. Similarly under both the crop growing seasons, D_1 transplanting experienced the highest average maximum temperature of 32.9°C (ranging between 31.0 to 38.6°C) and 32.8°C (ranging between 30.4 to 35.8°C) for years 2007 and 2008, respectively. However, prevalence of high maximum temperature was more pronounced during nursery period as well as during physiological maturity phase (130 DAS) of the crop in both the crop growing seasons. The daily mean temperature was not decreased gradually from the date of sowing to physiological maturity among all the dates of transplanting, but considerably lower mean temperatures prevailed during the flowering and milking stage in D_2 transplanting (Fig. 1c and f). This showed that, more so in the second date of transplanting, and its beneficial effect was indirectly reflected in grain yield.

Lowest average minimum temperatures recorded were 17.3, 17.5 and 16.2°C in D_1, D_2 and D_3 during 140, 120 and 130 DAS, respectively in the year 2007, while these were 11.8, 16.4 and 15.6 °C in D_1, D_2 and D_3 transplanting at 140, 130 and 130 DAS in the second year experiment, respectively (Fig. 1b and e). A downward trend of the mean temperature was noticed from 130 DAS, 100 DAS and 100 DAS till the end of maturity in D_1, D_2 and D_3, respectively under both the years of study. The average maximum temperatures observed during the crop period 2007 under different dates of transplanting were 32.9, 32.5 and 32.8°C, respectively in the first, second and third dates of transplanting. The corresponding values during 2008 were 32.8, 32.9 and 32.6°C, respectively (Table 1). An overall behaviour of the maximum temperature during both the years revealed that in D_1 and D_3 transplanting slightly higher maximum temperature was recorded in 2007 while D_2 recorded slightly lower temperature when compared with that corresponding to the season of 2008.

The average values of minimum temperature that prevailed during the year 2007 *kharif* season under different dates of transplanting were 24.5, 23.8 and 23.2°C, respectively in the first, second and third date of transplanting. The corresponding values during 2008 *kharif* season were 24.4, 22.7 and 22.8°C, respectively (Table 1). The average minimum temperatures decreased from 10 DAS till harvest in the first date of transplanting where as downward trend were recorded from 20 DAS to 120 DAS and 20 DAS to 110 DAS in D_2 and D_3 respectively and it was later resumed an upward trend during 2007. The downward trend of average minimum temperature was recorded from 10 DAS to harvest among all the date of transplanting in 2008 crop season (Fig. 1 b and e).

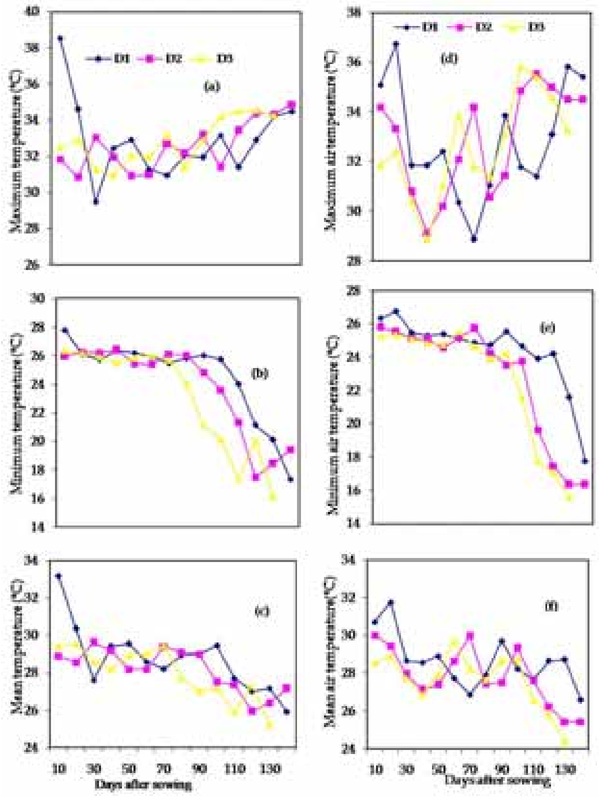

Fig. 1. Temporal variation in temperature during crop growing period under different dates of transplanting in 2007 (a, b and c) and 2008 (d, e and f)

Sunshine hours

The values of the bright sunshine hours exhibited more fluctuations during the study period of 2008 as compared to those of the study period of 2007 (Fig. 2a and d). The average value of daily bright sunshine hours were 6.4 and 5.8 hours for 2007 and 2008 crop seasons respectively with very little variation from one date of transplanting to another (Table 4.1). Highest average values of sunshine hours (6.83 h) were recorded by D_3 transplanting during 2007, while D_1

had shown the lowest average values of sunshine hours (5.0 h) in the year 2008. The deviation of actual value from the mean was more pronounced in the beginning stages of crop growth during both the years. The average sunshine hours showed a difference ranging from 0.1 to 9.7, 1.7 to 9.7 and 1.8 to 9.7 (h) in D_1, D_2 and D_3 respectively during crop season 2007 whereas D_1, D_2 and D_3 recorded 1.0 to 9.3, 0.2 to 9.4 and 1.0 to 9.3 respectively from nursery till maturity during 2008 crop season (Fig. 2a and d).

Fluctuations in the values of sunshine hours from one date of transplanting to another date of transplanting remained very high up to 110 DAS during crop growing season of 2007, while in 2008 larger fluctuations were noticed up to 90 DAS and there after fluctuation among date of transplanting become more or less very marginal during both the crop season (Fig. 2a and d). The highest average bright sunshine hours were encountered by the crop in D_2 transplanting than that of D_1 and D_3 in crop season 2008 and D_1 in 2007 through out the crop season where as D_3 recorded highest corresponding value during crop season 2007.

Wind speed

The average wind speed during the crop-growing season varied considerably between the years and also among the different dates of transplanting of the same season. The average wind speed worked out for the crop-growing season as a whole, for each of the respective crop seasons showed decreasing trend from the first dates of transplanting to subsequent transplanting during both the crop season. It was 5.0, 4.3 and 3.8 kmph in the first, second and third dates of transplanting, respectively in crop season of 2007 (Table 1). The magnitude of fluctuations in wind speed was found high up to 70 DAS and thereafter it was found to be more or less low till harvest during both the crop growing seasons (Fig. 2b). Average wind speed of 5.6, 4.3 and 4.3 kmph was recorded in the first, second and third date of transplanting, respectively (Table 1) during the crop-growing season of 2008. Low wind speeds during the reproductive phase in D_2 transplanting resulted into higher grain yield of the crop during both the year.

Mean vapour pressure

The mean vapour pressure showed a fluctuating trend during both the years

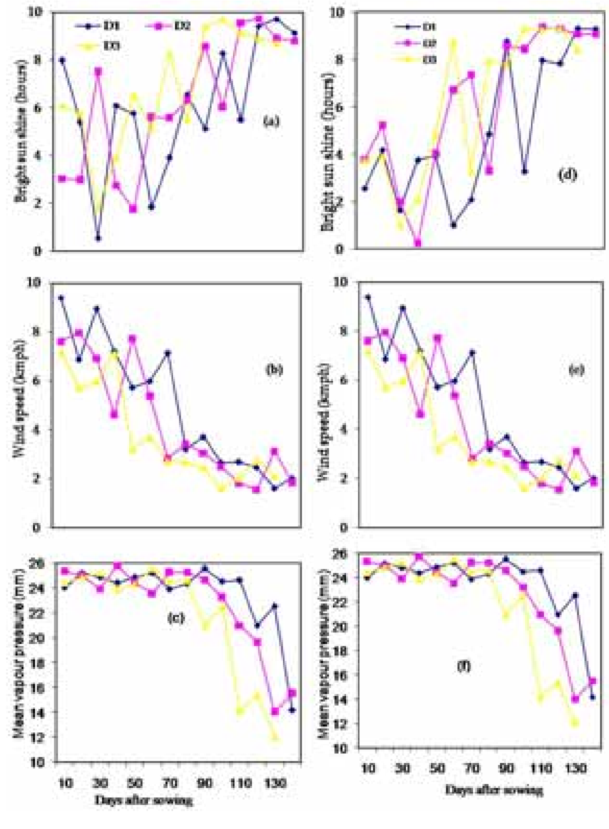

Fig. 2. Temporal variation in weather parameters during crop growing period under different dates of transplanting in 2007 (a, b and c) and 2008 (d, e and f).

of the study. The average vapour pressure during all the dates of transplanting was higher during 2007 as compared to that of 2008 (Table 4.1). The highest values of average of mean vapour pressure as recorded were 25.5, 25.8 and 25.5 mm of Hg in D_1, D_2 and D_3 at 90, 40 and 60 DAS, respectively in the crop-growing season of 2007 (Fig. 2c). Similarly, these values were 24.6, 24.8 and 24.6 mm of Hg remain prevalent during early reproductive phase of crop in D_1, D_2 and D_3 respectively in 2008 (Table 1). The second date of transplanting also encountered more or less constant lower mean vapour pressure than the D_2 transplanting during reproductive phase in both the crop year, while D_3 encountered higher fluctuation in mean vapour pressure during reproductive stage of crop although the values were remain lower than that of other dates of transplanting.

The lowest values of the average of the mean vapour pressure as encountered by the crop were 14.2, 14.0 and 12.1 mm of Hg in D_1, D_2 and D_3 during maturity phase respectively in the crop season 2007 (Fig. 2c). Correspondingly similar values recorded were 14.5, 12.1 and 11.6 mm in D_1, D_2 and D_3 transplanting respectively during the maturity phase of the crop in the crop season of 2008 (Fig. 2e).

Rainfall

The total annual rainfall was 1065.5 mm and its distribution was also very good throughout the crop season in all the dates of transplanting during 2007, where as 651.3 mm total annual rainfall was recorded by the year 2008 and distribution of rainfall was very erratic throughout the crop season under all the dates of transplanting. The total amount of rainfall was 1046.1, 964.1 and 609.4 mm in D_1, D_2 and D_3 transplanting respectively during the crop season of 2007, whereas corresponding values were lower i.e., 600.4, 582.4 and 543.0

Table 1. Average values of various weather elements (Max. Temp., Min. Temp., Mean Temp., BSSH and Mean V.P.) prevailed and total rainfall occurred during crop growing period under various dates of transplanting in *kharif* 2007 and 2008

Dates of Transplanting	Weather elements						
	Max. Temp. (°C)	Min. Temp. (°C)	Mean. Temp. (°C)	BSSH (Hrs)	Wind Speed (Kmph)	Mean V.P. (mm)	Total Rainfall (mm)
			Crop season 2007				
D1	32.9	24.5	28.7	6.1	5.0	23.4	1046.1
D2	32.5	23.9	28.2	6.2	4.3	22.7	964.1
D3	32.8	23.2	28.0	6.8	3.8	21.8	609.4
Crop season	32.7	23.9	28.3	6.4	4.4	22.7	1065.5
			Crop season 2007				
D1	32.8	24.4	28.6	5.0	5.6	22.7	600.4
D2	32.9	22.7	27.8	6.2	4.3	20.9	582.4
D3	32.6	22.8	27.7	6.1	4.3	21.1	543.0
Crop season	32.8	23.3	28.0	5.8	4.7	21.6	651.3

mm in D_1, D_2 and D_3 transplanting, respectively during the crop season of 2008 (Table 1).

The ten days total rainfall showed a fluctuating trend among dates of transplanting during both the crop season (Fig. 3a and b). The first date of transplanting received higher amount (1046.1 mm) of rainfall(Table1) with erratic distribution during the crop season 2007 than that of D_2 and D_3, but D_2 received all the rain up to 100 DAS and maturity phase remain free from any rainfall and cloud. In the case of D_3 transplanting, the total rainfall (609.4 mm) which was received during the crop season was almost half of the D_1 and D_2 transplanting in the same crop year. The distribution of the rainfall was also not good and crop has received total rain during vegetative phase i.e., up to 80 DAS (Fig. 3a).

The total amount of rainfall was quite low in all the dates of transplanting in the crop year 2008 than that of corresponding dates of transplanting in 2007 (Table 1). Although, the distribution of the rain was little bit smoother in the case of D_1 than that of D_2 and D_3 transplanting. But the differences in the total amount of rainfall were not remarkable among dates of transplanting. Crop received all the rain during the vegetative stage (80 DAS) in the case of D_2 and D_3 transplanting whereas, D_1 received rain up to early reproductive phase i.e., 100 DAS (Fig. 3b).

RESULTS AND DISCUSSION

Above ground biomass

The above ground biomass production in cv. Pankhali in the first date of transplanting (D_1) were 14125 kg ha^{-1}, second date of transplanting (D_2) 16471 kg ha^{-1} and under third date of transplanting (D_3) 14948 kg ha^{-1} during the crop season 2007 (Table 2). The

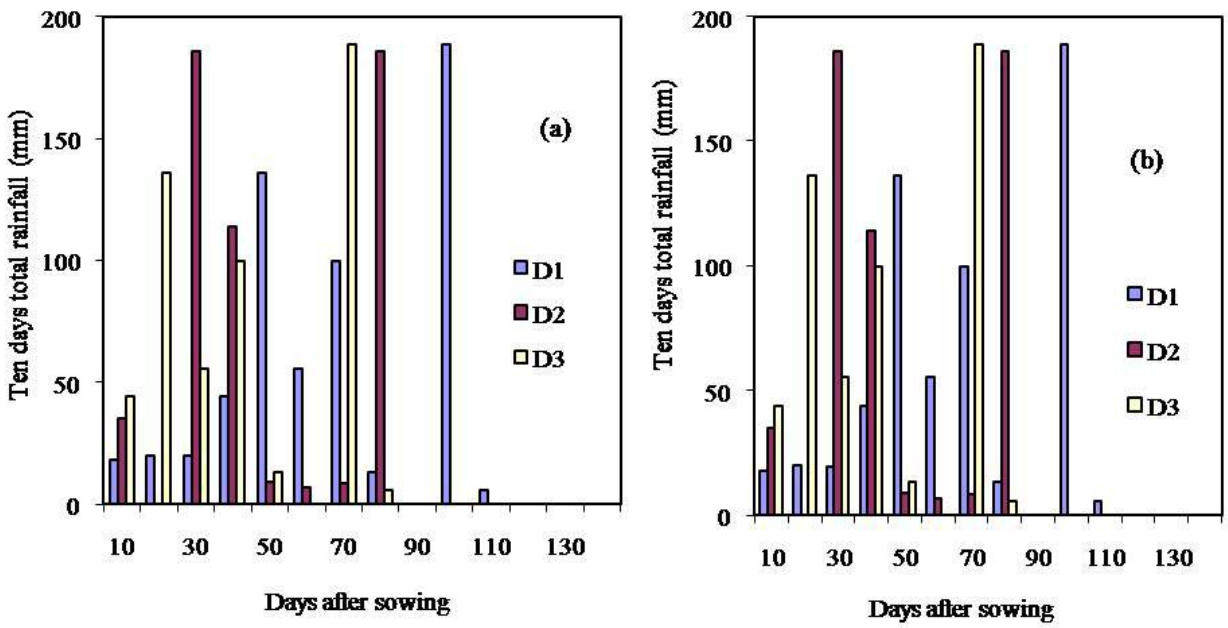

Fig. 3. Temporal variation in ten days total rainfall during crop growing period under different dates of transplanting in 2007 (a) and 2008 (b)

corresponding values of yields were 10918, 12688 and 11072 kg ha^{-1}, respectively in 2008. The above ground biomass in second year was lower than the first year but the trend was alike as that in the first year. The corresponding pooled values over two years were 12522, 14580 and 13010 kg ha^{-1}, respectively. D_2 transplanting yielded the highest (16471 kg ha^{-1} in 2007 and 12688 kg ha^{-1} in 2008) as compared to D_1 and D_3 transplanting. The results of the pooled above ground biomass over two years were also to be highest (14580 kg ha^{-1}) in D_2 transplanting compared with that recorded by the rest of the transplanting.

The above ground biomass production in cv. Narmada in the first date of transplanting (D_1) were 14965 kgha^{-1}, second date of transplanting (D_2) 16882 kg ha^{-1} and under third date of transplanting (D_3) 15656 kg ha^{-1} during the crop season 2007. The corresponding values of yields were 11783, 13451 and 11270 kg ha^{-1}, respectively in 2008. The above ground biomass production in second year was lower than the first year but the trend was alike as that in the first year. The corresponding pooled values over two years were 13374, 15167 and 13463 kgha^{-1}, respectively. D_2 transplanting yielded the highest (16882 kg ha^{-1} in 2007 and 13451 kg ha^{-1} in 2008) as compared to D_1 and D_3 transplanting. The results of the pooled above ground biomass production over two years were also to be highest (15167 kg ha^{-1}) in D_2 transplanting compared with that recorded by the rest of the transplanting.

The total above ground biomass production in cv. GR-104 in the first date of transplanting (D_1) were 16406 kg ha^{-1}, second date of transplanting (D_2) 20088 kg ha^{-1} and under third date of transplanting (D_3) 14975 kg ha^{-1} during the crop season 2007. The corresponding values of yield were 13658, 14672 and

Table 2. Effect of dates of transplanting on above ground biomass of four different cultivars of rice

Treatments		Above ground biomass(kgha^{-1})		
Cultivars	Dates of Transplanting	2007	2008	Pooled
Pankhali	D_1-8th July	14125	10918	12522
	D_2-22nd July	16471	12688	14580
	D_3-8th August	14948	11072	13010
Narmada	D_1-8th July	14965	11783	13374
	D_2-22nd July	16882	13451	15167
	D_3-8th August	15656	11270	13463
GR-104	D_1-8th July	16406	13658	15032
	D_2-22nd July	20088	14672	17380
	D_3-8th August	14975	11815	13395
Pusa Basmati-1	D_1-8th July	13136	12218	12677
	D_2-22nd July	15911	13868	14890
	D_3-8th August	12773	11176	11975

11815 kg ha^{-1}, respectively in 2008. The above ground biomass production in second year was lower than the first year but the trend was alike as that in the first year. The corresponding pooled values over two years were 15032, 17380 and 13395 kg ha^{-1}, respectively. D_2 transplanting yielded the highest (20088 kg ha^{-1} in 2007 and 14672 kg ha^{-1} in 2008) as compared to D_1 and D_3 transplanting. The results of the pooled above ground biomass production over two years were also to be highest (17380 kg ha^{-1}) in D_2 transplanting compared with that recorded by the rest of the transplanting.

The above ground biomass production in cv. Pusa Basmati-1 in the first date of transplanting (D_1) were 13136 kg ha^{-1}, second date of transplanting (D_2) 15911 kg ha^{-1} and under third date of transplanting (D_3) 12773 kg ha^{-1} during the crop season 2007. The corresponding values of yields were 12218, 13868 and 11176 kg ha^{-1}, respectively in 2008. The above ground biomass productions in second year were lower than the first year but the trend was alike as that in the first year. The corresponding pooled values over two years were 12677, 14890 and 11975 kg ha^{-1}, respectively. D_2 transplanting yielded the highest (15911 kg ha^{-1} in 2007 and 13868 kg ha^{-1} in 2008) as compared to D_1 and D_3 transplanting. The results of the pooled above ground biomass over two years were also to be highest (14890 kgha^{-1}) in D_2 transplanting compared with that recorded by the rest of the transplanting.

The Table 2 clearly showed that the highest above ground biomass productions were recorded by the genotype GR-104 among the four different cultivars of rice irrespective of dates of transplanting during both the crop seasons as well as on pooled data basis. It might be due to twin effects of longer vegetative phase which accumulated higher photosynthates in to dry matter from higher leaf area index and longer grain filling duration which added the more grain yield.

The overall trend of the above ground biomass production under different dates of transplanting was similar to that of grain as well as straw yields as it was the sum of the grain and straw yields. D_2 transplanting recorded highest above ground biomass production irrespective of cultivars during both the crop years and pooled basis. This result might be due to higher average bright sunshine hours (Fig. 2a and d) encountered by the crop in D_2 transplanting than that of D_1 in crop season 2007 and D_1 and D_3 in 2008 along with other congenial weather conditions which favoured higher grain yield and straw yield. The above ground biomass production in D_3 during 2007 might be offset by the lower crop duration. Munakata (1976) reported similar result for above ground biomass production in rice crop. Singh *et al.* (1996) reported that the yield variation explained by the relative humidity, air temperature and bright sunshine hours. Sarmah and Handique (2001) reported similar results and documented that weekly total rainfall, average weekly maximum temperature, average weekly bright sunshine hours, average weekly morning and evening relative humidity exhibited positive effects on rice yield. Patrohardjono*et al.* (1982) reported close correlation (r=0.739) between solar radiation during the ripening phase and the NAR which in turn affected dry matter production in rice crop.

Grain yield

The experimental results of grain yield of various cultivars of rice as influenced by different dates of transplanting are presented in Table 3. The grain yields of cv. Pankhali in the first date of transplanting (D_1) were 3075 kg ha^{-1}, second date of transplanting (D_2) 3725 kg ha^{-1} and under third date of transplanting (D_3) 3425 kg ha^{-1} during the crop season 2007. The corresponding values of yields were 2662, 3120 and 2747 kg ha^{-1}, respectively in 2008. The corresponding pooled values over two years were 2869, 3423 and 3086 kg ha^{-1}, respectively. D_2 transplanting yielded the highest (3725 kg ha^{-1} in 2007 and 3120 kg ha^{-1} in 2008) as compared to D_1 and D_3 transplanting. The results of the pooled grain yield over two years were also to be highest (3423 kg ha^{-1}) in D_2 transplanting compared with that recorded by the rest of the transplanting.

The grain yields of cv. Narmada in the first date of transplanting (D_1) were 3395 kg ha^{-1}, second date of transplanting (D_2) 4426 kg ha^{-1} and under third date of transplanting (D_3) 4400 kg ha^{-1} during the crop season 2007. The corresponding values of yields were 2924, 3215 and 2814 kg ha^{-1}, respectively in 2008. The corresponding pooled values over two years were 3160, 3821 and 3607 kg ha^{-1}, respectively. D_2 transplanting yielded the highest (4426 kg ha^{-1} in 2007 and 3215) as compared to D_1 and D_3 transplanting. The results of the pooled grain yield over two years were also to be highest (3821kg ha^{-1}) in D_2 transplanting compared with that recorded by the rest of the transplanting.

The grain yields of cv. GR-104 in the first date of transplanting (D_1) were 4665 kg ha^{-1}, second date of transplanting (D_2) 5820 kg ha^{-1} and under third date of transplanting (D_3) 4406 kg ha^{-1} during the crop season 2007. The corresponding values of yields were 3269, 3416 and 2859 kg ha^{-1}, respectively in 2008. The corresponding pooled values over two years were 3967, 4618 and 3633 kg ha^{-1}, respectively. D_2 transplanting yielded the highest (5820 kg ha^{-1} in 2007 and 3416 kg ha^{-1} in 2008) as compared to D_1 and D_3 transplanting. The results of the pooled grain yield over two years were also to be highest (4618 kg ha^{-1}) in D_2 transplanting compared with that recorded by the rest of the transplanting.

The grain yields of cv. Pusa Basmati-1 in the first date of transplanting (D_1) were 3575 kg ha^{-1}, second date of transplanting (D_2) 4655 kg ha^{-1} and under third date of transplanting (D_3) 3074 kg ha^{-1} during the crop season 2007. The corresponding values of yields were 2964, 3281 and 2920 kg ha^{-1}, respectively in 2008. The corresponding pooled values over two years were 3270, 3968 and 2997 kg ha^{-1}, respectively. D_2 transplanting yielded the highest (4655 kg ha^{-1} in 2007 and 3281 kg ha^{-1} in 2008) as compared to D_1 and D_3 transplanting. The results of the pooled grain yield over two years were also to be highest (3968 kg ha^{-1}) in D_2 transplanting compared with that recorded by the rest of the transplanting.

After examining the Table 3, it was very clear that the crop performed very well in crop season 2007 irrespective of dates of transplanting and genotypes than that of crop season 2008. It might be due to highly conducive weather condition prevailed during crop season 2007 than the crop season 2008 in terms of bright sunshine hours, wind speed, maximum temperature, amount and distribution of rainfall and mean vapour

Table 3. Effect of dates of transplanting on grain yields of various cultivars of rice

Treatments		Grain yield (kgha^{-1})		
Cultivars	Dates of Transplanting	2007	2008	Pooled
Pankhali	D_1-8th July	3075	2662	2869
	D_2-22nd July	3725	3120	3423
	D_3-8th August	3425	2747	3086
Narmada	D_1-8th July	3395	2924	3160
	D_2-22nd July	4426	3215	3821
	D_3-8th August	4400	2814	3607
GR-104	D_1-8th July	4665	3269	3967
	D_2-22nd July	5820	3416	4618
	D_3-8th August	4406	2859	3633
Pusa Basmati-1	D_1-8th July	3575	2964	3270
	D_2-22nd July	4655	3281	3968
	D_3-8th August	3074	2920	2997

pressure (Table 4.1). The average value of the daily bright sun shine hours were higher (6.4 h) in crop season 2007 than the crop season 2008 (5.8 h) which reflected in higher grain yields of all four cultivars of rice in all three dates of transplanting in crop season 2007 over the crop season 2008. Ramdoss and Subramaniam (1980) reported similar result and documented that the number of sunshine hours had positive effect on grain yield of rice. The higher average daily wind speed (4.7 kmph) might be grain yield reducing factor by affecting the flowering phase of the crop during crop season 2008 than the crop season 2007 (4.4 kmph). Viswambharan*et al.* (1989) reported the similar result and documented that excessive wind speed during flowering and maturation produces high spikeletsterility and low grain yield. The lower maximum temperature and higher mean vapour pressure and rainfall also might be conducive meteorological factors for higher grain yield in all treatments during crop season 2007 over the 2008. Singh *et al.* (1996) reported similar result during study of influence of agroclimatic elements on the grain yield of the rice. Agrawal*et al.* (1983) reported beneficial effect of humidity (vapour pressure) in general throughout the crop season on grain yield of rice. Bhargava*et al.* (1974) reported that the total rainfall during the crop season was highly correlated positively with yield of paddy. The genotype GR-104 gave the highest yield among the four different cultivars of rice irrespective of dates of transplanting during both the crop seasons as well as on pooled data basis. It might be due to dual effects of higher accumulation of photosynthates in to biomass from higher leaf area index during longer crop duration as well as longer grain filling duration.

The comparison of the results of grain yield during 2007 and 2008 separately as well as pooled basis revealed that differences in yield due to differences in the microenvironment created due to different dates of transplanting. Consistency in the best performance of the second date of transplanting was observed in all the four cultivars of aromatic rice and this was mainly attributed to more congenial weather that prevailed during this period as compared the weather that prevailed during the D_1 and D_3 transplanting. The prevalence of the lowest average maximum temperature in D_2 (31.4°C) during end of anthesis to beginning of grain filling (around100 DAS) in 2007 (Fig. 1a) crop growing season and 30.5 to 31.0°C during same crop phase i.e., around 90 DAS (as early anthesis was recorded in second crop year) during 2008 (Fig. 1d) for same transplanting helped in maximizing the grain yield. This result corroborated the findings of the Singh *et al.* (1996). The average minimum temperature in the second date of transplanting during both the years was the lowest viz., 17.5°C in 2007 (Fig. 1b) and 23.5°C in 2008 (Fig. 1e) in comparison with that which correspondingly prevailed in the treatments D_1 and D_3.

The lowest value of the average maximum temperature throughout the growing season and relatively low values of average minimum temperature during panicle initiation to beginning of grain filling of treatment D_2 proved themselves congenial for higher grain yield. The average mean temperature i.e., 25.9 and 27.4°C in 2007 (Fig. 1c) and 2008 (Fig. 1f) respectively, was also lower in D_2 in comparison to other date of transplanting during both the crop season. Considerably lower mean temperatures prevailed during the flowering and grain filling stages of the crop grown under D_2 and their beneficial effect was reflected in the grain yield during both the crop year. These results were in good agreement with the findings of Yoshida and Parao (1976) for the grain yield of rice. They reported that the relatively lower temperature during reproductive stage had remarkable effects on increasing spikelet number and hence grain yield. The highest yield of D_2 transplanting might be also due to more or less constant lower mean vapour pressure (Fig. 2c and f) and wind velocity encountered by the same date of transplanting during reproductive phase in both the crop year. These results highly strengthened the findings of the Agrawal*et al.* (1983) and Viswambharan*et al.* (1989) during the study of effects of humidity and wind speed on grain yield, respectively. Munakata (1976) had also reported similar result in the case of rice. Reddy and Reddy (1992) reported similar results and documented that grain yield was negatively correlated with maximum temperature and humidity (vapour pressure) during reproductive phase of the rice crop.Similar results were reported by Huda *et al.* (1975), Shi and Shen (1990), Samui*et al.* (1996), Singh *et al.* (1996), Samui (1999) and Nigam and Mishra (2003) for rice crop.

Conclusions

The data on yield had indicated that the individual treatment as well as different combinations of the treatments behaved consistently during both the seasons. Thus the task of ascertaining the most effective combination of treatments became quite simple.

Hence, on the basis of the data of two crop season on yield it was ascertained through visual scrutiny that the second date of transplanting (D_2)among all three dates of transplanting for all the four cultivars and genotype GR-104 among all the four aromatic cultivars of rice. viz., Pankhali (P 203), Narmada (Ambica), GR 104 and Pusa Basmati-1 could be reckoned as the optimum condition and high yielding respectively.

ACKNOWLEDGEMENTS

First author is grateful to the University Grants Commission (UGC),New Delhi to provide him financial assistance to carry out this experiment. He also acknowledge the help of the staffs of the Main Rice research Station, Nawagam and Department of Agricultural meteorology, Anand Agricultural University, Anand for their help and encouragement.

REFERENCES

Agrawal, R.; Jain, R.C. and Jha, M.P. (1983). Joint effects of weather variables on rice yield. *Mausam*, **34 (2):** 189-194.

Anonymous (2004).http://dacnet.nic.in/rice/Rice%20Export%20-%2004.htm

Anonymous (2006a).Rice.*Hand book of Agriculture*, ICAR publishers, New Delhi, India. pp. 817-844.

Anonymous (2007).http://indiabudget.nic.in/es2006-07/chapt2007/chap 83.pdf

Bhargava, P.N.; Pradhan, A. and Das, M.N. (1974).A study of the recurrence of rainfall deficiency in relation to rice crop.*J.N.K.V. Research Journal*, **8 (3-4):** 206-9.

Huda, A.K.S.; Ghildyal, B.P.; Tomar, V.S. and Jain, R.C. (1975).Contribution of climatic variables in predicting rice yield.*Agricultural Meteorology*, **15 (1):** 71-86.

Munakata, K. (1976). Effects of temperature and light on the reproductive growth and ripening of rice. International Rice Research Institute: Climate and rice. pp. 187-210.

Nigam, R. and Mishra, H.S. (2003).Effects of weather variables on rice in the Tarai Region.*Environment and Ecology*, **21 (3):** 645-648.

Patrohardjono, S.; Hendrik, V. and Ishikura, N. (1982).Effect of transplanting time on yield and yield components of rice. Contributions, Central Research Institute for Food Crops, Bogor, No. 66, pp. 13-20.

Ramdoss, G. and Subramaniam, S. (1980). Influence of weather parameters on rice yield. *Madras Agricultural J.* **67 (9):** 608-609.

Reddy, K.S. and Reddy, B.B. (1992). Correlation coefficients for crop weather relationships in rice. *J. Research*, APAU. **20 (1-2):** 85-87.

Samui, R.P. (1999). A note on the weather and rice yield relationship at some stations in India. Proceedings of the Indian Academy of Sciences, Earth and Planetary Sciences.**108 (4):** 309-316.

Sarmah, A.K. and Handique, B.K. (2001). Pre harvest forecasting of winter rice productivity: a yield weather parameters multiple regression approach. *J. Agricultural Science Society of North East India*, **14 (2):** 253-257.

Shi, C.H. and Shen, Z.T. (1990).Effect of high humidity and low temperature on spikelet fertility in indica rice.*International Rice Research Newsletter,* **15 (3):** 10-11.

Singh, A.K.; Rai, S.K.; Baghel, S.S. and Satri, R.A.S. (1996). Influence of Agroclimatic elements on the yield of rice at Raipur. *Mausam,* **47 (2):** 196-97.

Singh, P. and Virmani, S.M. (1996). Modelling growth and yield of chickpea (*Cicer arietinum* L.).*Field Crops Research*, 46: 41-59.

Viswambharan, K.; Rajaram, K.P.; Alexander, D.; Chinnamma, N.P. and Nair, N.R. (1989). Climatic constraints of high yielding photo insensitive winter rice in Kerala. *Current Science.* **58 (1):** 12-21.

Yoshida, S. and Parao, F.T. (1976).Climatic influence on yield and yield components of lowland rice in the tropics. International Rice Research Institute: Climate and rice. pp. 471-494.

J. Farming Systems Research & Development **20** (1) : 14-18 (2014)

EVALUATION OF GROUNDNUT IN KONKAN REGION OF MAHARASHTRA

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ABSTRACT

One of the major constraints of traditional farming is low productivity due to non-adoption of recommended package of practices and improved varieties. To replace this anomaly, ICAR,New Delhi sponsored all the four Krishi Vigyan Kendras from *Konkan* region of Maharashtra had conducted Front line demonstrations on various adopted farmers' fields. Front line demonstrations of different varieties at different locations showed accountable increase in yield over local check. The technology gap was more except variety SB-11 and TAG-24. It can be said that the full potential of the crops on farm thus remains untapped even though there is technology explosion in this fast changing world. According to the criterion, lower the value of the technology index more is the feasibility of the technology. In *rabi*-summer groundnut, variety TAG-24 is best followed by TG-26, *Konkan* Tapora, *Konkan* Gaurav and SB-11. Amongst the five groundnut varieties under study gross return from variety TAG-24 was highest (Rs.42,050/- per ha) followed by variety TG-26 (Rs.40,440/-) and *Konkan* Tapora (Rs.38,760/-) as compared to other varieties in *Konkan* region of Maharashtra.

Key words: Front line demonstrations, Technology gap, Extension gap, Technology index

India is the second largest producer of groundnut. The oil content of seed varies from 44 to 55 per cent, depending upon the varieties and agronomic conditions. Its oil finds extensive use as *vanaspati ghee*. It is also used in manufacturing soap, cosmetics and lubricants. Kernels are also eaten raw, roasted, salted or sweetened which is rich in protein as well as vitamins A and B.

India shares 22 per cent of the world production with an area of 5.26 million hectares and production of 6.96 million tonnes (GOI, 2012). Maharashtra state has an area of 0.24 million hectares during *kharif* and 0.07 million hectares during *rabi* under groundnut cultivation with production of 0.35 million tonnes. Average productivity of groundnut in the state is 1158 kg ha^{-1} (AICRPG, 2012).

In *Konkan* region of Maharashtra, groundnut is gaining popularity due to its high yield potential and its suitability under various cropping systems, where it is grown over an area of 1630 ha. with the average productivity of 1503 kg ha^{-1}, which is 27.23 and 34.67 per cent higher than the national and state productivity, respectively..

The agricultural technology is not generally accepted by the farmers completely in all respects. As such there always appears to be a gap between the recommended technology suggested by the scientist and its modified form at the farmer's level. The technological gap is thus the major problem in the efforts of increasing agricultural production in the country. A need of the day is to reduce the technological gap between the agricultural technology recommended by

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the scientist and its acceptance by the farmers on their field.

Keeping in view the significance of transfer of technology in groundnut, the present investigation attempts to study the yield gaps between potential yield, front line demonstration trials and farmers' yield, extent of technology adoption and benefit cost ratio.

Materials and Methods

The study was conducted in *Konkan* region of Maharashtra during the year 2008 to 2010. The data on output of different varieties of groundnut and inputs used per hectare have been collected from the front line demonstrations conducted by the entire four KVKs of *Konkan* region. In addition to this, data on traditional practices followed by farmers have also been collected. In the present study, technology index was operationally defined as the technical feasibility obtained due to implementation of front line demonstrations in groundnut. To estimate the technology and extension gap and technology index following formulae given by Sharma and Sharma (2004) have been used:

1. Technology gap = Pi (Potential yield) – Di (Demonstration yield)

2. Extension gap = Di (Demonstration Yield) – Fi (Farmers yield)

3. Technology index = $\frac{Pi - Di}{Pi} \times 100$

Where,

Pi =Potential yield of the crops

Di =Demonstration yield of the crops

Fi = Farmers yield

Results and Discussion

The description of Table 1 and Table 2 is summarized under following heads.

Technology gap and extension gap

The technology gap was due to non-transferable technologies such as recommended plant population per hectares and environmental differences between Research station and KVK focal village. The extension gap was due to resource-cum-management-cum-extension efforts. It is difference between the yield obtained due to adoption of technology in demonstration plot and yield obtained from traditional method of cultivation.

Yield of the Front Line Demonstrations (FLDs) and potential yield of the respective crop varieties were compared to estimate the yield gap which was further categorized into technology gap and extension gap as given in Table 1 and 2.

Data presented in Table 1 showed that, in *kharif* groundnut, the technology gap was highest in case of variety TG-26 (7.32 q ha^{1}) and lowest in variety TAG-24 (5.30 q ha^{1}). The extension gap was highest in TG-26 variety (4.90 q ha^{1}) and lowest in variety Konkan Gaurav (2.53 q ha^{1}). In case of TG-26 variety, it is observed that the technology gap was highest (7.32 q ha^{1}) in Sindhudurg district, whereas, extension gap was highest (4.90 q ha^{1}) in Ratnagiri district.

It is seen from Table 2 that in *rabi-summer* groundnut the technology gap was highest (6.00 q ha^{1}) in case of variety TG-26 and lowest (0.15 q ha^{1}) in variety TAG-24. Regarding variety TAG-24, it is seen that the technology gap was less than 3.0 q ha^{1} in Thane and

Table 1. Technology gap, Extension gap and Technology index for different varieties of groundnut in *kharif* season

Crop/ variety	Year	Location (District)	No. of Demo	Yield(q/ha) Potential	Demo	Farmers field	% increase in yield over farmers field	Technology gap (kg ha1)	Extension gap (kg ha1)	Technology index (%)
TG- 26	2008-09	Sindhudurg	10	25.00	17.68	13.00	36.00	7.32	4.68	29.28
TG- 26	2008-09	Ratnagiri	13	25.00	19.70	14.80	33.10	5.30	4.90	21.20
TAG-24	2009-10	Sindhudurg	15	22.00	16.74	12.41	34.89	5.26	4.33	23.91
Konkan Gaurav	2009-10	Ratnagiri	12	20.00	14.83	12.30	20.57	5.17	2.53	25.85
Avg	-		**50**	**23.00**	**17.23**	**13.12**	**31.32**	**5.77**	**4.11**	**25.08**

Table 2. Technology gap, Extension gap and Technology index for different varieties of groundnut in *rabi-summer* season

Crop/ variety	Year	Location (District)	No. of Demo	Yield(q/ha) Potential	Demo	Farmers field	% increase in yield over farmers field	Technology gap (kg ha1)	Extension gap (kg ha1)	Technology index (%)
TAG-24	2008-09	Sindhudurg	10	22.00	19.30	15.15	27.39	2.70	4.15	12.27
TAG-24	2008-09	Thane	10	22.00	20.20	15.90	27.04	1.80	4.30	8.18
TG- 26	2008-09	Sindhudurg	05	25.00	22.20	15.00	48.00	2.80	7.20	11.20
TG- 26	2008-09	Ratnagiri	13	25.00	19.00	14.80	28.38	6.00	4.20	24.00
TG- 26	2008-09	Raigad	10	25.00	19.70	14.32	37.56	5.30	5.38	21.20
SB-11	2008-09	Raigad	05	18.00	17.20	14.60	17.80	0.80	2.60	4.44
Konkan Gaurav	2008-09	Ratnagiri	12	20.00	17.00	13.79	23.28	3.00	3.21	15.00
TAG-24	2009-10	Sindhudurg	10	22.00	21.65	16.00	34.47	0.35	5.65	1.59
TAG-24	2009-10	Thane	15	22.00	21.85	16.10	35.71	0.15	5.75	0.68
Konkan Tapora	2009-10	Raigad	10	22.00	19.40	13.80	40.57	2.60	5.60	11.82
Avg			100	22.30	**19.75**	**14.95**	**32.19**	**2.55**	**4.80**	**11.04**

Sindhudurg district which is very much satisfactory. Same kind of result was obtained in case of variety SB-11 from Raigad district. In case of performance of variety TG-26 in Ratnagiri and Raigad district, technology gap was observed 6.00 q ha1 and 5.30 q ha1, respectively. More values of technology gap emphasize the need to conduct front line demonstrations more critically.

The extension gap was highest (7.20 q ha1) in variety TG-26 and lowest (2.60 q ha1) in variety SB-11 followed by variety Konkan gaurav (3.21 q ha1). At almost all the locations the extension gap of different oilseed varieties was between 4.15 q ha^{1} to 7.20 q ha^{1} which means there is wide gap in adoption of improved technology.

Thus, the data presented in Table 1 and 2 revealed that the technology gap was more except variety SB-11 and TAG-24.

The reason accountable for this is the partial or non-adoption of certain recommended package of practices like seed treatment, proper sowing method and application of copper sulphate, lime and intercultural operations even on the demonstration fields. This calls for critical monitoring of front line demonstrations so that the potential farm yield of the crops can be realized.

Technology Index

In this study, for ascertaining feasibility of evolved oilseed technology at the farmer's field, technology index was calculated. The criteria is lower the value of technology index more is the feasibility of the technology.

Data presented in Table 1 observed that technology index was highest (29.28 per cent) in *kharif* groundnut variety TG-26 followed by Konkan Gaurav (25.35%), TAG-24 (23.91 %) and TG-26 (21.20%) from Ratnagiri location. This indicates that in demonstrated groundnut varieties a wide gap exist between technology evolved at Research Station and farmers' field. Hence, according to criterion, TG-26 is best in *kharif* season at Ratnagiri location.

A perusal of Table 2 revealed that, in *rabi-summer* groundnut the technology index was highest (24.00%) in variety TG-26 in Ratnagiri district followed by variety TG-26 (21.20%) and Konkan Gaurav (15.00%) in location Raigad. The lowest viz. 0.68 per cent and 1.59 per cent technology index was observed in variety TAG-24 cultivated in Thane and Sindhudurg district, respectively. This might be due to good climatic conditions and proper implementation of demonstration programme. Further, lower technology index values were seen in variety SB-11 (4.44 per cent), TG-26 (11.20 per cent) and Konkan Trombay Tapora (11.82 per cent).

Hence, according to the criterion, in *rabi-summer* groundnut variety TAG-24 is best followed by SB-11, TG-26, Konkan Tapora and Konkan Gaurav in *Konkan* region of Maharashtra.

The findings are in line with the findings of Sharma and Sharma (2004), Singh *et al.* (2007), Hiremath *et al.* (2009) and Biplab and Samajdar (2010).

Comparison of input cost and returns

The comparative profitability of different groundnut varieties has been studied by estimating input cost, total cost, gross returns, net returns and benefit cost ratio and depicted in Table 3.

From Table 3, it is seen that cost of cultivation of all improved varieties was nearly equal. Amongst the five groundnut varieties under study, gross return from variety TAG-24 was highest (Rs.42,050/- per ha) followed by variety TG-26 (Rs.40,440/-) and Konkan Trombay Tapora (Rs.38,760/-) as compared to other varieties. The benefit cost ratio of variety TAG-24 and TG-26 was 1.72 and 1.58, respectively. However, benefit cost ratio of SB-11 and Konkan Tapora was found nearly equal. The adoption of recommended practices in front line demonstrations on

Table 3. Cost and returns of different groundnut varieties

Rice variety	**Input cost (Rs ha^{1})**	**Total cost (Rs ha^{1})**	**Gross returns (Rs ha^{1})**	**Net returns (Rs ha^{1})**	**Benefit: cost ratio**
TAG-24	19200	24450	42050	17600	1.72
SB-11	19000	24600	37140	12540	1.51
TG-26	19500	25600	40440	14840	1.58
Konkan Tapora	20000	25500	38760	13260	1.52
Konkan Gaurav	20000	25300	34150	8850	1.35

groundnut has increased the yield over the respective check (control) varieties. These findings are in line with the findings of Sharma and Sharma (2004) and Singh *et al.* (2007).

Conclusions

The findings of the study revealed that front line demonstrations of different varieties showed accountable increase in yield over local check. There was wide gap existed in potential and demonstration yield in *kharif* season as compared to *rabi-summer* season. Technology gap was found more (5.77 q ha^{1}) in *kharif* season whereas, it was less (2.55 q ha^{1}) in *rabi-summer* season. However, extension gap was found more than 4.00 q ha^{1} in both the seasons. This means that the full potential of the varieties on-farm remains untapped even though there is technology explosion in this fast changing world. Therefore, continuous monitoring and technical guidance is required for demonstrating farmers to bridge the adoption and yield gap.

References

AICRPG. 2012. Annual Report (*kharif* 2012), All India Co-ordinated Research Project on Groundnut, Directorate of Groundnut Research, Junagadh (Gujarat).

Biplab and Samajdar. 2010. Yield gap analysis of rapeseed-mustard through front line demonstration. *Agril. Extension Review* Vol. **12(6)**: 16-17.

GOI. 2012. Economic Survey 2011-12. Government of India, Ministry of Finance, Department of Economic Affairs, Economic Division. New Delhi.

Hiremath *et al.* 2009. Evaluation of front line demonstration trials on onion in Haveri district of Karnataka. *Karnataka J. Agri. Sci.*, **22 (5)**:1092-1093.

Sharma, R.N. and K.C. Sharma. 2004. Evaluation of front line demonstration trials on oilseeds in Baran district of Rajasthan. *Madhya Journal of Extension Education*. Vol.VII. pp.72-75.

Singh *et al.* 2007. Impact of New Technologies on Soybean at Farmers' Field. *Indian Res. J. Ext. Edn.* **7 (1)**: 39-40.

J. Farming Systems Research & Development **20** (1) : 19-23 (2014)

BIO-EFFICACY OF INSECTICIDES AGAINST COTTON PESTS AND PATHOGENS

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ABSTRACT

Major constraint in attaining high production of seed cotton is damage inflicted by insect pests. Newer chemistries of pesticides have raised the hopes for better management of dreaded pest worldwide. Therefore, an attempt was made to study the comparative efficacy of new group of insecticides against bollworms in cotton crop. The ravages of cotton bollworm are known to cause total crop failures in various regions where farmers are becoming victims of pest menace resulting in socio economic calamities, now and then. Thus, new group of insecticides proved their efficacy against cotton bollworm with highest seed cotton yield. Thus, insecticides (Spinosad, Indoxacarb and Profenophos) could be deployed for effective pest management.

INTRODUCTION

Cotton is of utmost importance to developing countries. Cotton constitutes more than 70% of the total world consumption of fibres. Besides being a major natural fibre crop, cotton also provides edible oil and seed by-products for livestock food. On about fifty species of cotton plants within the world only four are domestically cultivated for their fibres. The most commonly cultivated species of cotton in the world include *Gossypium hirsutum* and *Gossyspium barbadense*. *Gossypium hirsutum* L. is widely grown, since it has a very high adaptability and rich diversity for yield and yield related morphological and physiological characters. Cotton is unanimously designated as "King of fibres" as it tops the table depicting the statistics of fibre crops. As a leading commercial crop it is grown world wide India occupies largest area and third place in the production of cotton in the global scenario. Major constraint in attaining high production of seed cotton is damage inflicted by insect pests. The pest spectrum of cotton is quite complex and as many as 200 species of insects have been reported to attack cotton at different stages of crop growth in India (Anon., 1981) of which bollworm complex consisting of three notorious bollworms, *Helicoverpa armigera* Hub. (American bollworm) *Earias vittella* Fab. Spotted bollworms) and *Pectinophora gossypiella* Sau. (Pink bollworm) are considered to be great enace. Generally, the pest management problems are associated with resistance of *H. armigera* to various groups of insecticides translating into poor pest control and subsequent crop failure. The ravages of cotton bollworm are known to cause total crop failures in various regions where farmers are becoming victims of pest menace resulting in socio economic calamities, now and then. The most commonly used insecticides like Monocrotophos, Endosulfan, Quinalphos and Cypermethrin form the major insecticides share used in cotton plant protection. Reports of high level of resistance to these conventional insecticides in *H. armigera* and other

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pests of cotton (Kranthi *et al.*, 2001 and Ramsubramanian, 2004) have resulted in renewed interest in the farmers for using new group of insecticides available in the market. Newer chemistries of pesticides have raised the hopes for better management of dreaded pest world wide. Therefore, an attempt was made to study the comparative efficacy of new group of insecticides against bollworms in cotton crop.

MATERIAL AND METHOD

The present investigation was carried out at Institute of Science, Nagpur University, Nagpur during *kharif* 2006-07 and 2007-08 under rainfed conditions. The design of the experiment was laid out in Randomized Block Design (RBD) replicated thrice with plot size of 5.4 x 5.4 sq. m. for both years. The popular cotton hybrid DHH-11 was sown at a spacing of 90 x 60 cm.

All recommended agronomic practices were followed during the experimentation for proper crop management. The treatments included in the present study were 1) Spinosad 48SC @ 50gai/ha 2) Indoxacarb 15SC @ 75gai/ha 3) Endosulfan 35EC @ 875gai/ha 4) Chlorpyriphos 20EC @ 600 gai/ha 5) Profenophos 50 EC @ 1000 gai/ ha 6) Quinalphos 25 EC @ 500 gai/ ha 7) Cypermethrin 25 EC @ 60 gai/ ha 8) Untreated check (UTC). Total of six sprays were given based on ETL (one larvae per plant). Observations on number of *Helicoverpa* larvae per plant, fruiting body damage (%), number of good opened bolls (GOB) and bad opened bolls (BOB) were recorded before and after application of insecticides.

Table 1. Bio efficacy of new group of insecticides against cotton bollworms (2006-07)

Treatments	Dosage g a.i/ha	*Helicoverpa* larvae/ plant	Damage to fruiting bodies(%)	GOB /plant	BOB /plant	Yield (q/ha)
Spinosad 48 SC	50	1.42	19.84	20.98	1.88	19.20
Indoxacarb 15 SC	75	1.45	20.89	18.92	1.98	19.78
Endosulfan 35 EC	875	2.59	27.72	18.24	4.09	12.56
Chlorpyriphos 20EC	600	2.39	26.21	15.59	4.79	11.68
Profenophos 50 EC	1000	1.81	23.89	17.88	3.48	12.85
Quinalphos 25 EC	500	2.11	24.95	16.09	3.88	11.89
Cypermethrin 25 EC	60	2.41	28.15	13.87	5.31	11.01
U.T.C	-	3.31	32.39	8.95	10.87	7.95
SEm±	-	0.13	0.88	0.97	0.21	0.62
CV (%)	-	11.35	18.31	9.48	12.69	13.40
CD 5%	-	0.45	2.59	2.69	0.72	1.85

Table 2. Bio efficacy of new group of insecticides against cotton bollworms (2007-08)

Treatments	Dosage g a.i/ha	*Helicoverpa* larvae/ plant	Damage to fruiting bodies(%)	GOB /plant	BOB /plant	Yield (q/ha)
Spinosad 48 SC	50	0.45	8.92	18.29	1.25	14.02
Indoxacarb 15 SC	75	0.59	8.99	16.21	1.37	11.98
Endosulfan 35 EC	875	1.95	18.36	9.65	4.56	7.18
Chlorpyriphos 20EC	600	2.24	12.45	8.17	3.68	8.48
Profenophos 50 EC	1000	1.18	11.09	13.48	1.73	11.84
Quinalphos 25 EC	500	1.12	12.02	12.57	2.28	11.65
Cypermethrin 25 EC	60	1.33	16.27	11.86	2.89	10.19
U.T.C	-	2.65	29.02	4.29	6.87	4.87
SEm±	-	0.16	2.14	0.98	0.22	0.92
CV (%)	-	17.08	24.59	18.41	11.90	14.21
CD 5%	-	0.46	6.48	2.75	0.59	2.33

Results and Discussion

The average value of these observations has been subjected for statistical analysis to assess the overall impact on pest suppression and seed cotton yield. The data representing the efficacy of insecticides against bollworm incidence and yield has been presented in table 1 and 2 and Graphs 1 and 2. Indoxacarb @ 75 gai/ ha and Spinosad @ 48 SC @ 50 gai/ ha were found equally effective by registering significantly lowest larval population of 1.42 and 1.45 larvae/ plant respectively followed by Profenophos 50 EC @ 1000 gai/ ha (1.81 larvae/ plant) and Quinalphos 25EC @ gai/ ha (2.11 larvae/ plant) during 2005-06 and 2006-07. Significantly lowest percent of fruiting body damage was noticed in the treatment Spinodad 48 SC and Indoxacarb 15 SC (19.84 and 20.89 % respectively) compared to other treatment.

However, these treatments were followed by Profenophos 50 EC (23.89 %) and Quinalphos 25 EC (24.95%) but both were on par with each other. The two treatments Indoxacarb 15 SC and Spinosad 48 SC occupied top positions by registering maximum number of good opened bolls (18.92 and 20.98 bolls/ pant) as against untreated check (8.95 bolls /plant) and were at par with each other followed by Profenophos 50 EC and Endosulfan 35 EC. The next best is Quinalphos 25 EC and was on par with Chlorpyriphos 20EC. Significantly minimum number of bad opened bolls of 1.88 and 1.98 bolls per plants registered with Spinosad 48 SC and Indoxacarb 15 SC respectively as against 10.87 bolls per plant in untreated check, indicating superiority of the treatments which were followed by the Profenophos 50 EC, Quinalphos 25 EC and Endosulfan 35 EC. The treatments Spinosad 48 SC and Indoxacarb 15 SC were proved to be equally effective by recording higher yield of 19.20 and 19.78 q/ ha respectively followed by Profenophos 50 EC (12.85 q/ ha). Quinalphos 25 EC and Endosulfan 35 EC were next best treatments. The lowest yield was observed in untreated check (7.95 q/ ha).

During 2005-06, the incidence of bollworm was generally low compared to previous season but the trend in results was strikingly similar to that of previous season. The incidence of *Helicovpera* larvae maximum in untreated check with 2.65 larvae/ plant. However, the incidence was low in Spinosad 48 SC with 0.45 larvae/ plant followed by Indoxacarb 15 SC, Profenophos 50 EC and Quinalphos 25 EC with 0.59, 1.18 and 1.12 larvae/ plant respectively also with Spinosad 48 SC. Similarly lower incidence of bollworm was obtained with Spinosad and Indoxacarb (0.3 and 0.4 larvae/ plant at 7 days after treatment respectively) as reported by Patil *et al.*, (2004) who recorded lowest larval population of *Helicoverpa* with Spinosad 75 gai/ ha and 50 gai/ ha and Vadodaria *et al.*, (2000) and Russell, D.A and Kranthi, K.R. (2006) on Profenofos 50 EC.

The difference among the different insecticides in respect of fruiting body damage, GOB, BOB and yield were statistically significant in both years. Again in 2005-06, Spinosad 48 SC and Indoxacarb 15 SC were found to be equally superior by registering lowest fruiting body damage of 8.92 and 8.99 per cent respectively as against 29.02 per cent in untreated check followed by Profenophos 50 EC (11.09 per cent) and Quinalphos 25 EC (12.02 per cent). The next best were Chlorpyriphos 20 EC (12.45%), Cypermethrin 25 EC and Endosulfan 35 EC. Significantly maximum number of good opened bolls were obtained in the treatment Spinosad 48 SC (17.89 bolls/ plant) followed by Indoxacarb 15 SC (16.21 bolls/ plant). The Profenophos 50 EC, Quinalphos 25 EC and Cypermethrin 25 EC were the next best treatments. Where as Spinosad 48 SC was superior by registering significantly least bad opening of bolls (1.25 BOB / plant) followed Indoxacarb 15 SC (1.37 BOB/ plant) and Profenophos 50 EC (1.73 BOB / plant) and were comparable with each other and also with Spinosad 48 SC. Spinosad 48 SC remained superior with an highest yield of 14.02 as against 5.08 q/ ha in untreated check. Which was followed by Indoxacarb 15 SC (11.98 q/ha) and Profenophos 50 EC (11.84 q/ha) and were par with each other and with Spinosad 48 SC. The next best was Quinalphos 25 EC. The Chlorpyriphos 20 EC and Endosulfan 35 EC were inferior to other treatments. The present findings are in accordance with reports of Patil *et al.*, (2004) who noticed the efficacy of Spinosad and Indoxacarb 15 SC against boll worm and higher seed cotton yield. Similarly Vadodaria *et al.*, (2001) and Dandale *et al.*, (2000) reported on superiority of Spinosad against bollworm and Dhawan and Simwat (2000) on efficacy of Indoxacarb 15 SC against bollworm and Profenophos 50 EC (Vadodaria *et al.* 2000).

Thus, new group of insecticides proved their efficacy against cotton bollworm with highest seed cotton yield. As derivative marine Actinomycetes *Macropolyspora spinosa* Spinosad has been considered to be component of IPM programme apart from its proven bio-efficacy. Indoxacarb belongs to oxydiazinon a new chemical group of pests has novel mode of action to offset the resistance problem (Gunning and Devonshire, 2002). Thus, these two insecticides could be deployed for effective pest management. Though Profenophos belongs to organophosphate group its ovicidal property would be an added advantage.

References

Anonymous, 1981, The bio method in cotton fields. *Zaschita Rastenii at Vredeletlic Holezemi,* **8**: 4-6.

Dandale, H.G., Tikare, S.N., Rao, N.G.V. And Nimbalkar, S.A., 2000, Efficacy of spinosad against cotton bollworms in comparison with some synthetic pyrethroids. *Pestology,* **24** : 6-10.

Dhawan, A.K. And Simwat, G.S., 2000, Evaluation of Indoxacarb for the control of bollworm complex and its impact on population of sucking pests and beneficial arthropods in cotton ecosystem. *Pestology*, **24** : 15-20.

Gunning, R. V. And Devonshire, A.L., 2002, Negative cross resistance between indoxacarb and pyrethroids in Australian *Helicoverpa armigera* : a tool for resistance management. *Resistant Pest Management,* **11**: 52

Kranthi, K.R. Jadhav, D.R. Wanjari, R.R., Shakir Ali And Russell, D., 2001, Carbamate and organophosphate resistance in cotton pests in India ; 1995 to 1999. *Bulletin of Entomological Research,* **91**: 37- 46

Patil, S.S., Nemade, P.W., Siddhabatti, P.M. And Wadaskar, R.M., 2004, Comparative efficacy of representative insecticides against cotton bollworm, *H.armigera* (Noctuidae: Lepidoptera). *Pestology,* **28** :32-36.

Ramasubramanian, T., 2004, Magnitude, mechanism and management of pyrethroids resistance in *Helicoverpa armigera* (Hubner) in India. *Journal of Entomology,* **1** : 6-11

Russell, D.A and Kranthi, K.R. (2006).Global status of insecticide resistance mechanisms in the cotton bollworm Helicoverpa armigera.J.Indian Soc.Cotton Improv, 119-128.

Russell, D.A and Kranthi, K.R. (2006). Improved cotton bollworm control in small scale production systems. ICAC special issue, September 2006. pp 20-26.

Slosser, J. E., W. E. Pinchak, and D. R. Rummel. 2000. Population development and regulation of the cotton aphid, pp. 649-651. *In* Proceedings 1992 Beltwide Cotton Conf., National Cotton Council, Memphis, TN.

Vadodaria, M.P., Maisuria, I.M., Patel, J.R., Patel, R.B., Patel, C.J. And Patel, U.G., 2000, Management of cotton bollworms with newer insecticides for sustainable cotton yield. *Pestology*, **24** : 2-5.

Vadodaria, M.P., Patel, U.G., Maisuria, I.M., Patel, C.J. And Patel R.B., 2001, Bio efficacy of a new insecticide. Spinosad against bollworm of cotton. *Pestology*, **25** : 24-28.

J. Farming Systems Research & Development **20** (1) : 24-28 (2014)

INTER-RELATIONSHIPS AMONG PHYSIOLOGICAL ATTRIBUTES, GRAIN YIELD AND ITS COMPONENTS IN BREAD WHEAT

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Abstract

Correlation and path-coefficient analyses were studied for 13 characters related to physiological behaviour, grain yield and its components in bread wheat (*T. aestivum* L.). Grain yield had significant positive correlation with biological yield, harvest index and productive tillers/plant. The relationship between biological yield and harvest index was significant negative. Harvest index had significant positive association with productive tillers, grain filling period, while it had significant negative correlation with days to flowering and plant height. The negative association of both flowering and plant height with harvest index and grain yield indicated the chances for selection of early and dwarf statured plant types with high grain yield in the present set of material. Path-coefficient study indicated that biological yield followed by harvest index and productive tillers had very high direct effects on grain yield. Most of the yield contributing characters affected grain yield indirectly through harvest index. More emphasis during selection for high grain yield should be given on harvest index followed by biological yield and productive tillers.

In physiological efficient plant types, dry matter accumulation and its partition into grain and residual plant parts will help to convert maximum solar and soil energy in the form of biological energy and ultimately more productivity. Harvest index is the ratio between grain yield and biological yield and the latter described it as a measure of partitioning of photosynthates (Donald, 1968). For simultaneous improvement in biological yield and harvest index, The knowledge of inter-relationship among them and other related characters is essential. Due to the availability of more variables, it is necessary to assess the direct and indirect effects of these traits on grain yield. Therefore, the present study was undertaken to study correlation and path-coefficients in respect of physiological attributes, grain yield, its components traits in bread wheat.

Materials and Methods

Twenty eight single crosses derived from 8 parent diallel cross in wheat, were grown in a completely randomized block design with three replications during winter 2003-04 at Belatal. Each entry was accommodated in double rows plot of 3 m length with 30 and 15 cm spacing between and within rows, respectively. Observations were recorded on 13 metric traits viz., flag leaf area (FLA), synchrony of tillering (ST), days to flowering (DF), grain filling period (GFP), plant height (Pht.) length of spike (LS), number of grains per spike (GS), weight of grains per spike (W/S), number of productive tillers (PT), 1000-grain weight (GW), harvest index (HI), biological yield (BY) and grain yield/plant (G/Y). Correlations were workedout following Robinson *et al.* (1951) and path-coefficient by Dewey and Lu (1959).

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Results and discussion

The material in the present study showed a wide range of variation for all the 13 characters under study as indicated by their significant mean square values. Correlation study indicated that grain yield had significant positive association with biological yield, harvest index and productive tillers, and just positive with grain filling period, weight of grains/spike and 1000-grain weight. Singh *et al.* (2004, 2007 & 2010) had also reported positive association of productive tillers, biological yield and harvest index with grain yield in bread wheat.

The association between harvest index and biological yield was significant negative. Similar were the findings of Singh *et al.* (2010) in bread wheat. Grain yield has also been reported as the results of productive tillers, grain weight and grain filling period (Singh *et al.* 2010). But the results of the present study showed significant positive association of productive tillers with grain yield, but there were found week associations of grain weight and grain filling period with grain yield. It is imperative that some varieties do reach the desired level of grain filling period and grain weight of grain, but fail to maintain the productive tillers and vise-versa. Week associations of these traits with grain yield suggest the existence of high competition among these traits. More number of productive tillers may achieved at the expense of succeeding yield components. Due to component compensation an increase in one component nullified the effects of other yield components.

Number of grains per spike showed high positive association with weight of grains/spike, weight of grains/spike also had positive association with 1000- grain weight, and the latter was positively associated with long duration of grain filling period, which in turn had positive association with harvest index. Thus, the final yield of grains/spike in wheat is determined by the weight of grains, how much it contains. The weight attained by any grain depends upon the grain filling duration, rate of supply of assimilates to the grains and rate of incorporation of these into its structure form, from anthesis to seed formation. Improvement in harvest index represents increased plant capacity to mobilize photosynthates and translocate it to organs having economic value. These clarification are inagreement with the results of present findings. On the other hand number of productive tillers was associated positively with harvest index and grain yield but had no association with other yield component characters. It further indicated high competition among the yield component traits. Thus harvest index was proved to be an important middle indicator during selection for enhancement of grain yield.

Plant height, days to flowering, synchronous tillering and biological yield had negative association with harvest index. Earlier studies showed that harvest index might be increased through introducing dwarfing genes that reduced plant stature and decreased stem and sheath dry weight with early flowering. On the other hand plant height and days to flowering had positive association with biological yield and the latter was highly correlated with grain yield.

Therefore, in the genotypes tested during present study, some of the semi dwarf genotypes were capable of

Table 1. Phenotypic (P) and genotypic (G) correlations among 13 characters in bread wheat

Characters	FLA	ST	DF	GFP	PH	LS	GS	WS	PT	GY	BY	HI	GW
FLA	-	0.07	-0.13	-0.05	0.36*	0.43*	0.10	0.20	0.35	0.10	-0.05	0.18	0.18
ST	0.07	-	-0.03	0.12	0.34	0.26	-0.09	-0.09	-0.09	-0.33	-0.02	-0.46*	-0.02
DF	-0.013	-0.04	-	-0.90**	0.28	0.17	0.26	-0.05	-0.12	-0.07	0.21	0-.46*	-0.53*
GFP	0.02	-0.12	-0.94	-	-0.32	-0.30	-0.31	-0.06	0.09	0.12	-0.12	0.39*	0.47*
PH	0.42	0.44	0.33	-0.35	-	0.57**	-0.05	0.14	-0.13	-0.14	0.11	-0.39*	0.15
LS	0.49	0.39	0.26	-0.37	0.74	-	0.06	0.20	0.04	-0.18	0.00	-0.28	0.18
GS	0.11	-0.13	0.38	-0.46	-0.01	0.21	-	0.63*	-0.05	0.06	0.08	-0.04	0.06
WS	0.26	-0.14	-0.06	-0.10	0.20	0.36	0.65	-	-0.10	0.17	0.09	0.07	0.42*
PT	0.44	-0.06	-0.17	0.10	-0.16	0.06	-0.09	-0.11	-	0.42*	-0.20	0.44*	-0.19
GY	0.09	-0.37	-0.07	0.12	-0.14	-0.12	0.11	0.23	0.47	-	0.77**	0.47	0.19
BY	-0.06	-0.03	0.23	-0.12	0.11	0.00	0.12	0.14	-0.19	0.77	-	-0.36*	0.13
HI	0.18	-0.51	-0.48	0.41	-0.41	-0.34	-0.01	0.16	0.48	0.38	-0.35	-	0.13
GW	0.20	-0.04	-0.58	0.51	0.14	0.26	-0.02	0.60	-0.20	0.21	0.15	0.15	-

*Significant at 5%

**Significant at 1

producing at least much dry weight. Austin *et al.* (1980) had reported that semi dwarf cultivars tended to have more dry matter accumulation in the grains at all stages of grain filling period. Therefore, biological yield was highly associated positively with grain yield and negatively with harvest index.

Direct and indirect effects of different characters (Table 2) on grain yield indicated that biological yield followed by harvest index had high positive direct effects on grain yield. Singh *et al.* (2007, 2010) also reported similar finding in bread wheat. These traits had negative indirect effects via each other and had negligible indirect effect through all the other traits and thus produced net direct influence on grain yield.

The characters number of productive tillers and grain filling period had considerable positive indirect effects via harvest index on grain yield. However, only productive tillers had significant positive correlation within grain yield, which was contributed to some extent directly and more indirectly through harvest index. The positive indirect effect of grain filling period through harvest index was nullified by negative indirect effects via biological yield, and thus grain filling period produced week association with grain yield. Similarly positive indirect effects via biological yield for days to flowering, plant height and number of grains for spike were also nullified by negative indirect effects via harvest index, which resulted week association of these traits with grain yield. Although, weight of grains per spike and 1000-grain weight had positive indirect effects through both biological yield and harvest index, however, the values were not as much to reach the

Table 2. Direct and indirect effects of different characters in bread wheat

Characters		FLA	ST	DF	GFP	Pht	LS	G/S	W/S	PT	GW	BY	HI	G/Y	Genotypic correlation with grain yield	Genotypic correlation with H.I.
FLA	a	0.01	0.01	0.00	0.02	0.01	0.01	-0.01	-0.01	-0.02	0.01	-0.06	0.13	-	0.10	-
	b	-0.02	0.01	0.00	0.01	-0.01	-0.02	-0.02	-0.02	0.01	-0.01	0.09	-	0.12	-	0.18
ST	a	0.01	-0.01	-0.01	0.00	0.01	0.01	0.00	0.01	0.02	-0.02	-0.03	-0.32	-	-0.33	-
	b	0.02	-0.02	-0.02	0.01	-0.01	-0.01	0.00	-0.01	0.02	-0.02	0.04	-	-0.57	-	-0.46
DF	a	-0.02	0.00	0.01	-0.01	0.01	0.02	0.02	0.00	0.01	-0.01	0.23	-0.34	-	-0.07	-
	b	-0.01	0.00	0.02	-0.04	-0.01	-0.01	-0.01	-0.01	0.02	0.00	-0.32	-	-0.09	-	0.46
GFP	a	0.02	0.01	-0.01	0.02	-0.02	-0.02	-0.01	0.02	0.02	-0.01	-0.18	0.28	-	0.12	-
	b	0.01	-0.02	-0.02	0.04	0.01	0.01	0.02	-0.02	0.01	0.02	0.17	-	0.17	-	0.39
Pht	a	0.01	-0.02	-0.02	0.00	0.03	0.02	0.00	0.01	-0.02	0.02	0.12	-0.29	-	-0.14	-
	b	0.01	-0.01	0.00	-0.02	-0.03	-0.02	0.00	0.02	0.00	0.00	-0.16	-	-0.19	-	-0.39
LS	a	0.01	-0.02	-0.01	0.02	0.02	0.02	0.01	-0.02	0.02	-0.01	0.02	-0.24	-	-0.18	-
	b	-0.01	-0.01	0.02	-0.02	-0.02	-0.03	-0.01	0.03	0.03	-0.01	0.02	-	-0.28	-	-0.28
G/S	a	0.01	-0.01	-0.01	0.00	0.01	0.01	0.03	-0.03	0.00	0.00	0.12	-0.06	-	0.06	-
	b	0.00	0.00	0.01	-0.02	0.00	-0.01	-0.04	0.06	0.00	0.01	-0.16	-	0.15	-	-0.04
W/S	a	-0.02	-0.03	-0.01	0.02	0.03	-0.02	-0.02	-0.05	-0.01	0.02	0.15	0.11	-	0.17	-
	b	0.00	-0.02	0.01	0.01	-0.02	-0.03	-0.02	0.09	0.00	0.00	-0.26	-	0.31	-	0.07
PT	a	0.01	0.00	0.00	0.01	-0.01	0.00	0.00	0.01	0.23	0.00	-0.09	0.34	-	0.42	-
	b	-0.01	-0.02	-0.02	0.00	-0.02	0.00	0.00	0.00	0.02	-0.03	0.29	-	0.23	-	0.44
GW	a	0.00	-0.01	0.00	0.02	-0.01	-0.01	0.00	-0.03	0.00	-0.02	0.15	0.10	-	0.19	-
	b	0.01	0.01	-0.05	0.02	0.00	-0.01	0.00	0.06	0.00	0.01	-0.21	-	0.29	-	0.13
BY	a	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.00	0.00	1.02	-0.25	-	0.77	-
	b	-0.01	-0.02	0.00	-0.01	-0.02	0.00	0.00	0.01	-0.03	0.00	-0.40	-	1.05	-	-0.36
HI	a	0.02	0.02	0.00	0.00	-0.01	-0.01	0.00	-0.01	0.10	0.02	-0.36	0.70	-	0.47	-
	b	-	-	-	-	-	-	-	-	-	-	-		-	-	-
G/Y	a	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	b	0.00	0.01	0.00	0.01	0.00	0.01	0.00	0.02	0.16	0.02	-1.02	-	1.26	-	0.47

a = grain yield dependent character, residual effect – 0.004

b = Harvest index dependent character, residual effect – 0.00

Bold&Underline figure denote direct effect, the upper & lower figure of diagonal showed indirect effect desired level of significant positive associations of these traits with grain yield. The direct effects of these traits were also negative and thus, weight of grains/spike and per seed produced week association with grain yield.

The effects of different characters on harvest index showed that productive tillers and grain filling period had positive indirect effects via both grain yield and biological yield, resulting in significant positive association with harvest index. Similarly, plant height and days to flowering produced negative indirect effects via grain yield and biological yield on harvest index, and thus exhibited significant negative associations with harvest index. The positive indirect effects of other characters on harvest index via grain yield were nullified by negative indirect effects via biological yield and *vice-versa*.

On the basis of present study, it could be concluded that any prediction made on biological yield and harvest index regarding selection to increase grain yield would have more validity than for the other traits. For increasing harvest index, emphasis should be given on more productive tillers, long duration of grain filling period, early flowering and dwarf height. During selection a compromise must also be considered so that advance in one component may not be nullified by another.

REFERENCES

Austin, R. B., Blackwell, R. D., Evans, L. T., Ford, N. A., Morgan, C. L. and Toylor, N. (1980). Genetic improvement in winter wheat yield since 1900 and associated physiological changes. *Journal of Agriculture Sciences*. **49** : 675-689.

Dewey, D. R. and Lu, K. H. (1959). A correlation and path-coefficient analysis of components of crested wheat grass seed production. *Agronomical Journal*. **51** : 515-518.

Donald, C. N. (1968). The breeding of crop ideotypes. *Euphytica*. **17** : 385-403.

Robinson, H. F., Comstock, R. E. and Narvey, P. H. (1951). Genotypic and phenotypic correlations in corn and their implication in selection. *Agronomical Journal*. **43** : 283-287.

Singh, G. P., Yadav, Rajbeer and Chaudhary, H. B. (2007). Variability studies for morpho-physiological traits in wheat to post anthesis high temperature stress. *Journal of Wheat Research*. **1(1&2) :** 44-47.

Singh, K. N., Singh, S. K., Tiwari, L. P., Singh, N. B. and Srivastava, J. K. (2010). Morpho-physiological characters and their association under normal and late sown conditions in bread wheat. *Annals of Plant and Soil Research*. **12(1) :** 62-65.

Singh, N. B., Singh, Y. P., Singh, V. K. and Singh, V. P. N. (2004). Morpho-physiological traits associated with improvement of yield potential inwheat under timely sown irrigated condition. *Wheat for Tropical Areas*. **12 :** 97-103.

J. Farming Systems Research & Development **20** (1) : 29-34 (2014)

EFFECT OF SPACING AND NITROGEN LEVELS ON YIELD AND YIELD CONTRIBUTING TRAITS OF 'FIESTA' BROCCOLI (*BRASSICA OLERACEA* L. VAR. *ITALICA*)

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Abstract

An experiment was conducted to assess the effect of spacing and various levels of nitrogen on yield and yield attributes of broccoli during winter 2011. There were four levels of nitrogen *viz*., 125 kg/ha, 150 kg/ha, 175 kg/ha and 200 kg/ha along with three spacing *viz*. 45 x 45 cm, 45 x 30 cm and 30 x 30 cm. The experiment was laid out in randomized block design with three replications. The results showed that plant weight (g), head weight (g), length of flower stock (cm) and diameter of head (cm) were higher in the treatment 45 x 45 cm spacing with 200 kg N per ha whereas plant height (cm) and number of leaves were found maximum in the treatment spacing 45 x 30 cm with 200 kg N per ha. The maximum yield per plant was recorded for treatment combination spacing 45 x 45 cm with 200 kg N per ha whereas highest yield per unit area was recorded for treatment combination spacing 45 x 30 cm with 200 kg N per ha. It is recommended that spacing of 45 x 30 cm along with 200 kg N per ha gives higher yield per unit area.

Key words: broccoli, nitrogen levels, spacing, brassica, interaction effects.

Introduction

Broccoli (*Brassica oleracea* L. var. *Italica*) is an important cole crop belongs to family *Brassicaceae*, which found along the Mediterranean region (Decoteau, 2000). Broccoli is an European vegetable, native to the Mediterranean region, cultivated in Italy in ancient roman times. On the other hand, in USA commercially cultivation of broccoli was started around 1923 (Decoteau, 2000). In India, broccoli is cultivated on a limited area; however, due to increase in its popularity especially in metropolitan cities, there is a trend to increase cultivation by farmers as well as consumption by consumers. Broccoli is an important vegetable crop and has high nutritional and good commercial value (Yoldas *et al*., 2008). It is low in sodium food, fat free and calories, high in vitamin C and good source of vitamin A, vitamin B2 and calcium (Decoteau, 2000). Nowadays, broccoli attracted more attention due to its increasing demands in hotels, multifarious use and great nutritional value (Salunkhe & Kadam, 1998; Talalay & Fahey, 2001; Rangkadilok *et al.*, 2002 & 2004). Broccoli produces more biomass hence optimum spacing and doses of fertilizers especially nitrogen play key role in getting its potential yield.

Materials and Methods

The experiment was conducted at Hi-tech Horticulture Unit, Rajasthan College of Agriculture, Udaipur (Rajasthan) during September, 2011 to February, 2012. The trial was laid out in Factorial Randomized Block Design with three replications. The experiment was comprised of four levels of nitrogen *viz*. 125:100:100, 150:100:100,175:100:100

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and 200:100:100 (N:P:K) and three levels of spacing 45 × 45 cm (S_1), 45 × 30 cm (S_2) and 30 × 30 cm (S_3). All the cultural practices including irrigation and hoeing were carried out as per the standard commercial procedures. Spraying for pests and diseases were applied whenever it appeared necessary throughout the growing season. Data on yield and yield contributing characteristics *viz*. (plant height (cm), number of leaves, plant weight (g), main head weight (g), length of flower stock (cm), diameter of main head (cm), yield per plant (g) and total yield per plant (g) were recorded from randomly selected five tagged plants of each treatment and further analyzed. All data were subjected to analysis of variance to determine main treatment effect and interactions.

Results and Discussion

Results (Tables 1, 2 and 3) showed that plant spacing and levels of nitrogen significantly affect the yield and yield contributing traits of broccoli.

Effect of levels of nitrogen: Results (Table 1) indicated that different levels of nitrogen create significant differences for all the characters studied. The highest plant height (70.76 cm) was shown by both N_3 and N_4 levels of nitrogen where nitrogen was applied @ 175 kg per ha and 200 kg per ha, respectively. However plant weight (1626.22 g), main head weight (313.89 g), length of flower stalk (6.62 cm), diameter of main head (17.49 cm), number of leaves per plant (22.71), yield per plant (331.93 g) and total yield per ha (221.002 qt) were found maximum for treatment of highest level of nitrogen doses (200 kg per ha) *i.e* N_4, the positive effect of nitrogen fertilization on yield in this study is in agreement with the results of Babik and Elkner (2002), and Svoboda and Haberle (2006), whereas minimum values for all these traits were observed for level N_1 *i.e* 125 kg nitrogen per ha, this variation might be due to the availability of nutrients especially nitrogen and could be due to the improvement of soil water holding capacity as evident by Roe and Cornforth (2000). These findings are in conformity with the results of Greenwood *et al.*, (1980) who reported that optimum yields of broccoli (*Brassica oleracea* var. *italica*) can be obtained at nitrogen fertilizer applications of 175–250 kg per ha. Dufault & Waters (1985) and Kowalenko

Table 1. Effect of levels nitrogen on yield and yield contributing traits of Broccoli.

Treatments	Plant Height (cm)	Plant weight (g)	Head weight (g)	Length of flower stock (cm)	Diameter of head (cm)	Number of leaves per plant	Yield per plant (g)	Total yield per ha (qt.)
N_1 (125kg per ha)	64.92	917.11	182.22	4.46	14.98	15.62	257.24	174.28
N_2 (150kg per ha)	67.08	1152.44	193.00	4.38	15.19	18.16	261.66	178.07
N_3 (175kg per ha)	70.76	1303.89	279.00	4.77	15.80	20.60	267.73	182.69
N_4 (200kg per ha)	70.75	1626.22	313.89	6.62	17.49	22.71	331.93	221.00
SEm±	0.327	13.557	3.903	0.029	0.179	0.186	2.156	1.561
CD at 5%	0.965	40.019	11.520	0.085	0.53	0.548	6.364	4.608

& Hall (1987) also found increases in yield with an increase in nitrogen application from 168 to 224 and 125 to 250 kg per ha, respectively.

Effect of levels of spacing: Data presented in Table 2 revealed that plant height (70.74 cm), plant weight (1348.35 g), Main head weight (346.75 g), length of flower stalk (5.01 cm), diameter of main head (16.92 cm), number of leaves per plant (19.64) and yield per plant (420.90 g) were significantly higher at widest spacing i.e. 45 x 45 cm. Maximum head weight in broccoli at widest spacing was also observed by Saikia et al. (2010). This is because of good growth in wider spacing where lateral growth is more and more interception of sunlight and competition for soil moisture and nutrient is minimum, results are in close proximity with the findings of Khan *et al.* (1991) where as maximum yield per ha (210.58 q) was recorded for S_2 level of spacing *i.e* 45 cm x 30 cm, which was due to more number of plants per unit area, such trend was also seen by evident by Nassar *et al.* (1972). Lowest main head weight (144.33 g), diameter of main head (14.23 cm), yield per plant (133.73 g) and total yield per ha (148.60 qt) were reported for closest spacing. These traits showed a decreasing trend as the plant population increases, this was because of closer spacing there was more competition for necessary elements, soil moisture and other factors.

Interaction effect: The significant interaction (spacing × levels of nitrogen doses) effects were observed for all the characteristics. Interaction effects (presented in Table 3) showed that plant height (76.67 cm) and total yield per ha (256.11 qt) were found significant and maximum for treatment combination N_4S_2 (200 kg nitrogen per with 45 x 30 cm), whereas plant weight (1832.00 g), main head weight (516.67 g), length of flower stalk (7.07 cm), diameter of main head (19.47 cm), number of leaves per plant (24.23) and yield per plant (510.91 g) were recorded significantly higher for treatment combination N_4S_1 (200 kg nitrogen per with 45 x 45 cm). Treatment combination N_4S_2 (200 kg nitrogen per with 45 x 30 cm) recorded maximum yield per ha and it ranked second in plant height, length of flower stalk, diameter of main head and number of leaves per plant, however yield per plant was low for this treatment combination but due to increase in number of plants per unit area, total yield per ha is

Table 2. Effect of levels of spacing on yield and yield contributing traits of Broccoli.

Treatments	Plant Height (cm)	Plant weight (g)	Head weight (g)	Length of flower stock (cm)	Diameter of head (cm)	Number of leaves per plant	Yield per plant (g)	Total yield per ha (qt.)
S_1 (45 x 45 cm)	70.74	1348.58	346.75	5.01	16.92	19.64	420.90	207.85
S_2(45x 30 cm)	69.54	1276.50	235.00	4.96	16.45	19.18	284.29	210.59
S_3(30 x 30 cm)	68.35	1124.67	144.33	5.20	14.23	19.00	133.73	148.60
SEm±	0.283	11.741	3.380	0.025	0.155	0.161	1.867	1.352
CD at 5%	0.836	34.658	9.976	0.074	0.459	0.474	5.512	3.991

Table 3. Interaction effect of nitrogen level and plant spacing on yield and yield contributing traits of broccoli.

S. No.	Treatment Height	Plant weight (cm)	Plant head (g)	Main of weight (g)	Length of main flower stock (cm)	Diameter of head (cm)	Number per leaves per plant	Yield yield plant (g)	Total per ha (qt.)
1.	N_1 S_1	64.86	945.00	218.00	4.23	15.60	14.87	386.27	190.75
2.	N_1S_2	65.44	907.67	191.67	4.50	15.20	15.43	259.73	192.40
3.	N_1 S_3	64.46	898.67	137.00	4.63	14.13	16.57	125.73	139.70
4.	N_2 S_1	69.29	1237.00	234.00	4.27	15.90	18.27	389.27	192.23
5.	N_2 S_2	65.68	1114.67	203.33	4.27	15.67	17.80	263.82	195.43
6.	N_2S_3	66.26	1105.67	141.67	4.60	14.00	18.40	131.89	146.54
7.	N_3 S_1	72.52	1380.33	418.33	4.47	16.70	21.20	397.16	196.13
8.	N_3 S_2	70.37	1320.33	268.00	4.57	16.33	20.17	267.85	198.41
9.	N_3S_3	69.37	1211.00	150.67	5.27	14.37	20.43	138.18	153.53
10.	N_4 S_1	76.27	1832.00	516.67	7.07	19.47	24.23	510.91	252.30
11.	N_4S_2	76.67	1763.33	277.00	6.50	18.60	23.30	345.74	256.11
12.	N_4 S_3	73.30	1283.33	148.00	6.30	14.40	20.60	139.15	154.61
	SEm±	0.566	23.482	6.760	0.050	0.311	0.321	3.73	2.70
	CD at 5%	1.671	69.315	19.953	0.148	0.917	0.949	11.024	7.981

maximum. This trend was also observed by Nassar *et al.* (1972). Minimum plant height, plant weight, main head weight, yield per plant and yield per ha was observed for treatment combination N_1S_3 (125 kg nitrogen per with 30 x 30 cm), whereas length of flower stalk and number of leaves per plant were least for treatment combination N_1S_1 (125 kg nitrogen per with 45 x 45 cm). Changes in differences could be attributed to varying doses of nitrogen and closer spacing which reduced the availability of space, light and nutrients. These findings are in accordance with the results of Ameta *et al.* (2014) in capsicum who observed that lower plants per unit area produces more vigorous crops than at higher population density, but this could not compensate for a reduced number of plants per unit area. The total yield per plant may be high at wider spacing but yield per ha increased with higher planting densities. This was probably due to increase in the number of plants per unit area, which might contribute to the production of extra yield per unit area leading to high yield (Law and Egharevba, 2009). Based on the above findings, it could be concluded that broccoli should be grown at a spacing of 45× 30 cm with application of 200 kg nitrogen per ha for getting higher head yield per unit area.

REFERENCES

Ameta, K. D., R. A. Kaushik, R. B. Dubey and S. Pareek (2014) Effect of training and crop geometry on yield and yield attributes of poly house grown 'Natasha' red capsicum. *International Journal of Innovative Horticulture.* **3(1):** 67-70.

Babik I. and Elkner K. (2002): The effect of nitrogen fertilization and irrigation on yield and quality of broccoli. In: Proc. Eco. Fertil. Veg. Acta Hort., **571:** 33–43.

Decoteau, D.R., 2000. *Vegetable Crops*. Upper Rever Company. New Jersey, U.S.A

Dufault, R.J. and L. Waters Jr. (1985) Interaction of nitrogen fertility and plant populations on transplanted broccoli and cauliflower yields. *Hort Science* **20:** 127–128.

Greenwood, D.J., T.J. Cleaver, M.K. Turner, J. Hunt, K.B. Niendorf and S.M.H. Loquens (1980) Comparison of the effects of nitrogen fertilizer on the yield, nitrogen content and quality of 21 different vegetable and agricultural crops. *Journal of Agricultural Science*, Cambridge, **95:** 471–485.

Kahn, B.A., P.G. Shilling, G.H. Brusewitz & R.W. McNew (1991) Force to shear the stalk, stalk diameter, and yield of broccoli in response to nitrogen fertilization and within-row spacing. *Jour. Amer. Soc. Hort. Sci.* **116:** 222–227.

Kowalenko, C. G. and J. W. Hall (1987) Nitrogen recovery in single and multiple harvested direct seeded broccoli trial. *Jour. Amer. Soc. Hort. Sci.***112:** 4-8

Law-Ogbomo K, Egharevba, E. (2009) Effects of planting density and NPK fertilizer application on yield and yield components of tomato *(Lycopersicum esculentum* Mill) in forest Location. World J. Agric. Sci., **5(2):** 152-158

Nassar, S. H., M. El-Sherbni, M. G. Abdelgawad and M. S. Nasr (1972) Effect of some factors on cauliflower seed production. Agric. Res. Rev., **50(4):**109-119.

Rangkadilok, N., M.E. Nicolas, R.N. Bennett, D.R. Eagling, R.R. Premier and W.J. Taylor (2004) The effect of sulfur fertilizer on glucoraphanin levels in broccoli (*B. oleracea* L. var. italica) at different growth stages. *J. Agric. Food Chem.*, **52:** 2632–9

Rangkadilok, N., M.E. Nicolas, R.N. Bennett, R.R. Premier, D.R. Eagling and P.W.J. Taylor (2002) Determination of sinigrin and glucoraphanin in *Brassica* species using a simple extraction method combined with ion-pair HPLC analysis. *Scientia Horticulturae*, **96:** 27–41.

Roe, E.N. and C.G. Cornforth (2000) Effect of dairy lot scraping and composted dairy manure on growth, yield and profit potential of double-cropped vegetables. *Compost Sci. and Utilization*, **8:** 320–7.

Saikia, B. R., D. B. Phookan and S. Brahma (2010) Effect of time of planting and planting densities on growth, yield and economic production of broccoli (Brassica oleracea (L.) var. italica Plenck) cv. Pusa broccoli KTS-1. *Journal of Hill Agriculture* **1 (2):** 135-139.

Salunkhe, D.K. and S.S. Kadam (1998) *Handbook of Vegetable Science and Technology: Production, Storage and Processing*, 1st edition. Marcel Dekker, Inc. Madison Avenue, New York, USA

Svoboda P., Haberle J. (2006) The effect of nitrogen fertilization on root distribution of winter wheat. Plant Soil Environ., **52:** 308–313.

Talalay, P. and J.W. Fahey (2001) Phytochemicals from Cruciferous plants protect against cancer by modulating carcinogen metabolism. *American Soc. Nutr. Sci.*, **23:** 3027–33

Yoldas, F., S. Ceylan, B. Yagmur and N. Mordogan (2008) Effect of nitrogen fertilizer on yield quality and nutrient content in broccoli. *J. Plant Nutr.*, **31:** 1333–43

J. Farming Systems Research & Development **20** (1) : 35-45 (2014)

EFFECT OF DIFFERENT SEED SOURCES AND MANAGEMENT PRACTICES ON *BAKANAE* DISEASE SEVERITY AND YIELD IN BASMATI RICE

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ABSTRACT

During recent years,*Bakanae* or foot rot disease has appeared as a major disease of Basmati rice after the release of variety PB 1121. This variety is very much susceptible to this disease and due to increased area of this variety; the *Bakanae* has also increased tremendously and become a major disease of Basmati rice in the areas of Western Uttar Pradesh to Punjab and Haryana.Threetypes of seeds sources of rice variety PB 1121 i.e. certified grade seeds from field with <1% disease in the field (S1), infected seeds from fields with 10-15% disease incidence (S2), and infected seeds from fields with >25% disease incidence (S3) and eight different management practices were evaluated against *Bakanae* disease of Basmati rice. There was a clear cut response of seed sources (certified or uncertified) on the incidence of *Bakanae* disease in the field during both the years. The certified seed (S1) showed minimum disease incidence during both the years (1.44% in 2011 and 1.57% in 2012 at 90 DAT). This was followed by seed type S2 (from medium *Bakanae* infected field) which showed moderate level of disease (4.79% in 2011 and 5.46% in 2012) in the field at 90 DAT. The seed from heavily infected rice field (S3) produced maximum disease incidence during both the years at 90 DAT (6.44% in 2011 and 6.11% in 2012). Various management practices (T1-T8) significantly reduced the level of *Bakanae* incidence in the field during both the years as compared to control. Treatment 1 and 2 were found most effective during both the years, but were, in general, at par with other treatments. Hence, the use of certified seeds appeared as first measure to manage*Bakanae* or foot rot disease in Basmati rice.

Key Words: Basmati rice, *Bakanae*, PB 1121, seed source, Management

INTRODUCTION

'Basmati', the "Scented Pearl" indigenous of Indian sub-continent, comprises long grain aromatic rice grown for many centuries in the specific geographical area; at the Himalayan foot hills, endowed with characteristics extra-long slender grains that elongate at least twice of their original size with a characteristics soft and fluffy texture upon cooking, delicious taste, superior aroma and distinct flavour (Nene, 2000; Singh and Singh, 2009). Basmati has attained ''heritage rice'' status as it is considered as ''farmer's cultivar'' being maintained and grown by farmers of specific region of India and Pakistan for more than 250 years. The special quality of Basmati rice is attributed to unique combination of soil, water, climate and cultural practices under which it is grown, besides the inherent genetics controlling the features (http://www.apeda.gov.in; Singh *et al.*, 2003; Siddiq*et al.*, 2012). India is getting huge foreign currency (Rs.19390.51 crores and in terms of quantity 3456411metric tonnes during 2012-13) from the export of Basmati rice (Fig.1). The major importing countries are Saudi Arabia, UAE, Iran, Kuwait and European Union. During 2011-12, the total value of rice export (Rs. 24118 crores including Basmati and non-Basmati) from India was higher than any other agricultural commodity. Basmati rice alone contributed for Rs.15450 crores and ranked fourth after cotton, marine products and guar-gum meal (http://www.apeda.gov.in; Singh *et al.*, 2006; State of Indian Agriculture, 2012-13). Besides the foreign exchange, millions of people and many industries of the country are employed in the business of Basmati rice.Singh *et al.* (2009) reported that, aromatic rices in general, and Basmati rice in particular are highly susceptible to the major pests and diseases of rice. Blast, sheath blight, *bakanae*, false smut and bacterial leaf blight were described as major diseases in Basmati rice. The spread of high yielding varieties suitable for high input intensive cropping like PB 1 and PB 1121 facilitated the build-up of favourable environments for pests and diseases to assume a serious proportion. The genetic homogeneity in space and time, high input, particularly of irrigation and nitrogenous fertilizers and pesticides etc. in absence of suitable host plant resistance have made the pests-disease problems increasingly serious and complex. The wet regime and excessive nitrogen application are reported as causal factors for heavy incidence/attack of diseases in Basmati rice (Siddiq, 1996; Rai, 2002; Singh *et al.*, 2003; Singh *et al.*, 2009**)**.The foot rot or *bakanae*, which was first noticed in Basmati during 1989, has attained the status of major disease in Basmati growing belts of Haryana. Foot rot was found as a major disease of Basmati rice belt of Haryana and Punjab. In a recent study by Khilari*et al.* (2011),*Bakanae*/foot rot disease has appeared as a major disease of Basmati rice after the release of variety PB 1121. This variety is very much susceptible to this disease and due to increased area of this variety; the *Bakanae* has also increased tremendously and become a major disease of Basmati rice in the areas of Western Uttar Pradesh to Punjab and Haryana. A serious epidemic of *bakanae* has appeared in the year 2009 in West U.P. to Punjab and Haryana and its incidence was noticed up to 71.25% in some fields of Meerut district of Uttar Pradesh state in India.*Bakanae*/foot rot disease is caused by fungus *Fusariummoniliforme*Sheld(Teleomorph: *Gibberellafujikuroi*) and reported to perpetuate mainly through infected seeds in North-Western India(Singh *et al.*, 2003). There are very few recommendations for the management of *Bakanae*/foot rot disease with older fungicides, bioagents and balanced crop nutrition (Mew, 1991;Singh *et al.*, 2000). There is urgent need to work out on the management options of *Bakanae*/foot rot disease of Basmati rice under present scenario. Hence, present investigation was planned to evaluate the effect of different seed sources (from infected crop with variable severities of *bakanae*) and management practices on severity of *Bakanae*/foot rot disease and yield of Basmati rice under field conditions of Meerut district, India.

MATERIALS AND METHODS

The present investigation was conducted in micro-plots (2 x 2m^2) for two consecutive years i.e. *Kharif*season of 2011-12 and *Kharif*season of 2012-13 using most susceptible variety Pusa Basmati 1121at Crop Research Centre (CRC), Chirodi, of SardarVallabhbhai Patel University of Agriculture and Technology, Meerut, India. Threetypes of seeds of Basmati rice variety PB 1121 i.e. certified grade seeds from field with <1% disease in the field (S1), infected seeds from fields with 10-15% disease incidence (S2), and infected seeds from fields with >25% disease incidence (S3) were used and treated as first factor. Various management practices for *Bakanae* disease were treated as second factor and are given in Table 1. The experiment was conducted in Factorial Randomized Block Design with three replications.

The wet method was adopted to raise the nursery of rice. For this, nursery plots (1x1 m^2) were laid- out on a well prepared and pulverized field. At the time of field preparation, a well decomposed FYM was added in the nursery soil @5quintls/1000m^2. The certified grade healthy seeds were used @20kg/ha. Seeds in muslin cloth bags were soaked in fresh water for 18hrs. Thereafter, bags were removed for draining excess water. Required seed treatments operations (as in Table 1) were done for pre-soaked seeds and treated seeds were again filled in their respective marked bags and kept for germination for another 24hrs. After that, nursery plots were flooded with water and levelled with wooden rods. Germinating seeds were broadcasted uniformly on their marked plots. Watering was done time to time as per the requirement. Twenty four days old rice seedlings were transplanted in the main field. All the standard package of practices recommended for Pusa Basmati 1121, were followed in the rice crop. Treatments were applied time to time as per prescribed schedule mentioned in Table 1. Intermittent irrigations were applied to saturate the rice field as per the requirement. Recommended doses of fertilizers i.e. 90kg N/ha (30kg N as basal dose, 30kgN at 30DAS and rest of 30kg N before heading stage), 60kg P_2O_5/ha, 40 kg K_2O/ha (both as basal dose) were applied for rice.The dates of sowing of nursery were 20.06.2011 and 20.06.2012 and dates of transplanting were 16.07.2011 and 16.07.2012. Observations were recorded on the actual percentage of infected tillers and grain yield of rice.

Table 1. Treatment details for the management of *Bakanae* disease

Treat. No.	Treatment component
T1.	Seed treatment with Carbendazim 50WP@1g/kg seed before sowing + one spray of Carbendazim 50WP@1g/ l at 30 DAT
T2.	Seed treatment with combination product Carboxin 37.5% + Thiram 37.5% WS @3g/kg seed before sowing + one spray of Carbendazim 50WP@1g/ l at 30 DAT
T3.	Seed treatment with local isolate of *Trichoderma*@10g/kg seed before sowing
T4.	Seed treatment with *Trichoderma*(commercial name ‘Sanjeevani’) @10g/kg seed before sowing
T5.	Seed treatment with *Pseudomonas fluorescens* (commercial name ‘PhasalRakshak’) @10g/kg seed before sowing
T6.	Seed treatment with local isolates of *Pseudomonas fluorescens* and *Trichoderma*@ 5g + 5g T (10g/ kg seed) before sowing
T7.	Spray and soil drenching with Carbendazim 50WP@1g/ l at 10 DAT
T8.	Sprayand soil drenching with combination product Carbendazim 12% + Mancozeb 63% WP @ 1.5g/ l at 10DAT
T9.	Control (untreated)

RESULTS AND DISCUSSION

Effect of different seed sources and management practices on incidence of Bakanae disease

Data presented in Table 2 and 3 clearly indicate that, the type of seed has direct influence on the incidence of *bakanae* disease in the field. Maximum disease incidence was observed in case of seed type S3 (uncertified seeds from fields with >25 % *bakanae* incidence). The per cent disease incidence in this case were 0.98, 4.20 and 6.44% at 30, 60 and 90 DAT respectively in 2011 and 0.87, 4.3 and 6.11% respectively at 30, 60 and 90 DAT in 2012. The seed source S2 (uncertified seeds from fields with 10-15 % *bakanae* incidence) stood next, during both the years with average disease incidence of 0.48, 3.20 and 4.79 % at 30, 60 and 90 DAT respectively in 2011 and 0.74, 3.96 and 6.11 % at 30, 60 and 90 DAT respectively in 2012. Seed source S1 (certified seed) was found to be most effective in preventing the *bakanae* disease incidence in the field during both the years. The average disease incidence recorded for S1 were 0.00, 0.85 and 1.44% at 30, 60 and 90 DAT respectively during 2011 and 0.00, 1.11 and 1.57% at 30, 60 and 90 DAT respectively during 2012. A clear trend of the effect of type of seed on the incidence of *bakanae* disease in the field is presented in Fig.1 and 2.

There was a clear cut response of various seed sources (certified or uncertified) on the incidence of *Bakanae* disease in the field during both the years. The healthy certified seed (S1) showed minimum disease incidence during both the years (1.44% in 2011 and 1.57% in 2012 at 90 DAT). This was followed by seed type S2 (from medium *Bakanae* infected field) which showed moderate level of disease (4.79% in 2011 and 5.46% in 2012) in the field at 90 DAT. The seed from heavily infected rice field (S3) produced maximum disease incidence during both the years at 90 DAT (6.44% in 2011 and 6.11% in 2012). The seed borne nature of *Bakanae* disease pathogen *Gibberella fujikuroi* and use of disease free healthy seed to manage this disease were reported by various workers (Nyvall, 1979; Mukhopadhyay and Singh, 1984; Ahuja*et al.* 1995; Khilari *et al.*, 2011). Seed is the major source of primary inoculum for *Bakanae* disease and it plays an important causative role in the spread of disease in next season and the degree of infection in seeds decides the level of disease incidence in field during next season (Vincent, 2008). Infected seeds

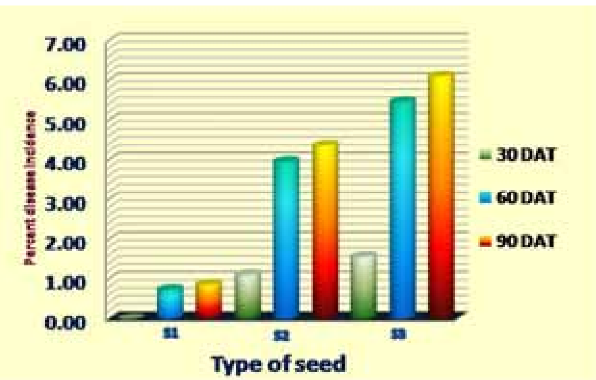

Fig.1. Effect of type of seed on the incidence of *Bakanae* disease in field (2011)

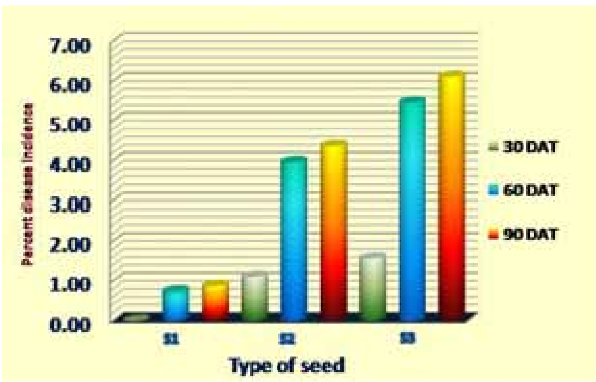

Fig.2. Effect of type of seed on the incidence of *Bakanae* disease in field (2012)

Table 2. Effect of different seed sources and disease management practices on the severity of *Bakanae* disease in 2011

Seed source (S) / Treatment (T)	Percentdisease incidence at different intervals											
	30 DAT				60DAT				90DAT			
	S1*	S2	S3	Mean	S1	S2	S3	Mean	S1	S2	S3	Mean
1. Seed treatment with Carbendazim 50WP+ Spray of Carbendazim 50WP at 30 DAT	0.00	0.33	0.33	0.22	0.50	2.67	4.33	2.50	1.17	3.83	4.83	3.27
2. Seed treatment with Carboxin 37.5% + Thiram 37.5% WS + spray of Carbendazim 50WP at 30 DAT	0.00	0.17	0.33	0.17	0.33	1.83	3.67	1.94	1.33	3.17	7.17	3.88
3. Seed treatment with *Trichoderma* (local isolate)	0.00	0.00	1.17	0.39	0.50	2.33	3.33	2.06	1.33	4.17	5.00	3.50
4. Seed treatment with *Trichoderma* (commercial name 'Sanjeevani')	0.00	0.33	0.50	0.28	0.50	3.00	3.67	2.39	1.00	4.67	5.17	3.61
5. Seed treatment with *Pseudomonas fluorescens* (commercial name 'PhasalRakshak')	0.00	0.67	1.17	0.61	1.33	1.83	4.17	2.44	1.67	3.67	6.17	3.83
6. Seed treatment with local isolates of *Pseudomonas fluorescens* + *Trichoderma*	0.00	0.33	0.50	0.28	0.50	2.50	3.67	2.22	1.17	4.17	6.00	3.77
7. Spray and soil drenching with Carbendazim 50WP at 10 DAT	0.00	0.00	1.17	0.39	0.50	2.67	3.67	2.28	1.33	4.67	6.33	4.11
8. Sprayof Carbendazim 12% + Mancozeb 63% WP at 10DAT	0.00	0.67	0.50	0.39	1.17	4.50	2.33	2.67	1.50	5.83	5.00	4.11
9. Control	0.00	1.83	3.17	1.67	2.33	7.50	9.00	6.28	2.50	9.00	12.33	7.94
Mean=	0.00	0.48	0.98	-	0.85	3.20	4.20	-	1.44	4.79	6.44	-
CD (p=0.05) for S=	0.14				0.51				0.49			
T=	0.25				0.88				0.86			
S×T=	0.44				1.53				1.49			

* S1= certified grade seeds from field with <1% disease in the field, S2= infected seeds from fields with 10-15% disease incidence, and S3= infected seeds from fields with >25% disease incidence

Table 3. Effect of different seed sources and disease management practices on the severity of *Bakanae* disease in 2012

Type of Seed (S) / Treatment (T)	Percentdisease incidence at different intervals											
	30 DAT				60DAT				90DAT			
	S1*	S2	S3	Mean	S1	S2	S3	Mean	S1	S2	S3	Mean
1. Seed treatment with Carbendazim 50WP+ Spray of Carbendazim50WP at 30 DAT	0.00	0.00	0.50	0.16	1.00	2.33	4.00	2.44	1.33	3.33	4.50	3.05
2. Seed treatment with Carboxin 37.5% + Thiram 37.5% WS + spray of Carbendazim 50WP at 30 DAT	0.00	0.50	0.50	0.33	1.00	2.33	3.67	2.33	1.67	3.33	4.17	3.05
3. Seed treatment with *Trichoderma* (local isolate)	0.00	0.33	1.00	0.44	0.67	3.00	3.00	2.22	1.50	3.83	4.33	3.22
4. Seed treatment with *Trichoderma* (commercial name 'Sanjeevani')	0.00	1.17	0.67	0.61	1.33	4.50	4.50	3.44	1.50	5.67	7.67	4.94
5. Seed treatment with *Pseudomonas fluorescens* (commercial name 'PhasalRakshak')	0.17	0.50	0.83	0.50	1.17	5.00	4.50	3.55	1.83	7.00	6.17	5.00
6. Seed treatment with local isolates of *Pseudomonas fluorescens* + *Trichoderma*	0.00	0.83	0.50	0.44	0.67	4.17	2.67	2.50	1.17	5.33	4.17	3.55
7. Spray of Carbendazim 50WP at 10 DAT	0.00	0.33	0.33	0.22	1.00	3.00	3.17	2.38	1.33	4.50	5.33	3.72
8. Sprayof Carbendazim 12% + Mancozeb 63% WP at 10DAT	0.00	0.50	0.33	0.27	0.83	5.17	4.67	3.55	1.50	7.17	6.00	4.88
9. Control	0.00	2.50	3.17	1.88	2.33	6.17	9.17	5.88	2.33	9.00	12.67	8.00
Mean=	0.01	0.74	0.87	-	1.11	3.96	4.37	-	1.57	5.46	6.11	-
CD (p=0.05) for S=	0.15				0.38				0.51			
T =	0.26				0.66				0.89			
S x T=	0.46				1.15				1.55			

* S1= certified grade seeds from field with <1% disease in the field, S2= infected seeds from fields with 10-15% disease incidence, and S3= infected seeds from fields with >25% disease incidence

may be one of the major reason for recent epidemic of *Bakanae*in North-Western part of India.

The management practices (seed treatment with chemical fungicides, biocontrol agents, *Pseudomonas fluorescens* and *Trichoderma*; spraying with chemical fungicides) did have significant effect on *bakanae* disease incidence in the field. All the treatments from T1 to T8 were significantly effective in suppressing *bakanae* incidence in field when compared to control. During 2011, the treatment 2 (seed treatment with combination product Carboxin + Thiram @3g/kg followed by 1 spray of Carbendazim at 30 DAT) was found most effective against this disease with 0.17 and 1.94% disease incidence at 30 and 60 DAT respectively. This treatment was found at par with rest of other treatments except T5 at 30 DAT and at par with all disease management practices at 60 DAT. At 90 DAT, all the disease management practices significantly reduced the disease but were at par with each other. During 2012, all the disease management practices (T1-T8) significantly reduced the *bakanae* incidence in field at all the stages as compared to control. At 30 DAT, treatment 1 (Seed treatment withCarbendazim 50WP+ Spray of Carbendazim 50WP at 30 DAT) stood first with minimum disease incidence (0.16%), but it was at par with treatments 2, 7 and 8. Treatments 3, 4, 5 and 6 stand at second ranks and were at par with each other. The interaction effects of seed sources and management practices (treatments) were also found significant. During 2011 at 90 DAT, minimum disease incidence (1%) was recorded with S1 with treatment 4 (ST with commercial *Trichoderma* formulation) and this was at par with treatments 1, 2, 3 6 and 7. During 2012 at 90 DAT, minimum incidence of *bakanae* was recorded in case of S1 with treatment 6 and it was at par with rest of other treatments with S1.

Various management practices (T1-T8) significantly reduced the level of *Bakanae* incidence in the field during both the years as compared to control. Treatment 1 and 2 were found most effective during both the years, but were, in general, at par with other disease management treatments. Management of *Bakanae* disease in rice by seed treatment with chemical fungicides like Carbendazim, biocontrol agents like *Pseudomonasfluorescens* and *Trichoderma* spp. and spraying of Carbendazim, were earlier advocated by Mew (1991), Kumar *et al.* (2009); Khilari *et al.* (2011). Kumar *et al.* (2009)reported the use of Carboxin + Thiram for seed treatment in rice to manage the *Bakanae* disease.

Effect of different seed sources and management practices on grain yield of rice

There was clear cut response of the seed sources on the grain yield of rice with respect to *bakanae* disease infection (Table 4). A significant difference between the grain yields of rice crop from different seed sources was observed during both the years. Maximum grain yield of 3751 kg/ha and 3701 kg/ha were recorded with S1 (certified seed) during 2011 and 2012 respectively. It was followed by S2 where 3525kg/ha and 3524kg/ha grain yields were recorded during 2011 and 2012 respectively. Seeds from highly *bakanae* infected rice field (S3) resulted in minimum grain yield of 3262 kg/ha and 3302 kg/ha respectively

Table 4. Effect of different *Bakanae* disease management practices on the yield of PB 1121

Type of seeds (S) / Treatment (T)		Rice grain yield (kg/ha)								
		2011				2012				Mean of
		S1*	S2	S3	Mean	S1	S2	S3	Mean	2 Years
1. Seed treatment with Carbendazim 50WP+ Spray of Carbendazim 50WP at 30 DAT		4141	3700	3791	3877	3808	3825	3500	3711	3794
2. Seed treatment with Carboxin 37.5% + Thiram 37.5% WS + spray of Carbendazim 50WP at 30 DAT		4375	4291	3933	4200	4108	4041	3916	4022	4111
3. Seed treatment with *Trichoderma* (local isolate)		3600	3583	3291	3491	3683	3525	3525	3577	3534
4. Seed treatment with *Trichoderma* (commercial name 'Sanjeevani')		3741	3458	3225	3475	3816	3708	3383	3636	3555
5. Seed treatment with *Pseudomonas fluorescens* (commercial name 'PhasalRakshak')		3816	3375	3200	3463	3900	3650	3400	3650	3556
6. Seed treatment with local isolates of *Pseudomonas fluorescens* + *Trichoderma*		3975	3850	3491	3772	3875	3516	3441	3611	3691
7. Spray of Carbendazim 50WP at 10 DAT		3533	3400	2841	3258	3575	3241	3016	3277	3268
8. Sprayof Carbendazim 12% + Mancozeb 63% WP at 10DAT		3333	3216	3041	3197	3508	3350	3116	3325	3261
9. Control		3250	2850	2541	2880	3041	2858	2425	2775	2827
Mean=		3751	3525	3262	-	3701	3524	3302	-	-
CD (p=0.05)=	S=	105				78				
	T=	181				136				
	S x T=	NS				NS				

* S1= certified grade seeds from field with <1% disease in the field, S2= infected seeds from fields with 10-15% disease incidence, and S3= infected seeds from fields with >25% disease incidence

during 2011 and 2012. The mean yield of rice for various seed sources are given in Fig.3.

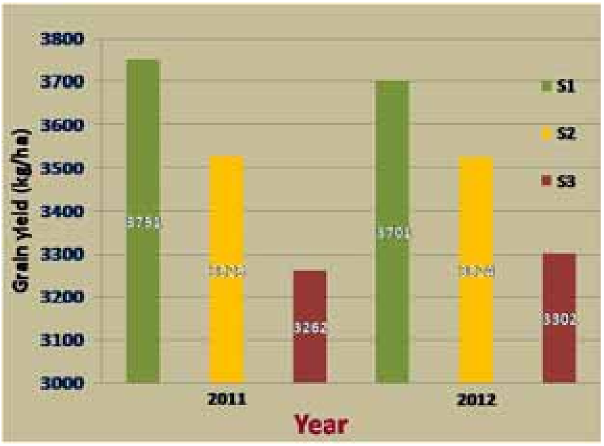

Fig. 3. Effect of different *bakanae* infected seed sources on grain yield of rice

The grain yield of Basmati rice variety PB1121was greatly affected by the type of seeds (certified or diseased) used for raising nursery. The treatment with healthy seeds (S1) produced maximum grain yield of rice during 2011 and 2012. This was followed by S2 and minimum, grain yield was recorded with S3 (the seeds from heavily infected field with *Bakanae*). This showed the importance of certified healthy seeds in the management of *Bakanae* disease and getting higher yield of Basmati rice variety PB 1121. Use of healthy seeds for the management of *Bakanae* disease and producing higher yield of rice was suggested by Mukhopadhyay and Singh (1984); Singh *et al.* (2000) and Khilari *et al.* (2011).

Various management practices for *bakanae* disease had significant effect on the grain yield of rice during both the years. During 2011, treatment 2 (ST with Carboxin+ Thiram + one spray of Carbendazim at 30 DAT) out-yielded (4200 kg/ha) all other treatments. It was followed by treatment 1 (ST with Carbendazim + one spray of Carbendazim at 30 DAT) with 3877 kg/ha of grain yield and treatment 6 (ST with local isolates of *Pseudomonas fluorescens* + *Trichoderma*) with rice grain yield of 3772 kg/ha. During 2012, treatment 2 again out-yielded (4111 kg/ha) all other management practices. Treatment 1 was again found on second rank (3794 kg/ha), but it was at par with treatment 6 in terms of rice grain yield. Minimum grain yield (2775 kg/ha) was recorded in the control. The management practices (T7 and T8) where, no seed treatment was done, were inferior to those with seed treatment (either with chemicals or bioagents), during both the years. The interaction effects of seed type and treatments were found non-significant during both the years for rice grain yield.

All the disease management treatments (T1-T8) significantly increased the grain yield of rice over the control during both the years. Treatment 2 (seed treatment with combination product Carboxin+ Thiram @ 3g/kg + one spray of Carbendazim at 30 DAT) out-yielded all other the treatments during both the years. Treatment 1 (seed treatment with Carbendazim @ 1g/kg + one spray of Carbendazim at 30 DAT) stood next in terms of rice grain yield during both the years, but it was at par with Treatment 6 in 2011 and Treatments 5, 4 and 6 during 2012. Minimum rice grain yield was recorded in case of control. Seed treatment with Carbendazim, combination product of Carboxin+ Thiram, bioagents like *Pseudomonas fluorescens* and *Trichoderma* for managing *Bakanae* disease and thereby producing higher rice yield was earlier suggested by Singh *et al.* (2000);Kumar *et al.* (2009) and Khilari *et al.* (2011).

ACKNOWLEDGEMENTS

The first author isthankful to ICAR for awarding the Senior Research Fellowship during the study.

REFERENCES

Ahuja, S.C.; Panwar, D.V.S.; Ahuja, U. and Gupta, K.R. 1995.Basmati Rice-The Scented Pearl.CCS Haryana Agriculture University, Hisar, India.63p.

Govt. of India. 2013. State of Indian Agriculture 2012-13. Ministry of Agriculture, Department of Agriculture and Cooperation, Directorate of Economics and Statistics, New Delhi, Govt. of India. 221p. http://www.apeda.gov.in

Khilari, K.; Bhanu, C.; Sharma, R.; Gupta, A. and Gangwar, B. 2011.Bkanae disease – A serius threat to Basmati rice cultivation.*In:* Compendium of Abstracts (Supplement), National Symposium on Advances in Biotechnological Research in Agri-Horticultural Crops for Sustaining Productivity, Quality Improvement and Food Security, 14-16 Sept., 2011, College of Biotechnology, SVPUA&T., Meerut-250 110. India. p-12.

Kumar, K.V.K.; Reddy, M.S.; Kloepper, J.W.; Lawrence, K.S.; Groth, D.E. and Miller, M.E. 2009.Sheath blight disease of rice (*Oryzasativa*L.) - An overview.*Biosciences, Biotechnology Research Asia* **6(2):** 465-480.

Mew, T. W. 1991. Disease management in rice.*In:* CRC Handbook of Pest Management in Agriculture, 2nd Ed., Vol. III (D. Pimentel Ed.). CBS Publishers and Distributors, Shahadara, Delhi- 110 032. pp. 279-300.

Mukhopadhyay, A.N. and Singh, R.A. 1984. *Phaslonkerog.*2nd Ed. G.B. Pant Univ. of Agric. & Tech., Pantnagar, India.443p.

Nene, Y.L. 2000. Basmati rice: A distinct variety (cultivar) of the Indian Sub-Continent. *In*: *In*: A treatise on the Scented Rices of India (R.K. Singh and U.S. Singh Eds.). Kalyani Publishers, New Delhi- 110 002. pp:7-21.

Nyvall, R.F. 1979. Field crop diseases Handbook. AVI Pub. Co., INC, Westport, USA. 436p.

Rai, M. 2002. A perspective for developing Action programme for sustaining productivity of rice-wheat system in the Indo-Gangetic plains.*In*: Rice-Wheat Consortium of the Indo-Gangetic Plains. Proc. International Workshop on "Developing an Action programme for farm level impact in rice-wheat systems of the Indo-Gangetic Plains", 25-27 Sept. 2000, New Delhi, India. Rice-Wheat Consortium Series 14.Pp.1-9.

Siddiq, E.A. 1996. Rice.*In:* 50 years of crop sciences research in India (R.S. Paroda and K.L. Chadha Eds.). Indian Council of Agricultural Research, New Delhi-110002.Pp.191-218.

Siddiq, E.A.; Vemireddy, L.R. and Nagaraju, J.2012. Basmati rices: Genetics, breeding and trade. *Agri. Res.* **1(1):** 25-36.

Singh, R. and Singh, B.P. 2009. Efficacy of Validamycin at different crop stages against sheath blight of rice. *Indian Phytopath.* **62:** 319-323.

Singh, R.K.; Ahuja, U. and Ahuja, S.C. 2006.Basmati for prosperity.*Indian Farming* **56 (7):** 33-36.

Singh, U.D.; Choudhary, V. and Mathuria, R.C. 2009.Disease management in Basmati rice.*Indian Farming* **59(1):** 26-29.

Singh, U.S.; Rohilla, R.; Singh, A.; Tewari, S.N. and Singh, H.M. 2000.Plant Protection in Aromatic Rices.*In*: Aromatic Rices (R.K. Singh; U.S. Singh and G.K. Khush Eds.). Oxford & IBH Pub. Co. Pvt. Ltd., New Delhi.pp:216-255

Singh, U.S.; Tewari, S.N.; Singh, N.; Varshney, S.; Singh, H.N.; Singh, G.; Rohilla, R.; Ram, D. and Singh, R.K. 2003. Pest profile and integrated pest management in aromatic rices. *In*: A treatise on the Scented Rices of India (R.K. Singh and U.S. Singh Eds.). Kalyani Publishers, New Delhi- 110 002. pp:165-187.

J. Farming Systems Research & Development **20** (1) : 46-52 (2014)

EFFECT OF DIFFERENT MANAGEMENT PRACTICES ON THE LEAF BLAST DISEASE CAUSED BY *PYRICULARIA ORYZAE* CAVARA IN BASMATI RICE NURSERY

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ABSTRACT

Different seed treatment (ST) practices with different dates of sowing (either timely, on 20th June or late, on 7th July), were evaluated against Basmati rice diseases during 2011 and 2012 at the nursery stage. Three controls (without seed treatment) with modified dates of sowing and top dressing of nitrogen (urea), were kept for comparison. All the treatments (total 9) were evaluated on two rice varieties i.e. PB 1 and PB 1121. Only one rice disease i.e. leaf blast, appeared as visible in the nursery. Seed treatment with combination product, Carboxin + Thiram @ 3g/kg with timely sowing (20th June) performed best during both the years with complete suppression of the leaf blast. Early sowing of rice nursery in case of treatment 1 (seed treatment with Carboxin + Thiram) and treatment 7 (Control 1, no ST) were found to significantly reduce the blast disease in nursery as compared to late sowing in treatment 2 and treatment 8 respectively. Top dressing of nitrogen (urea) in nursery was found to aggravate the rice blast severity in both, ST and control treatments. The Basmati rice variety PB 1 was found to be more susceptible to leaf blast disease than PB 1121, at nursery stage. Early sowing of rice nursery (by 20th June), seed treatment with combination fungicide Carboxin + Thiram @ 3g/kg seed and avoidance of top dressing of nitrogenous fertilizer (urea) were found as effective strategies to manage the rice blast disease, during the nursery stage of Basmati rice.

Key Words: Basmati rice, Nursery, Blast, Management, Carboxin + Thiram

INTRODUCTION

'Basmati', the "Scented Pearl" indigenous of Indian sub-continent, comprises long grain aromatic rice grown for many centuries in the specific geographical area; at the Himalayan foot hills, endowed with characteristics extra-long slender grains that elongate at least twice of their original size with a characteristics soft and fluffy texture upon cooking, delicious taste, superior aroma and distinct flavour. India is getting huge foreign currency (Rs.19390.51 crores) from the export of Basmati rice (3456411metric tonnes during 2012-13). During 2011-12, the total value of rice export (Rs.24118 crores including Basmati and non-Basmati) from India was higher than any other agricultural commodity (http://www.apeda.gov.in; Singh *et al.*, 2006; State of Indian Agriculture, 2012-13). Many of the districts of Western U.P. are under consideration for designation under Geographical Indication for growing Basmati rice in the country and are the rising potential area for this kind of rice. Pusa Basmati-1 (PB1) and Pusa Basmati 1121(Pusa Sugandha-4 as PB1121) are among the most important varieties from export point of view and are largely cultivated in Basmati growing regions and Western Plain Zone (WPZ) of U.P. In most of the regions, rice is produced under high input application to get maximum yield. Under this high input application, the higher nitrogen content in leaf, higher plant density, homogenization of cultivars and cultural practices over the space and time and high congenial environments in rice ecosystem, favour the attack of various kinds of pests and diseases.

Blast is number one disease of Basmati rice belts in India and one of the bottlenecks in the production of this high value crop. Two high yielding, principal Basmati rice varieties PB 1 and PB 1121 are highly susceptible to this disease (Ahuja *et al.*, 1995; Singh *et al.*, 2003). In a pest ranking study for South Asian Countries, Geddes and Iles (1991) reported rice blast pathogen as number one most serious pest in the Basmati rice zone followed by yellow stem borer and other insect-pests, pathogens and weeds. Rice blast is a potentially damaging disease in upland environments where, drought and soil stress predispose the rice crop to severe attacks by the pathogen. Yield losses due to blast can be as high as 98% when the disease occurs in epidemic forms (Gnanamanickam, 2009; Singh, 2009; Singh *et al.*, 2009). However, seedling stage of rice is one of the most susceptible stages of rice for blast pathogen and responsible for the losses during nursery and carryover of the inoculum from nursery to transplanted field (Singh, 2009). Effective management of blast pathogen in nursery is must to prevent the losses during nursery and early inoculum build up in the transplanted field. Keeping above challenges in view, the present investigation was planned to manage the blast disease during nursery of Basmati rice varieties.

Materials and Methods

The study was conducted at CRC farm of S.V.P.U.A. & T., located at Chirodi during *Kharif* seasons two consecutive years (2011 and 2012). The wet method was adopted to raise the nursery of rice. For this, nursery plots (1x1 m^2) were laid- out on a well prepared and pulverized field in a randomized complete block design. At the time of field preparation, a well decomposed FYM was added in the soil of nursery plots @5quintls/1000m^2. The certified grade healthy seeds were used @20kg/ha. Seeds in muslin cloth bags were soaked in fresh water for 18hrs. Thereafter, bags were removed for

Table 1. Various management practices for blast disease control in Basmati rice nursery

S.No.	Seed treatment	Time of sowing
1.	Carboxin 37.5% + Thiram 37.5% WS@3g/kg seed	20^{th} June
2.	Carboxin 37.5% + Thiram 37.5% WS WS@3g/kg seed	7^{th} July
3.	Carboxin 37.5% + Thiram 37.5% WS WS@3g/kg seed + Broadcasting of urea at 15DAS	7^{th} July
4.	Carbendazim 50WP@1g/kg + Copper oxychloride @2.5g/kg	7^{th} July
5.	Streptocycline @500ppm+ Copper Oxychloride @2.5g/kg	7^{th} July
6.	*Pseudomonas fluorescens* (Psf) and *Trichoderma viride* (Tv), 5g Psf and 5g Tv (total 10g/ kg)	20^{th} June
7.	Control (No seed treatment)	20^{th} June
8.	Control (No seed treatment)	7^{th} July
9.	Control (No seed treatment) + Broadcasting of urea at 15DAS	7^{th} July

draining excess water. Required seed treatments operations as given in Table 1, were applied for presoaked seeds and treated seeds were again filled in their respective marked bags and kept for germination for another 24hrs. After that, nursery plots were flooded with water and levelled with wooden rods. Germinating seeds were broadcasted uniformly on their marked plots. Three replications were maintained for each treatment. Broadcasting of urea was done @40kg/ha in desired treatments at 12 days after sowing (DAS). Watering was done time to time as per the requirement. Disease scoring was done at 22 DAS as per standard evaluation system for rice (IRRI, 1996).

RESULTS AND DISCUSSION

Only one rice disease i.e. leaf blast, appeared as visible during the nursery. Symptoms of leaf blast were visible as early as 15 DAS in the nursery, but disease scoring was done at 22 DAS for leaf blast. Data presented in Table 2, showed that, all the treatments have variable effects on blast disease severity during nursery stage.

Seed treatment with combination product, Carboxin + Thiram @ 3g/kg seed with timely sowing on 20th June (treatment 1) was found most effective against leaf blast phase in the nursery. This treatment gave complete protection from blast disease in nursery during both the years. The same seed treatment when applied with late sowing (treatment 2), was found next to the treatment 1 in 2011 (average disease severity 4.78%), but ranked third after treatment 6 (seed treatment with local isolates of bioagents Psf and Tv + early sowing) during 2012. Treatment 6 (seed treatment with local isolates of bioagents *Pseudomonas fluorescens* or Psf and *Trichoderma viride* or Tv @10g/kg + early sowing) was found next to treatment 2 in 2011 and 2nd best treatment in 2012 with consistently lower mean disease severity (6.01% in 2011 and 5.09% in 2012). Seed treatment with Streptocycline + Copper oxychloride (COC) was found ineffective against leaf blast and at par with treatment 8 (Control 2). Seed treatment with Carbendazim + COC with late sowing in treatment 4 was also found ineffective against leaf blast in nursery with higher mean disease severities (10.40% in 2011 and 12.46 % in 2012). The effective management of blast and other rice diseases through seed treatment with combination product of Carboxin + Thiram were earlier reported by Serghat *et al.* (2002) and Kumar *et al.* (2009). This treatment combination was also reported to be effective against sheath blight, brown spot, sheath rot and *Bakanae* (foolish seedling) diseases of rice (Kumar *et al.*, 2009).

Application of nitrogen (urea) as top dressing with or without seed treatment aggravated the leaf blast severity in nursery during both the years. Even most effective seed treatment i.e. Carboxin + Thiram, showed significantly increased level of disease severity (20.96% in 2011 and 26% in 2012) when combined with top dressing of nitrogen in the nursery as compared to seed treatment with Carboxin + Thiram without top dressing (treatment 2). Maximum leaf blast severity (52.06%) was observed with late sown control plots, in combination with top dressing of nitrogen (treatment 9).

Early sowing of rice nursery in case of treatment 1 (seed treatment with Carboxin + Thiram) and treatment 7 (Control 1) were found to significantly reduce the blast disease in nursery as

Table 2. Effect of various management practices on the severity of leaf blast disease in Basmati rice nursery at 22 DAS

S. No.	Seed treatment/date of sowing	Rice variety	Severity (%) of blast disease in nursery during the year						
			2011			2012			Mean of
			PB 1	PB 1121	Mean	PB 1	PB 1121	Mean	2 years
1.	Carboxin 37.5% + Thiram 37.5% WS@3g/kg seed	20th June	(0.00) 0.00*	(0.00) 0.00	(0.00) 0.00	(0.00) 0.00	(0.00) 0.00	(0.00) 0.00	(0.00)
2.	Carboxin 37.5% + Thiram 37.5% WS@3g/kg seed	7th July	(6.67) 14.96	(2.89) 9.74	(4.78) 12.35	(21.15) 27.36	(4.32) 11.93	(12.73) 19.65	(8.76)
3.	Carboxin 37.5% + Thiram 37.5% WS@3g/kg seed + Broadcasting of urea at 15DAS	7th July	(24.90) 29.92	(17.03) 24.35	(20.96) 27.13	(31.93) 34.39	(20.67) 26.94	(26.30) 30.67	(23.63)
4.	Carbendazim 50WP@1g/kg + Copper oxychloride @2.5g/kg	7th July	(12.29) 20.49	(8.69) 17.11	(10.40) 18.80	(13.57) 21.53	(11.35) 19.65	(12.46) 20.59	(11.84)
5.	Streptocycline @500ppm+ Copper Oxychloride @2.5g/kg	7th July	(24.86) 29.87	(4.52) 12.23	(14.69) 21.05	(51.51) 45.85	(3.89) 11.35	(27.70) 28.60	(21.20)
6.	*Pseudomonas fluorescens* (Psf) and *Trichoderma viride*(Tv), 5g Psf and 5g Tv (10g/ kg)	20th June	(7.71) 16.09	(4.31) 11.92	(6.01) 14.00	(6.47) 14.72	(1.87) 7.80	(4.17) 11.26	(5.09)
7.	Control 1(No seed treatment)	20th June	(14.89) 22.68	(5.78) 13.89	(10.33) 18.28	(10.45) 18.84	(4.70) 12.52	(7.57) 15.67	(8.95)
8.	Control 2 (No seed treatment)	7th July	(20.76) 27.09	(8.89) 17.32	(14.82) 22.20	(25.49) 30.31	(12.29) 20.50	(18.89) 25.40	(16.86)
9.	Control 3 (No seed treatment) + Broadcasting of urea at 15DAS	7th July	(69.20) 56.28	(27.57) 31.64	(48.38) 43.96	(64.63) 53.50	(46.86) 43.17	(55.74) 48.34	(52.06)
		Mean=	(20.14) 24.15	(8.85) 15.35	-	(25.02) 27.39	(11.77) 17.09	-	
		CD (p=0.05)=		Treatment= Variety= Treatment x variety=	1.35 0.63 1.91		1.68 0.78 2.35		

* Arcsine transformation, data in the parentheses are original

compared to late sowing in treatment 2 and treatment 8 respectively. This might be due to lesser availability of natural blast inoculum in and around rice nursery field during hot summer weather of June. The secondary inoculum of blast may increase in field with the increase in growth and development of alternative weeds and other hosts leading to increased blast severity in late sown (July) rice nursery. Early sowing/ planting of rice was earlier reported to be helpful for the management of blast disease by Ahuja *et al.*(1995); Singh *et al.* (2000); Singh (2009) and Henry and Devasahayam (2011). Here the disease escape and/or avoidance principles of plant disease management, contribute to reduce the blast disease in rice nursery (Rush *et al.*, 1997). In the nursery, leaf blast symptoms first become apparent as early as 15 DAS. Here, most of the inoculum seems to be natural and not the seed borne. Long *et al.* (2001) during their studies on 'Rice Blast Epidemics Initiated by Infested Rice Grain on the Soil Surface', found that, sporulation of rice blast fungus on infested seed started as early as 14 days after seeding in the field and rice plots inoculated with those infested seeds shown first symptoms of leaf blast at 35 days after sowing. Hence, early appearance of leaf blast symptoms in the present study indicates towards the natural availability of blast inoculum from some external sources, most probably the alternative weed hosts.

Top dressing of nitrogen (urea) in nursery was found to aggravate the rice blast severity (treatment 3 and treatment 9) as compared to no top dressing of urea in treatment 2 and treatment 8 respectively with similar set of treatments. Excessive or imbalance use of nitrogenous fertilizers was reported to increase the rice blast severity particularly at its most susceptible stages, by Singh *et al.* (2003) and Singh (2009).

The Basmati rice variety PB 1121 showed significantly lesser leaf blast severities (8.85% in 2011 and 11.77% in 2012) as compared to the variety PB 1(20.14% in 2011 and 25.02% in 2012). The variety PB 1 showed significantly greater blast severity with all the seed treatment combinations during both the years as compared to PB 1121, except in case of treatment 4 during 2012 where, it was statistically at par with PB 1. Early sowing of rice in all the cases (treatment 1 and treatment 7), resulted in reduced leaf blast severities during nursery as compared to similar seed treatments with late sowing (treatment 2) and control (treatment 8). The mean leaf blast severity (of two years) in rice nursery as affected by various treatments is shown in Fig.1.

Acknowledgements: The first author is thankful to ICAR for awarding the Senior Research Fellowship during the study.

REFERENCES

Ahuja, S.C.; Panwar, D.V.S.; Ahuja, U. and Gupta, K.R. 1995. Basmati Rice- The Scented Pearl. CCS Haryana Agriculture University, Hisar, India.63p.

Geddes, A. M. W. and Iles, M. 1991. The relative importance of crop pests in South-Asia. NRI Bulletin No. 39. Overseas Development Administration, Kent, U.K. 102p.

Gnanamanickam, S. S. 2009. Biological Control of Rice Diseases. Springer Science, London. 108p.

Govt. of India. 2013. State of Indian Agriculture 2012-13. Ministry of Agriculture, Department of Agriculture and Cooperation, Directorate of Economics and Statistics, New Delhi, Govt. of India. 221p.

Henry, L.D.C. and Devasahayam, T.H.L. 2011. Crop Diseases: Identification, Treatment and Management. New India Pub. Agency, New Delhi – 110 088. 619p.

http://www.apeda.gov.in

Kumar, K.V.K.; Reddy, M.S.; Kloepper, J.W.; Lawrence, K.S.; Groth, D.E. and Miller, M.E. 2009. Sheath blight disease of rice (*Oryza sativa* L.) - An overview. *Biosciences, Biotechnology Research Asia* **6(2):** 465-480.

Long, D.H.; Correll, J.C. and TeBeest, D.O. 2001. Rice Blast Epidemics Initiated by Infested Rice Grain on the Soil Surface. *Plant Disease*, **85 (6):** 612-616.

Rush, C.M.; Piccinni, G. and Harveson, R.M. 1997. Agronomic measures-Part V (Cultural Control). *In*: Environmentally safe approaches to crop disease control (N.A. Rechcigl and J.E Rechcigl Eds.). CRC, Lewis Publishers, Boca Raton. pp: 243-282.

Serghat, S.; Mouria, A.; Touhami, A.O. and Douria, A. 2002. *In vivo* effect of some fungicides on the development of *Pyricularia grisea* and *Helminthosporium oryzae*. *Phytopathol. Mediterr.* **41:** 235–246.

Singh, R. S. 2009. Plant Diseases. 9th Ed. Oxford and IBH, Pub., New Delhi.

Singh, R.K.; Ahuja, U. and Ahuja, S.C. 2006. Basmati for prosperity. *Indian Farming* **56 (7):** 33-36.

Singh, U.D.; Choudhary, V. and Mathuria, R.C. 2009. Disease management in Basmati rice. *Indian Farming* **59(1):** 26-29.

Singh, U.S.; Rohilla, R.; Singh, A.; Tewari, S.N. and Singh, H.M. 2000. Plant Protection in Aromatic Rices. *In*: Aromatic Rices (R.K. Singh; U.S. Singh and G.K. Khush Eds.). Oxford & IBH Pub. Co. Pvt. Ltd., New Delhi.pp:216-255

Singh, U.S.; Tewari, S.N.; Singh, N.; Varshney, S.; Singh, H.N.; Singh, G.; Rohilla, R.; Ram, D. and Singh, R.K. 2003. Pest profile and integrated pest management in aromatic rices. *In*: A treatise on the Scented Rices of India (R.K. Singh and U.S. Singh Eds.). Kalyani Publishers, New Delhi- 110 002. pp:165-187.

J. Farming Systems Research & Development **20** (1) : 52-59 (2014)

COMPUTATIONAL MODELLING INTELLIGENCE IN AGRICULTURE

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Abstract

Computational intelligence as a viable tool for solving problems in agricultural. A model is a simplified representation of a system and simulation is the study of the system and its behavior using model. Calibration and validation are the two most important processes before giving any outcome of the model for the study area or the systems studied. Calibration or parameterization of model is needed for adjusting certain model parameters or relationships to make the model work for study sites. Validation is the comparison of the results of model simulations with observations from crops that were not used for the calibration. Application part of the model fulfills the requirement for which it was developed. Computational models are being very much used for yield forecasting, yield gap analyses, yield trend analysis, devising agronomic management strategies, extrapolation to other locations and impacts of climate change on yields. Computational models have also been used to estimate national food production and thus aid government policy decisions. Combined use of satellite imagery, GIS and computational model is useful for mapping potential land productivity and suitability. Computational models can also be useful in teaching crop and soil processes and crop system behaviour in response to weather, management and site conditions.

Keywords: Computational Modelling Agriculture, Intelligence, Calibration and Validation.

Introduction

Computational modeling and computational intelligence is a set of nature-inspired computational methodologies and approaches to address complex problems of the real world applications to which traditional methodologies and approaches are ineffective or infeasible [1]. The new technologies that are currently developing or will be developed over the next five to ten years, and which will substantially alter the business and social environment “Farming System is a complex multidisciplinary matrix of soil, plants, animals, implements, power, labour, capital and other inputs controlled in parts by farming families and influenced to varying degrees by political, economic, institutional and social forces that operate at many levels” [2]. The theory of computational modeling can be considered the creation of models of all kinds in the field of computer science. In the last decade we have witnessed a perfect storm in terms of the impact on our ability to predict climate condition. Compared to a decade ago, compute power is far cheaper, resulting in faster predictions. Emerging technologies are those technical innovations which represent progressive developments within a field for agricultural. Agriculture region can be considered as a collection of individual fields that vary in environmental conditions and management practices.

21st century has been defined by application of and advancement in agriculture technology in view of the decline in per capita availability of land from 0.5 ha in 1950-51 to 0.15 ha. by the turn of the century and a projected further decline to less than 0.1 ha by 2020, it is imperative to develop strategies and agricultural technologies that enable adequate employment and income generation, especially for small and marginal farmers who constitute more than 80% of the farming community [3]. Under the gradual shrinking of land holding, it is necessary to integrate land based enterprises like fishery, poultry, duckery, apiary, field and horticultural crops, etc. within the bio-physical and socio-economic environment of the farmers to make farming more profitable and dependable [4]. Currently popular approaches include deep learning, statistical methods, computational intelligence and traditional symbolic artificial intelligence.

Emerging trend in the Indian agricul-ture is leading towards the economic analysis in other fields; agricultural economists are more likely to broaden their experimental perspective to include interaction or feedback between humans and the natural world. This orientation has led in large part to increased interest in studies of economic processes over both time and space, using both dynamic optimization and spatial analysis [5][6][7]. The recent advancements in two computational economics modeling which useful for agricultural economics are—stochastic dynamic programming (SDP) and agent-based modeling (ABM) [8][9][10].

Farming systems approach, therefore, is a valuable approach to addressing the problems of sustainable economic growth for farming communities in India. Certainly this will play a key role in agricultural revolution in the 21st Century, which is very much important to make India a developed nation.

Design Technique / Methodology of computational modeling

The general methodology for computational modeling system is depicted in fig.1. The main elements in the design techniques are identification phase, conceptualization phase, formalization, system design & development, testing/evaluation and prototype revision phase [15].

Identification phase: It is the definition phase which identifies the problem. To identify, characterize and define the problem is the objective of Identification phase. After defining the problem the necessary resources, goals and objectives are identified.

Conceptualization phase: The second stage of ES development, conceptualization, involves designing the proposed program to ensure that specific interactions and relationships in the problem domain are understood and defined [16]. Relationships between objects and processes and control mechanisms are determined as key concepts. This is the initial stage of knowledge acquisition. It involves the specific characterization of the situation and determines the expertise needed for the solution of problem.

Formalization Phase: The formalization phase involves organizing the concepts, sub problems and information flow into the formal representations. To identify a domain with a collection of all possible solutions, the hypothetical solution space, the underlying model, and the characteristics of the data are the key objectives. It is difficult to separate the conceptualization phase from the formalization phase and, in reality, knowledge-base design proceeds almost in parallel with knowledge acquisition [17].

System design phase: Identification of design blocks, determination of storage devices, detail design block specifications are the three phases in the system design phase. During the system design phase, the designer specifies how the system will meet the requirements identified during the previous three phases of the development [18].

System development phase: The computational modeling is created during the system development stage with the design created during the System design phase.

Testing and evaluation phase: Testing is the most important part of the computational modeling. During this phase, the prototype system is evaluated. Whether the computational modeling is meeting the requirements of the designer/user is evaluated in the phase [19]. Perhaps the most difficult aspect of testing is accurately handling the uncertainty that is incorporated in most CM in one way or another.

Prototype revision phase: A computational modeling evolves over time, calling for almost constant revision, a trait expert systems share with most prototypes. Based on the results of the testing/evaluation phase, concepts and relations are refined, the solution space, the model, and the data characteristics are renormalized, and the system is redesigned.

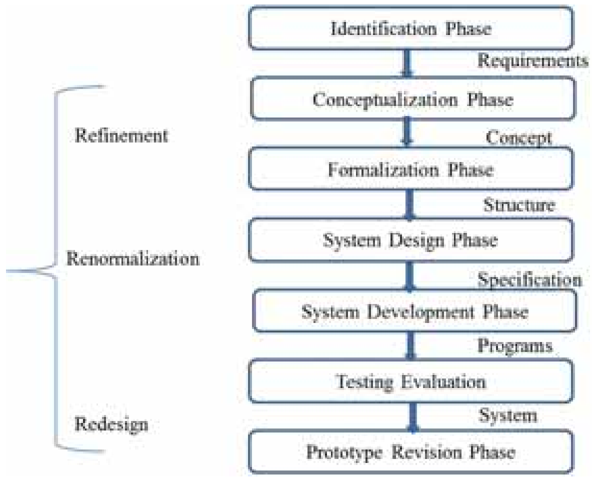

Fig. 1. The steps in a typical computational modeling analysis and design methodology

Theoretical concepts and computational methods that describe, represent and simulate the functioning of real-world processes; computer simulations in agriculture system are becoming a 'third way' of performing research, expanding thus traditional experimental and theoretical approaches: simulation can be regarded as a numerical experiment, but it often requires advancements in theory simulations can provide information which is impossible or too expensive to measure, as well as insights which are not amenable or too complicated for analytical theory methods models are simplified abstractions of reality representing or describing its most important/driving elements and their interactions simulations can be regarded as model runs for certain initial conditions (real or designed). In fact, most research efforts in the last few decades have dedicated to finding the most efficient methods in solving complex systems [20].

Purpose of computational modeling

- Analysis and understanding of observed phenomena

- Testing of hypotheses and theories
- Prediction of spatial-temporal systems behavior under various conditions and scenarios (both existing and simulated, often performed to support decision making)
- New discoveries of functioning of geospatial phenomena enabled by unique capabilities of computer experiments

Approaches to modeling and simulations

- Real processes are complex and often include non-linear behavior, stochastic components and feedback loops over spatial and temporal scales, therefore models can represent the processes only at a certain level of simplification
- Empirical models are based on statistical analysis of observed data, and they are usually applicable only to the same conditions under which the observations were made (for example the Universal Soil Loss Equation for modeling annual soil loss based on terrain, soil, rainfall and land cover factors) [11].
- Process based models are based on understanding of physical, chemical, geological, and biological processes and their mathematical description (for example, hydrologic and erosion models SIMWE: [12][13].
- Models of complex systems often use combination of empirical and process based approaches

Computational modeling related to multi-discipline computer software

Computational modeling software has emerged as the most popular medium for data interpretation during the last decade. Software comes with various values added features, which make simulation software truly multipurpose equipment. Software can be used as a result of the raw data. Many models exist for predicting how crops respond to climate, nutrients, water, light, and other conditions. One of the most widely used modeling systems across the world is the DSSAT model (Decision Support System for Agrotechnology Transfer). Currently, the DSSAT shell is able to incorporate models of 27 different crops, including several cereal grains, grain legumes, and root crops [14].

Scope of computational modeling in agriculture

- Building an integrated computational model of the agriculture based on studies of farm mechanics, farmers interactions, which ultimately will help accelerate to agricultural farming systems.
- Using a computational model of the farming system to understand the fundamental weather, plant, bio fertilizer, irrigation and mechanical functions of the soil.
- Studies of farming information processing, including computational modeling of the encoding and processing of complex sounds by the cropping system and of processes involved in learning of farming system.

- **Natural resources**
  a. Water, sediment and contaminants
  b. SWAT: Soil and Water Assessment Tool
  c. Solid earth processes
  d. SAND: conditional simulations for mining and landscape evolution
  e. Atmospheric modeling and dynamic ecological simulation
- **Socio-economic**
  a. Transportation
  b. Transportation management with GIS
  c. Population growth and migration
  d. Urban growth and Food production
  e. Interfacing crop growth models with GIS
- **Integrated models of complex systems**
  a. Atmospheric + hydrologic + plantgrowth + erosion/ sedimentation + crops + dairy + horticulture
  b. Modular Modeling System
  c. Economic-ecological systems
  d. Integrated Ecological Economic Modeling And valuation of Watersheds: Patuxten watershed model

As computational modeling exposes hidden assumptions in the theory, addressing those assumptions can extend the scope of the theorizing. Seen in this way, computational models become not only a way to concretize theories, but also a framework for theory construction [21].

Farming Systems simulation: Farming systems is a powerful research tool for natural and human resource management in developing countries particularly in India. This is a multidisciplinary holistic approach and very effective in solving the problems related to farmers specially required for small and marginal farmers. The approach aims at increasing income and employment from small-holdings by integrating various farm enterprises and recycling crop residues and by-products within the farm itself [22][23]. A model is a simplified abstraction of the real world. It simulates the behaviour of a real system. Modeling begins with the analysis of the systems, its circumstances and purposes. Defining the model gives insight into the working of the system. So far, the farming systems research has been rather inadequate or slow, particularly in less developed countries. Perhaps the only way by which improvement can be achieved is by the construction and application of suitable whole farm models [24]. Recent computer software development may provide the basis for a start in modelling of whole farm systems even with incomplete conceptual understanding and data sets.

Farming Systems Research Models: Farming system models are useful for improving the production and profitability of the farms through the following ways:

(a) To improve the understanding of farming systems, thereby helping in prioritization of enterprises, better planning and designing of FS experiments, and farm management and policy development.

(b) To analyses and explain behaviour of a complex system and to determine the relative importance of different components/enterprises of the systems.

(c) To examine the different scenarios resulting due to integration or mixing of different components or modifying different components in the systems.

(d) To identify the areas where the knowledge of the system is fundamentally lacking.

(e) Improvising the system for its wider application in varying situations i.e. under varying resource availability and resource constraints situations.

Validating Computational Models

Verification is a rigorous statistically based approach to validation. A potential error in verification is the use of non-comparable data. That is, for comparability the results of the computational model and the real data should be obtained under comparable situations and environmental conditions [25],[26]. Such comparability can be enhanced by setting input data and parameters in the computational model to resemble as closely as possible those in the real situation. The process of validating computational models and techniques for performing such validation that have been and are being used in the social and organizational sciences have been described.

Conclusion

A model is a simplified representation of a system and simulation is the study of the system and its behaviour using model. Computational models have also been used to estimate national food production and thus help government policymakers. Combined use of satellite imagery, GIS and computational model is useful for agricultural mapping potential land productivity and suitability. The computation-al models for agriculture may help to fill in data gaps that currently exist. Computational models can be used before screening compounds to prioritize those of most interest, as was recently demonstrated by scoring the algorithms of used the farming system. But this dataset may be useful for validating computational models with the ca-veat that the IFS (Integrated Farming System).

References

Sanjeev S. Sannakki et al, 2013. *Computational Intelligence for Pathological Issues in Precision Agriculture* DOI: 10.4018/978-1-4666-2518-1.ch026

Behera, U.K. and Mahapatra, I.C. 1999. Income and employment generation of small and marginal farmers through integrated farming systems. *Indian Journal of Agronomy*. **44(3):** 431-439.

Jha, D. 2003. An overview of farming systems research in India. *Annals of Agricultural Research* **24(4):** 695-706.

Behera, U.K., Jha, K.P. and Mahapatra, I.C.2004. Integrated management of available resources of the small farmers through IFS, Indian Journal of Agronomy.

Kennedy, J. O. S. 1986. *Dynamic Programming: Applications to Agriculture and Natural Resources*. London: Elsevier.

Miranda, M. J. and P. L. Fackler. 2002. *Applied Computational Economics and Finance*. Cambridge, MA: MIT Press.

Nelson, G. 2002. Introduction to the special issue on spatial analysis for agricultural economists.*Agricultural Economics* **27 (3):** 197–200.

Berry, B. J. L., L. D. Kiel and E. Elliot. 2002. Adaptive agents, intelligence, and emergent human organization: Capturing complexity through agent-based modeling. *Proceedings of the National Academy of Sciences* **99 (Suppl 3):** 7178–88.

Hernandez, C., K. Troitzsch and B. Edmonds, eds. 2008.*Social Simulation Technologies: Advances and New Discoveries*. Hershey, PA: Information Science Reference.

Waldrop, M. 2009. A model approach. *Nature* **460:** 667.

Renard, K. G., Foster G. R., Weesies G. A. and Porter, J. P. 1991, Revised Universal Soil Loss Equation. Journal of Soil and Water Conservation, **46(1):** p. 30-33.

Mitas L., Mitasova H. 1998 Distributed erosion modeling for effective erosion prevention. Water Resources Research **34(3):** 505-516.

Goodchild, M.F., L. T. Steyaert, and B. O. Parks, eds.,1996, GIS and Environmental Modeling: Progress and Research Issues, GIS World, Inc., Ft. Collins, CO *proceedings from a conference in Breckenridge, CO, 1993 reflects progress in integration of GIS and modeling*

Hoogenboom, G., White, J.W., 2003. Improving physiological assumptions of simulation models by using gene-based approaches. *Agron. J.* **95:** 82–89.

Jay Liebowitz (1989) Expert systems technology for training applications, Educational Technology Volume **29:** Issue 7 Pages: 43–47.

Hayes-Roth, F., Waterman, D. A., and Lenat, D. B., Building Expert Systems, Addison-Wesley, Reading, MA, 1983.

Waterman, D. A., A Guide to Expert Systems, Addison-Wesley, Reading, MA, 1986.

Shaalan Khaled, El-Badry Mona, Rafea Ahmed; 2004; A multiagent approach for diagnostic expert systems via the internet; Expert Systems with Applications **2** (2004) 1-10

Harmon, P. and King, D., Expert Systems: Artificial Intelligence in Business, John Wiley & Sons, Inc., New York, 1985.

Rafea A, Shaalan K; 1996; Using Expert Systems as a Training Tool in the Agriculture Sector in Egypt; Expert Systems with Applications – An International Journal; Vol 12(12) Pergamon

Marsella, S. & Gratch, J. (2009) EMA: A Process Model of Appraisal Dynamics. *Journal of Cognitive Systems Research,* **10:** 70-90.

Behera, U.K. and Mahapatra, I.C. 1999.Income and employment generation of small and marginal farmers through integrated farming systems.*Indian Journal of Agronomy*. **44(3):** 431-439.

Singh, S.S. 1997. Crop Management under irrigated and rainfed conditions. Kalyani Publishers, Ludhiana, India.

Dent, J.B.1990. *Systems theory applied to agriculture and the food chain*. Elsevier, Amsterdam.

Kleijnen, J.P.C. 1995. “Statistical Validation of Simulation Models.” European Journal of Operational Research, **87(1):** 21-34

Dee, D. P. (1994).*Guidelines for Documenting the Validity of Computational Modeling Software* (24 pp). Delft, The Netherlands: International Association of Hydraulic Research.

J. Farming Systems Research & Development **20** (1) : 60-66 (2014)

PERFORMANCE OF PADDY GENOTYPES TRANSPLANTED AT DIFFERENT AGE OF SEEDLINGS AND SPACING UNDER SYSTEM OF RICE INTENSIFICATION (SRI) IN WESTERN PLAIN ZONE OF UTTAR PRADESH

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ABSTRACT

A field experiment was carried out at Farm of *Krishi Vigyan Kendra, Hastinapur (UP)* during *kharif* seasons of 2008 to 2011. The soil of the experimental field was sandy loam having pH 7.8 with low in organic carbon (0.35 %), medium in available phosphorus (17 kg/ha) and potash (152 kg/ha). The experiment had 8 treatments combinations including 2 varieties (Pusa Basmati-1 & Pusa Sugandha- 4), 2 age of seedlings (10 & 12 days old) and 2 spacings (25 cm x 25 cm & 30 cm x 30 cm) replicated 3 times in a factorial randomized block design. The crop was fertilized with 120 kg N, 60 kg P_2O_5, 60 kg K_2O and 25 kg $ZnSO_4$/ha. The results indicated that the variety Pusa Sugnadha-4 produced significantly higher number of spikes/hill (25.4), grain (37.7 q/h), straw (45.5 q/ha) and biological (83.2 q/ha) yields as well as gross return (Rs. 60267/ha), net return (Rs. 31254/ha) and B: C ratio (2.08) as compared to Pusa Basmati-1. In case of age of seedlings slightly higher values of yield attributes, yields and economics of paddy were recorded when 10 days old seedlings were transplanted as compared to 12 days old seedlings but could not reach up to significant difference. Further, in SRI method there was no significant difference in growth and yield attributes due to change in spacing of transplanting, however, transplanting at 25 x 25 cm spacing gave 5.25, 5.31 and 5.28 per cent higher grain, straw and biological yields as well as more gross return of (Rs. 2853/ha), net return (Rs. 2666/ha) and B: C ratio (0.09) as compared to wider spacing (30x30 cm).

Key words: System of Rice Intensification, Genotypes, Spacings, Seedlings, Transplanting, Yield.

Rice forms staple food for more than half of the world's population and the word demand for rice will grow continuously. Though, India has the largest area under rice in the world, but its productivity level of 3.1tonnes/ha (Economic Survey, 2012) is far below the neighboring country like China greater than (6.0 tonnes/ha) and the world average (4.0 tonnes/ha). To overcome low yields, system of rice intensification has been projected as a potential method of rice cultivation. Husain *et al.* (2004) reported 30 % yield advantages from SRI in Bangladesh and Namara *et al.* (2003) showed an even larger benefit (44 %) in Sri Lanka.

Rice is the largest consumer of irrigation water. In the Indo-gangetic plains of India, total water requirement of rice varies from 1566 mm in clay loam to 2262 mm in sandy loam soils (Tripathi, 1990) about 50-80 % of total water input percolates deep in soil profile and only 30-40 % is utilized consumptively (Koga, 1992). The SRI method which envisages alternate wetting and drying may help

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reduce water losses and improve productivity. Under any method of cultivation, optimum water supply is the important factor governing availability and uptake of essential nutrients, growth, yield and quality of the rice. However, optimum ground space available to each plant is also important for exploitation of available resources. In SRI a wider spacing is recommended, which leads to vigorous root growth and profuse tillering, however, it may be variety dependent and location specific. The square geometry at wider spacing facilitates the movement of mechanical weeder, which is one of the other essential components of SRI techniques. Crop geometry and irrigation may influence the growth and yield of different genotypes to varying degree. A variety with shy tillering and short stature requires to be planted closer, while a tall and profusely tillering one may require wider spacing to produce desire number of healthy and productive shoots per unit area. Likewise, different varieties may respond differently to moisture stress. Thus, the effect of key production components like genotype, irrigation regime and crop geometry on productivity of rice need to be investigated for making any policy on the cultivation of rice with SRI method, especially in the water scares areas.

A System of Rice Intensification (SRI) has attracted attentions because of its apparent success in increasing rice yields with less water use (Uphoff *et al.*, 2008). SRI management involves many departures from the methods conventionally recommended for rice cultivation. SRI proposes the use of single young seedlings, drastically reduced plant densities, keeping fields unflooded, use of a mechanical weeder which also aerates the soil and enhanced soil organic matter. These practices have the aim of providing optimal growth conditions for the plant to get better yield and resource productivity (Stoop *et al.*, 2002). SRI practices are reported to increase the yields of irrigated rice by 20-50 % or even more (Thakur *et al.*, 2010) while reducing water requirements (Satyanarayana *et al.*, 2007). Keeping this in view, a field experiment was planned to evaluation the performance of paddy genotypes transplanted at different age of seedlings and spacing under Systems of Rice Intensification (SRI) in Western Plain Zone of Uttar Pradesh.

Materials and Methods

The field experiment was carried out at the Farm of Krishi Vigyan Kendra, Hastinapur (UP) during *kharif* seasons of 2008 to 2011. Hastinapur is situated at $29^0$01'N, $77^0$45'E and 237 m above mean sea level in Western Plain Zone of Utter Pradesh. The climate the area is semi arid, with an annual average rainfall of 805 mm (75-80% of which is received during July to September), minimum temperature of 0 to 4^0C in January and maximum temperature of 41 to 45^0C in June along with 67 to 83% relative humidity throughout the year. The soil of the experimental field was sandy loam having pH 7.8 with low in organic carbon (0.35 %), available nitrogen (170 kg/ha), medium in available phosphorus (17 kg/ha) and potash (152 kg/ha). The experiment consisted 8 treatments combinations including 2 varieties (Pusa Basmati- 1 & Pusa Sugandha- 4), 2 age of seedling (10 & 12 days old) and 2 spacings (25 cm x 25 cm & 30 cm x 30 cm) replicated 3 times. The treatments were arranged in a factorial randomized block design. The experiment had 24 plots of size 9 m x 6 m each. The rice seedlings were raised on a raised bed of size 1.25 m x 8 m with wet bed method.

For nursery establishment germinated seeds were broadcasted in first fortnight of July during all the years of experimentation. The nursery was adjacent to the main field so that transplanting could be performed quickly to minimize injury. Ten and Twelve day old seedlings were transplanted on 20th and 22nd July, respectively in all the years of study in the SRI plots within half an hour after removal from the nursery. With both varieties, organic manure was applied at the rate of 5 tonnes per hectare along with chemical fertilizers. The crop was fertilized with 120 kg N, 60 kg P_2O_5, 60 kg K_2O and 25 kg $ZnSO_4$/ha. One third of nitrogen and full dose of phosphorus, potash and zinc sulphate through fertilizers (urea & diammonium phosphate for N & P, muriate of potash for K and zinc sulphate hepta hydrate for Zn) were applied as basal before transplanting. The remaining dose of nitrogen was top dressed equally in 3 splits at 20 days after transplanting, grand tillering stage (40-45 DAT) and panicle initiation (60-65 DAT).

First irrigation was applied 5 days after transplanting to moisten the field without ponding. The second irrigation was given on the evening of 9th day of transplanting at a ponding depth of 2-5 cm, and in the next morning a weeding was performed by a cono-weeder. Thereafter, the alternate wetting and drying method of irrigation was followed and irrigation water was applied 3 days after the disappearance of ponded water. After panicle initiation, all the plots were kept flooded with a thin layer (2-3 cm) of water and all were drained at 15 days before harvest. To control weeds, cono-weeder was run manually in the rows of rice crop twice, in both the directions, at 10, 20 and 30 days after transplanting (DAT) during all the years of investigation.

Data on plant height was recorded before harvesting of crop from all the plots. Average tiller number and panicle number were determined from the crop harvested from a square metre area from each plot. Panicle length, number of grains per panicle and 1000 grain weight were measured from the samples harvested from a square metre area from each replication. The data on grain yield, straw yield and biological yield were recorded at crop maturity from the samples of crop harvested from three square metre areas from each plot. The economic-parameters (gross return, net return and B: C ratio) were worked out on the basis of prevailing market prices of inputs and outputs.

All the data were statistically analyzed using analysis of variance (ANOVA) technique as applicable to factorial RBD as per the procedures described by Rangaswamy (2006). The significance of the treatment effect was determined using F-test and to determine the significance of the difference between two treatments means, least significant difference (LSD) was estimated at 5% probability level.

RESULTS AND DISCUSSION

Growth and yield attributes of paddy

The growth and yield attributes of rice were not influenced significantly due to variation in genotypes, age of seedlings and spacing grown under system of rice intensification (SRI) method except number of spikes/hill (Table-1).

Table 1. Effect of genotypes, age of seedling and spacing on growth parameters and yield attributes of paddy under SRI method (Average of 04 years)

Treatments	Plant height (cm)	Tillers/ hill (No.)	Spikes/ hill (No.)	Spike length (cm)	Grain/ spike (No.)	Test weight (g)
Genotypes						
Pusa Basmati- 1	114.4	32.8	19.1	20.0	195	32.0
Pusa Sugandha- 4	117.9	38.6	25.4	19.8	201	33.4
CD (P=0.05)	3.50	6.08	3.73	0.91	9.55	2.87
Age of seedlings (Days)						
10	117.5	38.7	23.0	20.0	198	34.0
12	114.8	32.8	21.5	19.8	197	31.4
CD (P=0.05)	3.50	6.08	3.73	0.91	9.55	2.87
Spacings (cm)						
25 cm x 25 cm	115.5	34.3	21.4	19.5	195	32.3
30 cm x 30 cm	116.8	37.2	23.1	20.2	200	33.1
CD (P=0.05)	3.50	6.08	3.73	0.91	9.55	2.87

Significantly higher numbers of spikes per hill (25.4) were recorded in the genotype Pusa Sugandha-4 as compared to Pusa Basmati-1 (19.1). However, higher values of growth and yield attributes of rice were found in Pusa Sugandha-4 as compared to Pusa Basmati-1.

In case of age of seedlings slightly higher values of growth and yield attributes were recorded when 10 days old seedlings were transplanted as compared to 12 days old seedlings. Similar results were also reported by Patra and Haque (2011).

Further, there was no significant difference in growth and yield attributes due to change in spacing of transplanting, however, slightly higher values of plant height (116.8 cm), number of tillers/hill (37.2), number of spikes/hill (23.1), spike length (20.2 cm), grains/ spike (200) and test weight (33.1g) were recorded when transplanting was done at wider spacing (30 x 30 cm) as compared to closer spacing (25 x 25 cm), but could not reach up to significant difference. This might be due to faster and more development of roots on individual plants transplanting in wider spacing due to more space and less completion for nutrients, water and solar radiation resulted in higher value of growth and yield attributes characters. Thakur *et al.* (2010) and Dass and Chandra (2012) also reported that performance of individual hills was significantly improved with wider spacing compared to closer spaced hills in terms of root growth and xylem exudation rates, leaf number and leaf sizes, canopy angle, tiller and panicle number, panicle length and grain number per panicle, grain filling and

1000-grain weight and straw weight in SRI practice.

Paddy productivity

The productivity of paddy influenced significantly due to variation in genotypes and spacing of transplanting under system of rice intensification, but age of seedlings had no significant effect on grain, straw and biological yields of paddy (Table 2). The two genotypes, Pusa Basmati-1 and Pusa Sugandha- 4 grown under SRI method, exhibited sharp difference in grain, straw and biological yields. Pusa Sugnadha-4 produced significantly higher grain (37.7 q/h), straw (45.5 q/ha) and biological (83.2 q/ ha) yields, which were 14.9, 15.2 and 15.07 per cent more as compared to Pusa Basmati-1. This could likely be due to higher values of growth and yield attributes in Pusa Sugandha- 4. Shekhar *et al.* (2009) also reported that higher yields under SRI method.

Transplanting of different age seedlings had no significant effect of grain, straw and biological yields as well as harvest index on paddy grown under SRI method. However, slightly higher grain (0.9 q/ha), straw (1.8 q/ha) and biological (2.7 q/ha) yields were obtained when transplanting was done at 10 days age of seedlings as compared to 12 days old seedlings. This might be due to early establishment of seedlings in the main field resulted in better root and shoot development ultimately produced more yield. Similar results were also reported by Patra and Haque (2011).

Yield of paddy influenced significantly due to transplanting at different spacings. Transplanting at wider spacing

Table 2. Effect of genotypes, age of seedling and spacing on yield and economics of paddy under SRI method (Average of 04 years)

Treatments	Grain yield (q/ha)	Straw yield (q/ha)	Biological yield (q/ha)	Harvest index (%)	Gross return (Rs./ha)	Net return (Rs./ha)	B: C ratio ratio
Genotypes							
Pusa Basmati- 1	32.8	39.5	72.3	45.3	52427	24252	1.86
Pusa Sugandha- 4	37.7	45.5	83.2	45.3	60267	31254	2.08
CD (P=0.05)	0.98	1.85	2.98	0.04	1478	1241	0.03
Age of seedlings (Days)							
10	35.7	43.4	79.1	45.1	57066	28328	1.98
12	34.8	41.6	76.4	45.5	55628	27178	1.95
CD (P=0.05)	0.98	1.85	2.98	0.04	1478	1241	0.03
Spacings (cm)							
25 cm x 25 cm	36.1	43.6	75.7	45.3	57773	29086	2.01
30 cm x 30 cm	34.3	41.4	79.7	45.3	54920	26420	1.92
CD (P=0.05)	0.98	1.85	2.98	0.04	1478	1241	0.03

(30 x 30 cm) produced significantly less grain (34.3 q/ha), straw (41.4 q/ha) and biological (75.7 q/ha) yield as compared to transplanting at slightly narrow spacing (25 x 25 cm). In SRI method, transplanting of seedlings at 25 x 25 cm spacing gave 5.25, 5.31 and 5.28 per cent higher grain, straw and biological yields as compared to wider spacing (30 cm x 30 cm). The low yield was recorded at 30x30 cm spacing under SRI practice, as a result of less plant population (11 hills/m^2), despite improved hill performance. Menete *et al.* (2008) and Thakur *et al.* (2010) also reported that wider spacing in SRI method to be disadvantageous, however, wider spacing in SRI improve the productivity of individual hill, but not sufficiently to compensate for the higher yield in area basis as achieved with the lower spacing.

Paddy economics

The economics of paddy cultivation also influenced significantly due to different genotypes and transplanting at different spacings but transplanting of different age seedlings had no significant effect on economics of paddy (Table 2). Significantly higher gross return of Rs. 60267/ha and net return of Rs. 31254/ ha as well as B: C ratio (2.08) were obtained with the cultivation of variety Pusa Sugandha-4 under SRI method as compared to variety Pusa Basmati-1 (Rs. 52427/ha, Rs. 24252/ha and 1.86, respectively). This might be due to higher yield of Pusa Sugandha-4 as compared to variety Pusa Basmati-1. Similar results were also reported by Shekhar *et al.* (2009) and Dass and Chandra (2012).

Age of seedling had no significant effect on economics of paddy (Table-2). However, slightly more values of gross return of (Rs. 1438/ha), net return (Rs. 1150/ha) and B:C ratio (0.03) were obtained when paddy seedlings were planted at the age of 10 days as compared to 12 days old seedlings under SRI method. These higher values may be due to higher yields of paddy at 10 days seedlings.

Transplanting of paddy at different spacings also influenced the economics of paddy cultivation under SRI method (Table-2). Paddy transplanting at 25x25 cm spacing gave significantly higher gross return of (Rs. 57773/ha), net return (Rs. 29086/ha) and B:C ratio (2.01) as compared to wider spacing (30x30 cm). The difference in increased values was Rs. 2853 in gross return, Rs. 2666/ha in net return and 0.09 in B: C ratio over transplanting at 30x30 cm spacing. The results are in close conformity with those of Dass and Chandra (2012).

In conclusion, paddy varieties respond differently when grown under SRI conditions but transplanting at slightly different age of seedling had no significant effect on paddy performance. Wider spacing beyond optimum plant density, however, does not give higher grain yield on an area basis but performance of individual hills improves with increase in spacing, therefore, for achieving this; a combination of improved hills with optimum plant population must be worked out for SRI according to location specific conditions.

References

Dass, Anchal and Chandra, Subhash. 2012. Effect of different components of SRI on yield, quality, nutrient accumulation and economics of rice (Oryza sativa) in tarai belt of northern India. *Indian Journal of Agronomy* **57 (3):** 250-254.

Economic Survey, 2012. Government of India. Ministry of finance. Department of Economic Affairs. Economic Division. Oxford University Press, New Delhi. A19 pp.

Husain, A. M.; Chowhan, P.B.; Uddin, A.F.M. and Rahman, A.B.M. 2004. Final evaluation report on Verification and Refinement of the System of Rice Intensification (SRI) Project in selected areas of Bangladesh.

Koga, K. 1992. Introduction to paddy field Engineering, Asian Institute of Technology, Bankok, Thailand. pp.118.

Menete, M.Z.I.; Van Es, H.M.; Brito, R.M.L.; DeGloria, S.D. and Famba, S. 2008. Evaluation of system of rice intensification (SRI) component practices and their synergies on salt-affected soils. *Field Crop Research* **109**: 34-44.

Namara, R.E.; Weligamage,P. and Barker, R. 2003. Prospects for adopting System of Rice Intensification in Sri Lanka : A Socio-economic Assessment Research Report 75. International Water Management Institute, Colombo, Sri Lanka.

Patra, Partha Sarathi and Haque, Samsul.2011. Effect of seeding age on tillering pattern and yield of rice (Oryza sativa L.) under System of Rice Intensification. *ARPN Journal of Agricultural and Biological Science.* **6(11):** 33-35.

Rangaswamy, R. 2006. *A Text Book of Agricultural Statistics*. New Age International (P) Limited, New Delhi, pp.496.

Satyanarayana, A.; Thiyagarajan, T.M. and Uphoff, N. 2007. Opportunities for water saving with higher yield from the system of rice intensification. *Irrigation Science* **25:** 99-115.

Shekhar, J.; Mankotia, B.S. nad Dev, S.P. 2009. Productivity and economics of rice (Oryza sativa0 in system of rice intensification in north-western Himalayas. *Indian journal of Agronomy* **54 (4):** 423-427.

Stoop W.A.; Uphoff, N. and Kassam, A. 2002. A view of agricultural research issue raised by the System of Rice Intensification (SRI) from Madagascar: Opportunities for improving system for resource poor farmers. *Agricultural Systems* **71**: 249-274.

Thakur, A.K.; Rath, S.; Roychowdhury,S. and Uphoff,N. 2010. Comparative performance of rice with System of Rice Intensification (SRI) and conventional management using different plant spacings. *Journal of Agronomy & Crop Science* **196 (2010):** 146-159.

Tripathi, R.P.1990. Water requirement in rice-wheat system. *(In): Proceedings of Rice-Wheat Workshop*. October 15-16. Modipuram, U.P.

Uphoff, N.; Kassam, A. and Stoop, W.A. 2008. A critical assessment of a desk study comparing crop production systems; the example of the 'System of Rice Intensification' versus 'Best management Practice'. *Field Crop Research* **108:** 109-114.

J. Farming Systems Research & Development **20** (1) : 67-76 (2014)

ECONOMICS OF EXISTING FARMING SYSTEMS IN CHITTORGARH DISTRICT OF SOUTHERN RAJASTHAN

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ABSTRACT

Farming system represents integration of farm enterprises such as cropping system, animal husbandry, fisheries, forestry, and poultry etc. for optimal utilization of resources bringing prosperity to the farmer. Rajasthan, the largest state of Indian union occupies nearly 10.4 per cent geographical area of the country. The present investigation was under taken to Economics of existing farming system in Chittorgath district of Rajasthan during 2012-13. A tatal sample of 60, household, consisting of 30 rainfed and 30 irrigated household was selected for study. Four farming systems were existed in all both the rainfed and irrigated areas of Chittorgarh district they are: FS-I: Crop+Vegetables (C+V), FS-II Crop + Dairy (C+D), FS-III Crop + Dairy +Goat (C+D+G), FS-IV Crop +Goat +Poultry (C+G+PO). In rainfed area of Chittorgarh district the maximum (40 %) of households were adopted FS-II (Crop + Dairy). The cropping intensity ranged from 94.34 per cent to 98 per cent. The highest cropping intensity (98%) was observed in FS-I whereas lowest cropping intensity (94.34%) was found in FS-IV. In irrigated area of Chittorgarh district four farming systems were prevailing i.e. FS-I crop + vegetable(C+V) +FS-II Crop+Dairy (C+D) FS-III crop + Dairy +Goat and IV Crop+ Goat+ orchard (C+G+O). The maximum households were falls in FS-II (C+D) 46.67 followed by FS-IV C+G+O 23.23 per cent. In rainfed area of Chittorgarh district on the household basis the net returns was profitable (‘ 80146.05) in FS–III (Crop+Goat+Dairy) while the returns per rupees (‘ 1.55) basis FS-IV (Crop+Goat+ Poultry) was found most profitable. In a irrigated area of Chittorgarh district on net return and returns per rupee (‘ 162689.87) and (‘ 1.69) basis FS-I (Crop+ Vegetables) found most profitable.

Key words: Farming System, Chittorgarh, rainfed, Irrigatation,

INTRODUCTION

Farming system represents integration of farm enterprises such as cropping system, animal husbandry, fisheries, forestry, and poultry etc. for optimal utilization of resources bringing prosperity to the farmer. Farming system approach introduces a change in farming techniques for higher production from the farm as a whole with the integration of all the enterprises like dairy, poultry, piggery, fishery, sericulture etc. suited to the given agro-climatic condition and socio –economic status of farmer would bring prosperity to the farmer. Every farmer tries to choose the farm activities/enterprises depending upon physical and economic conditions prevailing in his ecosystem. Integration of various farm enterprises ensures growth and stability in overall productivity and profitability. It also ensures optimization of resource use, minimization of risk and generation of employment. The basic aim of integrated / sustainable farming system is to derive a set of resource development management and utilization practices that lead to a substantial and sustained increase in agriculture production. Since farming system differ in different situation such studies conducted on farming system showed that farming

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system approach is better than conventional farming (Ravishankar,et al.2007and Singh et.al 2007).Farming enterprise includes crop, livestock, poultry, fish, sericulture, vermicompost, dairy, goat, *etc.* A combination of one or more enterprises with cropping, when carefully chosen, planned, and executed, gave greater dividends than single enterprise especially for small and marginal farmers. Farm as a unit is to be considered and planned for effective integration of enterprises to be combined with crop production activity. Judicious mix of one or more of these enterprises with crop should complement the farm income.

Rajasthan, the largest state of Indian union occupies nearly 10.4 per cent geographical area of the country. Agriculture and allied activities accounted for nearly one fourth of the state domestic product against 13.8 per cent at national level. Therefore agriculture despite all odds constitutes to be the main stay of rural masses. The agriculture in most part of the state is rain fed and is prone to high risk. In order to meet the farm and family requirement, the farmers in the state have evaluated different combinations of crop livestock, horticulture, forestry etc. In other words farming system is an age old practices in the state of Rajasthan. Out of 10 agro climatic regions of the state, the one regions i.e. sub-humid Southern plane and Aravalli hills zone (IVA) falls in southern Rajasthan and is relatively more diversified for crop and livestock production. In this regions crops like maize, jowar, cotton, black gram, soybean, groundnut, cluster bean etc. are grown in kharif and crops like wheat, barley, rape seed and mustard, gram, isabgol, etc are grown in rabi. There are substantial areas under different vegetables in these regions. Among livestock cattle, buffalo, goat and sheep are the most dominating animals. The farming system models practice by the farmers include various combinations of field crops, horticulture crops and livestock in southern Rajasthan. Keeping above facts in view, the present study was conducted in Chittorgarh district of southern Rajasthan.

METHODOLOGY

The present study was conducted for existing farming systems of Chittorgarh district A multi stage random sampling plan was used for the present study, in which at first stage tehsils, villages in second stage and the households were selected in third stage. Two tehsils from Chittorgarh district were selected on the basis of highest area under rainfed crops and irrigated crops in the total cultivated area. Selected tehsils represented irrigated farming system and rainfed farming systems in the district. Two villages from each selected tehsil were selected randomly to represent irrigated and rainfed conditions. A list of all the households in the selected villages was prepared. Out of which 15 farmers were randomly selected from each village. Thus, a total sample of 60 households was selected from the district which consisted of 30 households of rainfed condition and 30 households of irrigated conditions to have a clear cut comparison of farming systems adopted by households in two different situations in the district. The present study was based on primary data for the agricultural year 2011-12.

Costs and Returns Estimation

The following method for estimation of costs and returns was used:

Gross Cost = Total Variable Cost (TVC) + Total Fixed Cost (TFC)

Gross Return = (Quantity of produce X Prevailing price of produce + Quantity of by-produce X Price of by-produce)

Net return = Gross return – Total cost

Fixed Costs: The various items of fixed costs were land revenue, land rent and depreciation. The depreciation rates, life span and junk value for various agricultural implements and machinery were decided in consultation with the respondents. Consequently, the depreciation was calculated using the straight line method as shown below.

$$\text{Depreciation} = \frac{\text{Purchase Value} - \text{Junk Value}}{Life\ Span}$$

Interest on fixed capital was calculated at the prevailing bank rate (10 %) on the value of the farm and livestock assets.

Total Cost (TC) = Total Variable Cost (TVC) + Total Fixed Cost (TFC)

Returns: The returns from crop, livestock, goat rearing and poultry were estimated by multiplying the actual price realized to quantity sold by them and the quantities that was retained for seed or consumption was evaluated at the rates prevailing at the time of harvest. The same method was also followed for the evaluation of by-products of various enterprises.

Results and Discussion

Farming Systems

There were number of farming systems existed in the study area. Farming system is a combination of crops, vegetables, orchards, dairy enterprise and poultry to maximize the farm income. In the present study irrespective of the rainfed and irrigated condition as well as location of the selected district four farming systems were observed.

FS – I : Crops + Vegetable (C+V)

FS – II : Crops + Dairy (C+D)

FS – III : Crops + Dairy+ Goat (C+D+G)

FS – IV: Crops+ Goat +Poultry + Orchard(C+G+ P+O)

The farming systems existed in Chittorgarh district in rainfed and irrigation condition were studied separately.

Existing Farming Systems in Rainfed area of Chittorgarh District

Farming systems in rainfed area of Chittorgarh district are presented in Table 1. It is evident from the table that in this area crops were grown only in kharif season and dairy, goat and poultry were also taken up by the farmers along with crops and vegetables. In the rainfed area out of thirty farmers, the maximum households were falls in FS-II C+D (40 %) followed by FS-I(C+V) and FS-III (C+D+G) having 23.33 per cent each and only 13.33 per cent households follow FS-IV (C+G+PO). Crops were grown in kharif session only and the cropping intensity ranging from 94.34 per cent to 98.00 per cent. The highest cropping intensity (98.00%) was observed in FS-I whereas lowest cropping intensity (94.34 %) was found in FS -IV. The major crops grown in rainfed condition were maize and soybean the four farming systems, blackgram in three farming

Table 1. Existing Farming System in Rainfed Area of Chittorgarh District

Farming System	No. of Farmers	Net Cropped Area (ha)	Total Cropped Area (ha)	Cropping Intensity (%)	Crops Name	Crops Area (ha)	Vegetable Name	Vegetable Area (ha)	Livestock (No)	Goat (No)	Poultry (No)
FS-I (C+V)	7 (23.33)	1.14 (33.43)	1.16	98.28	Maize Soybean Blackgram	0.38 0.34 0.32	Okra Bottle gourd	0.05 0.05	-	-	-
FS-II (C+D)	12 (40.00)	1.17 (34.31)	1.20	97.50	Maize Soybean Blackgram	0.45 0.52 0.20			2.08	-	-
FS-III (C+D+G)	7 (23.33)	0.60 (17.60)	0.62	96.77	Maize Soybean Blackgram	0.30 0.20 0.10			2.40	8.50	-
FS-IV (C+G+Po)	4 (13.33)	0.50 (14.66)	0.53	94.34	Maize Greengram Soybean Fallow Land	0.20 0.10 0.10 0.10			-	7.04	52.85
Total	30 (100)	3.41 (100)	3.51	96.72		3.31		0.10	4.48	15.54	52.85

C- Crop, D- Dairy, Po- Poultry, G- Goat , V- Vegetable (Figures in parentheses are percentages of column total.

systems while greengram and vegetables had shown their presence only in one farming system. In FS-I of the total cropped area i.e. 1.14 hectare kharif crops were put under 1.04 hectare (91.2%) and only 0.1 ha kept for the vegetables. The crops grown were maize, soybean and blackgram while the vegetables grown were mostly okra and bottle guard. In farming system –II, the crops were same as grown in FS-I. Of the gross cropped area of 1.17 ha, soybean was grown in the maximum area (0.52ha) followed by maize (0.45 ha) and blackgram (0.20ha). Similarly in FS-III of the gross cropped area (0.60 ha), the crops grown were maize (0.3 ha), soybean (0.2 ha) and blackgram (0.10 ha) while in FS-IV gross cropped area had reduced to 0.5 ha and black gram crop was replaced by greengram. The area under crops in all the four farming systems was 3.41 ha in which the maximum area contributed by FS-II (34.31%) followed by FS-I (33.43%). Non crop enterprises were found only in three farming systems i.e. FS-II, FS-III and FS-IV and in FS-I non-crop enterprises has not occupied any place. In FS-II, the average number of dairy cattle were 2.08, in FS-III average number of dairy cattle were 2.4 and average number of goats were 8.50 while in FS-IV average number of goats in 7.04 and the poultry birds were 52.85. Baishya et.al.(2007) identified three farming systems under rainfed situation of Borpeta district of Assam among which crop +dairy +fisheries +goat rearing were found most profitable than traditional farming system. Ravishankar et.al.(2007) also reported similar results in their study on farming systems.

Existing Farming System in Irrigated Condition

Farming systems existed in irrigated area of Chittorgarh district is presented in Table 2. It was revealed from table that in irrigated area, crops and vegetable were grown in both the season i.e. kharif and rabi and dairy, goat and orchard were taken by the farmers along with crops and vegetables. The maximum households were adopted FS-II (C+D) i.e. 46.67 per cent followed by FS-IV (C+D+G+O) 23.23 i.e. per cent, FS-I (C+V) i.e.20 per cent and the lowest in FS-III (C+D+G) *i.e* 10.00 per cent. The cropping intensity varied from 188.77 per cent to 195.45 per cent. The highest cropping intensity (195.45) was observed in FS-III(C+D+G) followed by FS –I (C+V) i.e. 193.10 per cent, FS-II (C+D) i.e.191.67 per cent and lowest in FS-IV (C+G + PO) 188.77 per cent. In the irrigated area cropping intensity was high due to irrigation facilities farmers taken crops in both seasons i.e crops in kharif and vegetables in rabi season. The Cropping pattern in irrigated area in farming system-I major crops grown in kharif season were included maize (0.45 ha.) and cotton (0.15ha.) and in rabi season the main crops were wheat (0.65 ha) and rapeseed & mustard (0.29 ha). The vegetables mostly were grown in both the season i.e. Kharif and rabi in 0.70 ha (31.25%) area of total cropped area. The vegetables were grown tomato, okra, bottle guard and bitter guard. The main vegetable crops in the FS-I was okra (leady finger) and tomato. FS –II the main crops grown were maize (0.80 ha) followed by soybean (0.20 ha) and cotton (0.20 ha). In rabi season the main crops were wheat (0.95 ha) barley (0.5 ha) and rape seed and mustard (0.10 ha). In farming system III and FS-IV the maize was the main crop followed by soybean, blackgram, greengram and cotton and in rabi season wheat and rape seed & mustard were the main crops. The total cropped area in FS-I, FS-II, FSIII and FS-

Table 2. Existing Farming System in Irrigated Area of Chittorgarh District

Farming System	No. of Farmers	Net Cropped Area (ha)	Total Cropped Area (ha)	Cropping Intensity (%)	Crops Name	Crops Area (ha)	Vegetable Name	Vegetable Area (ha)	Livestock (No)	Orchard (No of plants)	Goat (No)
FS-I (C+V)	6 (20.00)	2.24 (26.23)	1.16	193.10	Maize	0.45	Tomato	0.22	-		
					Cotton	0.15	Okra	0.30			
					Wheat	0.65	Bottle Guard	0.17			
					Mustard	0.29	Bitter Guar	0.01			
FS-II (C+D)	14 (46.67)	2.30 (26.93)	1.20	191.67	Maize	0.80			3.50		-
					Soybean	0.20					
					Cotton	0.20					
					Wheat	0.95					
					Barley	0.05					
					Mustard	0.10					
FS-III (C+D+G)	3 (10.00)	2.15 (25.18)	1.10	195.45	Maize	0.65			2.60		16.00
					Soybean	0.35					
					Black gram	0.25					
					Wheat	0.70					
					Mustard	0.20					
FS-IV (C+G+O)	7 (23.33)	1.85 (21.66)	0.98	188.77	Maize	0.50				120	11.55
					Moong	0.20					
					Cotton	0.25					
					Soybean	0.20					
					Wheat	0.55					
					Mustard	0.15					
Total	30 (100)	8.54 (100)	4.44	192.25		7.84		0.70	6.10	120	37.55

C- Crop, D- Dairy, O- Orchard, G- Goat, V- Vegetable (figures in parentheses are percentage of the column total.

IV were 2.24, 2.30, 2.15 and 1.85 ha., respectively. The non-crop enterprises were found only in three systems i.e. FS-II, FS-III and FS-IV. In FS-II the average number of cattle were 3.50, in FS-III average number of dairy cattle were 2.60 and average number of goats were 16.00 where as in FS-IV average number of goats were 11.55 and 120 plants in orchards. Baishya et.al (2007) identified three farming system under irrigated situation of Kamrup district of Assam among these crop+ dairy+goat+ fisheries were more profitable. Same finding were also found by Ravishanker et.al.(2007) and Singh et.al.(2012).

Comparison of Costs and Returns in Rainfed farming Systems in Chittorgarh district

The comparison of costs and returns are presented in Table 3. The total cost in rainfed farming system were the lowest in FS-I and the highest in FS-III it was due to only kharif crops + small scale vegetable were grown system in FS-I whereas in FS-III crops supported by goats and dairy cattle. Dairy and goats contributed more percentage share in total cost. It varied from ‘ 62076.55 in FS-I to ‘1,76, 933.10 in FS-III and total variable cost as percentage of total cost varied from 81.12 in FS-II to 85.10 in FS-I. It was observed that the total fixed cost as percentage of total cost was highest (18.88) in FS-II because of higher cost towards construction of cattle sheds. The gross return varied from ‘84358.17 in FS-I to ‘2,57,079.15 in FS-III and net return from ‘ 22281.62 in FS-I to‘ 80146.05 in FS-III more net returns in FS-III were due to goat and dairy enterprise. The returns for dairy productes and sale of goats contribute more returns in the system. Similar finding were also found by Singh *et.al.* (2012) and Ramarao (2005). It was

Table 3. Comparison of Costs and Returns in Existing Farming Systems in Chittorgarh District

Particulars	Rainfed Condition				Irrigated Condition			
	FS 1	**FS 2**	**FS 3**	**FS 4**	**FS 1**	**FS 2**	**FS 3**	**FS 4**
Costs								
TVC	52826.55 (85.10)	118158.15 (81.12)	150403.10 (85.01)	104458.95 (83.58)	201410.27 (86.31)	238354.95 (84.62)	230759.10 (82.25)	218613.80 (81.63)
TFC	9250.00 (14.90)	27505.29 (18.88)	26530.00 (14.99)	20525.00 (16.42)	31957.52 (13.69)	44660.12 (15.78)	49793.37 (17.75)	49193.37 (18.37)
TC	62076.55 (100)	145663.44 (100)	176933.10 (100)	124983.95 (100)	233367.79 (100)	283015.07 (100)	280552.47 (100)	267807.17 (100)
Returns								
GR	84358.17	188109.33	257079.15	194058.50	394983.16	389835.25	409432.06	407128.71
NR	22281.62	42445.89	80146.05	69074.55	162689.87	106820.18	128879.59	139321.54
Returns/Rupee Investment	**1.36**	**1.29**	**1.45**	**1.55**	**1.69**	**1.38**	**1.46**	**1.52**

figures in parentheses are the percentage of the total cost.

evident from the table that the net returns in FS-III ‘ 80,146.05 and FS-IV was ‘ 69074.55 in rainfed area. The return per rupee was the lowest (‘1.29) in FS-II and highest (‘1.55) in FS-IV in rainfed area due to goat and poultry contribution. Thus, on the basis of net returns FS-III while on the basis return per rupee FS-IV was the profitable farming systems. Sharma (2007) also reported the same results in his study.

Irrigated Condition

The total costs in irrigated area of farming systems were lowest in FS-I and highest in FS-II and it varied from ‘ 2,33,367.79 in FS-I to ‘2,83,015.07 in FS-II that happens due to only crops and vegetable taken in FS-I whereas in FS-II farmers had taken buffaloes and cow there total cost were high. Total variable costs as percentage of total costs varies from 81.63 per cent in FS-IV to 86.31 per cent in FS-I variable cost share high in FS-I due to more insecticide and pesticide and fertilizer applied in vegetables. Among the four farming systems in irrigated area lowest fixed cost was observed in FS-I due to crop and vegetable only, they need minimum amount of fixed cost in farming system but in FS-IV farmers were taken crop, goat and poultry enterprises they need high fixed costs. Gross returns in irrigated area were lowest in FS-II and highest in FS-III. Gross returns varies from ‘3,89,835.25 in FS-II to ‘ 4,09,432.06 in FS-III. The net returns were lowest in FS-III (‘1, 28,879.59) and highest in FS-I (‘ 1,62,689.87). The returns per rupee investment was highest in FS-I (‘ 1.69) followed by FS-IV (‘ 1.55), FS-III (‘ 1.46) and FS-II (‘ 1.38), respectively. Singh (2007) identified the efficient farming systems model for irrigated situation of eastern U.P. he also developed crop+ dairy + Poultry and fishery were the most profitable farming system and the net returns of the model were Rs.42160 per hectare under irrigated situation of eastern U.P.

Thus it was concluded that on the gross return basis highest gross return came from in FS-III (‘ 409432.06) and lowest from FS-II (‘ 389835.25). The net returns were lowest in FS-III (‘ 1, 28,879.59) and highest in FS-I (‘ 1,62,689.87) due to vegetables which gave more net returns due to remunerative prices in vegetables in FS-I. The return per rupee investment was highest in FS-I (‘ 1.69). Similar finding were found by Sing *et.al.* (2012) and Ravishankar *et.al.* (2007), Singh *et.al.* (2007).

CONCLUSIONS

Four farming systems were existed in all both the rainfed and irrigated areas of Chittorgarh district they are:

1) FS-I: Crop+Vegetables (C+V)

2) FS-II Crop + Dairy (C+D)

3) FS-III Crop + Dairy +Goat (C+D+G)

4) FS-IV Crop +Goat +Poultry (C+G+PO)

Rainfed Condition

In rainfed area of Chittorgarh district the maximum (40 %) of households were adopted FS-II (Crop + Dairy). The cropping intensity ranged from 94.34 per cent to 98 per cent. The highest cropping intensity (98%) was observed in FS-I whereas lowest cropping intensity (94.34%) was found in FS-IV. Maize and soybean were the important crops in all the farming systems and vegetables had its place only in FS-I. Non-crop enterprises had shown their existence in each of three systems. Dairy enterprises in FS-II and FS-III and goat enterprises in (FS-III and FS-IV) were taken up in two farming systems while poultry birds (FS-IV) existed only in one farming system.

Irrigated Condition

In irrigated area of Chittorgarh district four farming systems were prevailing i.e. FS-I crop + vegetable(C+V) +FS-II Crop+Dairy (C+D) FS-III crop + Dairy +Goat and IV Crop+ Goat+ orchard (C+G+O). The maximum households were falls in FS-II (C+D) 46.67 followed by FS-IV C+G+O 23.23 per cent. The Cropping intensity varied from 188.77 per cent to 195.45 per cent. The highest cropping intensity was observed in FS-III (C+D+G) 195.45 per cent following by FS-I (C+V) 193.10 per cent. The total cropped area in FS-I, FS-II, FS-III and FS-IV were 2.24, 2.30, 2.15 and 1.85 ha, respectively. Thus maize and soybean in kharif and wheat barley and rape seed and mustard in rabi reseason were the main crops. Non-crop enterprises were found in three systems i.e. FS-II, FS-III and FS-IV.

In rainfed area of Chittorgarh district on the household basis the net returns was profitable (‘ 80146.05) in FS–III (Crop+Goat+Dairy) while the returns per rupees (‘ 1.55) basis FS-IV (Crop+Goat+ Poultry) was found most profitable. In a irrigated area of Chittorgarh district on net return and returns per rupee (‘ 162689.87) and (‘ 1.69) basis FS-I (Crop+ Vegetables) found most profitable.

References

Sharma, A.K. Koushal, Sanjay and Kaehroo, Dileep 2007 study on integrated farming system for mid hills of jammu region. Extended summaries 3rd national symposium on integrated farming system October 26-28 2007.

Baishya A., M.C. Kalita, D.K.Mazumdar, J.P.Hazarika and S.Ahmed 2007 characterization of farming systems in Borpeta and Kamrup districts of lower Brahmaputra valley zone of Assam. Extended summaries 3rd national Symposium on integrated farming systems, October 26 -28 .

Nanda, S.S., Mishra ,S.N. and Mohanty, M. 2007. On farm farming system for income and employment generation in Kalahandi district of Orrisa. *Journal of Farming System Research & Development* **13 (1):** 56-59.

Narasimhan, S., Raju, V. T. and Sharif, 2003, Cost and returns paddy in Yanam Region of Union Territory of Pondicherry.

Neelappa Shetty, T., 2002, Technical and allocative efficiency of paddy production in TBP area–An Economic Analysis. Unpublished *M.Sc. (Agri.) Thesis*, Univ. Agric. Sci., Dharwad.

Norman, D. and Collinson, M., 1985, Farming systems research in theory and practice. *Proceedings of the International Workshop held at Hawkesbury Agric. College, Richmond, N.S. W. (Australia):* pp.16-30.

Singh, K., Bohra, J. S., Singh, T. K., Singh, J. P., Yogeshwar Singh and Singh, C. S., 2007, Productivity and economics of integrated farming system in irrigated agro-ecosystem of eastern Uttar Pradesh, *Indian J. Agron.* **52 (1)** : 11- 15.

Singh,J.P.Gangwar,B.Kochewad,S.A. Pandey,D.K 2012 Integrated farming system for improving livelihood of small farmers of western plainzone of Uttar Pradesh, India. SAARC Journal of Agriculture; **10:**1,45-53.

Singh, K.P. 2002. Integrated farming systems for small holders- A key issue for research. Education-Extension linkage in semi arid tropical conditions. Paper Submitted to 17th symposium of International Farming Association, Nov. 17-20-2002. Orlando, Florida.

Singh Hari, Jain N.K. and Dashora, L.N 2010 Characterization and Constraint Analysis of Udaipur District of Rajasthan *J. Farming Systems Research &Development* **16(1&2):** 57-62

Singh, M. and Joshi, A. S. 2008. Economic analysis of crop production and dairy farming on marginal and small farms in Punjab. *Agricultural Economics Research Review*, **21**: 251-257.

Singh, M.K., 2004, Economics of efficiency in vegetable business system of Mahakoshal Region in Madhya Pradesh. *Indian J. Mark.*, **36(3):** 3-7.

J. Farming Systems Research & Development **20** (1) : 77-81 (2014)

EPIDEMIOLOGY AND MANAGEMENT OF ALTERNARIA BLIGHT OF MUSTARD CAUSED BY *ALTERNARIA BRASSICA*

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Abstract

Indian mustard (Brassica juncea L. czern and con) is one of the major oil seed crop cultivated in India as well as all over the world. In north India mostly crop is grown for edible oil and cake for man and animal (Thakur, 1975). The crops are grown in both the tropical as well as of the temperate zone and require relative cool temperature for satisfactory growth. Crop is grown in *rabi* season from September to November in our country. The mustard crop is grown well in these areas having 24-40 cm of rainfall. In India, Utter Pradesh is the second largest producer of rapeseeds mustard after Rajasthan, having an area of 1.2 million hectare with the production of 0.7 million tones. The average productivity of mustard in India is about 9.68 q/ha which is much below than international standard (13.0 q/ha). The main reasons of low productivity are disease. Mustard crop is affected by more than twenty fungal, bacterial, viral, mycoplasma, phanrogamic parasites and physiological disease. Among them the spot disease caused by *Alternaria brassica* (Berk) Sacc. is one of the most wide spread and destructive disease of mustard. Under natural condition this leaf blight disease of mustard appear throughout the world and appear each year in crop field (Khan et al. 1998) .The disease is caused by *Alternaria brassicae and Alternaria brassicicola,* single or concomtaantly(Khan *et al* 1998) relative frequency of the two species varries with region and crop stage . The disease was first reported by Dey (1948) in Utter Pradesh which caused severe losses in yield. Khan *et al,* (1998) have reported 26.5% infection by by *Alternaria brassicola* and 22.6% by *Alternaria brassicae* , whereas reached 50.90% is accounted for concomitant infection of two species. The leaf blight may caused yield lass of 46-47% in yellow sarson and 35-38% in mustard kolte, *et.al,* (1987). The quantitative loss, seed quality in terms of seed size , seed colour and oil contents are also reduced due to the fungus infection (Kaushik et al 1984 & Kumar 1997). The degree of infection depends on the weather parameter (temperature RH & rainfall), age and vigour of plants. The management of disease through chemical is not economically and eco friendly .Use of resistant varieties are not sufficient method for management of disease because these varieties taking a specific time for growth. The disease management by means of biological control is not fully covered against already established phyllosphere disease like alternaria blight .The cultural practices with the adjustment of chemical doses and keeping with the environmental factors are to be an appropriate approach for reducing the initial inoculums density of the pathogen. These practices (Epidemiological factors and cultural practices) are the method of sustainable disease management. The epidemiological and cultural practices are sustainable management method, there are also eco friendly. Therefore keeping in this view present study was under taken with an objective to reducing the disease incidence and increases the yield through the adjustment of the epidemiological and cultural practices against this disease.

Methods and materials

Integrated disease management

A field experiment was conducted during *Rabi* season in two consecutive years (2001-02 and 2002-03) at the oilseed farm of C.S.A. University of Agricultural. & Technology , Kanpur to find out the effect of date of sowing on occurrence of disease .the cultivar Varuna was sown on two different date at 30 days interval (*ie*.18th October , 18th November) in all the two consecutive years with three replication .a plot size was 5m x 3m. and recommended dose of NPK was applied as half dose of Nitrogen and total amount of Phosphorus and Potash at the time of sowing and remaining half Nitrogen used as second time of foliar application .The certified seeds were collected from Seed Research Farm,C.S.Azad University of Agriculture and Technology , Kanpur and treated with Ziram @2.5 g /kg of seed .Forty or sixty leaves of mustard plant were randomly selected at one . The fungicides were sprayed after 50 days after sowing and repeated 70 and 90 days after sowing when pod formation indicated. The experiment was laid out in a factorial design. The trial was constituted with cross combination of two date of sowing. The PDI was recorded by using five point scales (0-5) Chenulu and Singh (1964). Leaves with no sign of infection received as score of zero, while these with the highest infection, received a score of 4th. Similarly leaves with 1-25, 26-50 and 51-75 % area covered with Alternaria blight received a score of I,.II and III respectively. The data on disease incidence was recorded at the maturing stage as per the scale suggested by Conn (1990). Grain yield of each plot of all the replication was also recorded.

Date of sowing

- D_1 =18th October,
- D_2 =18th November

Spray of fungicide

- S_1= First spray of Ridomil MZ 72 WP (0.25%) just after appearance of Alternaria blight followed by two spray of Mancozeb (0.2%) at 15 days interval.
- S_2= First spray of Ridomil MZ 72 WP (0.25%) followed by two spray of Carbendazim (0.05%) + Mancozeb (0.2%).
- S_3= First spray of carbendazim (0.05%) + Mancozeb (0.2%) followed by two spray of Mancozeb.
- S_4 = No spray.

Effect epidemiological factors in management alternaria blight

The experiment was laid out in split plot design with one replication and four date of sowing at 15 days intervals stared from 1st October (2001-02). The cultivar Varuna was sown on four different of spot at 15 days interval in 5.0 m. x1.5m plot size with spacing 30x10cm. Metrological data like temperature, rainfall, and R.H. were collected from metrological station Department of Agronomy, C.S.A. University of Agricultural. & Technology, Kanpur to find out the correlation among disease severity temperature and relative humidity.

RESULT AND DISCUSSION

Integrated disease management

Table revealed that all the treatment gave better repose in minimizing the disease intensity and increased the yield over control. Early sowing (18 Oct.) reduced the disease incidence significantly and enhanced the yield during both the year in comparison to late sown crop *ie*. 18th November. The minimum disease intensity 24.92% and

Table 1. Epidemiological studies of Alternaria blight in rapeseed and mustards (2002 - 2003).

Period	Disease intensity (%) of diff. Date of sowing.				Temp. (°C)		Rainfall		Relative humidity
	1st Oct	15th Oct.	30th Oct.	15th Nov.	Max.	Min.	Amount days	Rainy days	(%)
15.11.02	-	-	-	-	29.20	12.7	1.8	1	65.35
30.11.02	8.0	2.0	3.0	-	27.55	9.25	-	-	59.40
15.12.02	9.1	7.2	5.8	3.0	25.45	6.10	-	-	59.75
30.12.02	15.0	9.4	8.8	7.2	23.60	7.80	0.4	1	66.05
14.01.03	16.2	11.2	9.8	9.2	13.75	3.08	6.5	1	85.96
29.01.03	18.6	12.0	13.6	12.8	16.55	2.79	-	-	81.96
13.02.03	23.6	24.0	17.2	19.3	24.49	8.64	18.5	1	76.97
28.02.03	31.0	24.4	24.8	28.6	26.97	12.63	2.9	1	66.42
15.03.03	34.2	32.9	37.1	37.9	28.16	11.14	-	-	64.61
30.03.03	37.0	40.1	40.8	43.6	30.46	16.14	-	-	53.93
Yield (q/ha)	17.33	16.66	12.66	12.39	-	-	-	-	-

20.62% was recorded during 2001-2002 and 2002-2003 respectively in $D_{-1}S_2$ combination. The maximum yield (24.83q/ha and 13.49 q/ha) was also observed in the same combination D_1 S_2. The maximum disease incidence 29.36 and 63.12 per cent in both year were found in D_1S_4 combination (without spraying). In this combination minimum yield was also recorded 22.44 q/ha and 9.66q/ha. during both the years.

The results indicated that the Ist spraying of Ridomil MZ – 72 WP (0.25%) followed by to spraying of carbendazim (0.05%) + Mancozeb (0.2%) gave the significant response in reducing the disease intensity and also increasing the yield in both dates of sowing during the year 2001-2002 and 2002-2003. In all the treatment combination significantly superior yield was obtained over control in both years, it means spraying of the fungicide and early sowing have significantly superior effect. Sinha et al., (1992) reported from Bihar that the incidence of disease on *B. compestris* var. *toria* was lowest with consequential increased in yield when the crop was sown early *i.e.* between 30th Sept. and 15th Nov

Effect epidemiological factors in management Alternaria blight

Environmental factor such as atmospheric temperature, R.H. rainfall and date of sowing plays on important role in disease development. Table 2 revealed that environmental factors *viz.* minimum and maximum temperature, relative humidity and date of sowing have significantly effects in the disease development. There is a good correlation between, temperature, R.H. and rainfall on the disease incidences. In the year

Table 2. Integrated disease management (2001-2002)

S. No.	Treatment	Disease intensity (%)		Seed yield q/ha		Mean 1000 seed weight	
		2001-2002	2002-2003	2001-2002	2002-2003	2001-2002	2002-2003
1	D_1 S_1	27.67	28.92	23.49	12.24	5.6	3.42
2	D_1 S_2	24.92	20.62	24.83	13.49	5.8	3.50
3	D_1 S_3	25.74	28.80	23.74	12.83	5.8	3.61
4	D_1 S_4	29.36	63.12	22.49	09.66	5.4	3.14
5	D_2 S_1	40.58	28.67	11.94	10.41	5.2	3.37
6	D_2 S_2	38.57	20.85	13.74	11.49	5.8	3.80
7	D_2 S_3	38.86	24.62	12.13	11.41	5.6	3.56
8	D_2 S_4	41.26	68.07	11.83	08.66	4.9	2.92

2002-2003, the disease appeared in the field in second fortnight of November when maximum and minimum average temperatures were 27.55°C and 9.25°C respectively with 59.40 per cent relative humidity. The disease incidence increased rapidly up to the second fortnight of December in all the sowing dates. The disease progress up to the IInd fortnight of Dec. 15%, 9.4%, 8.8% and 7.2% respectively for sowing of Ist Oct., 15th Oct., 30th Oct. and 15th November (maximum temperature 23.6°C and minimum 7.8°C with 66.05 per cent R.H.). In the monthly of January the disease developed very slightly because there was very low temp. (Minimum 2.79°C and the maximum 16.55°C). With the increase of temperature the disease also progressed and it reached to its maximum in second fortnight of March for all the sowing dates *i.e.* 37%, 40.1%, 40.8% and 43.6% for Ist Oct., 15th Oct., 30th Oct., and 15th Nov. sowing. The average minimum and maximum temperature were 30.46°C & 16.14°C respectively with R.H. 59.93% in this period. Saxena (1998) also reported that crop sown as 15th October gave the maximum yield with lower disease intensity.

REFERENCES

Thakur, C. (1975). *Scientific crop production*. Metroplitan Book Co. New Delhi.

Dey, P.K. (1945). Plant pathology. *Adm. Rep.* agric. Dept. U.P. 1945, **46:** 43-46.

Conn, K.L.; Tewari, J.P. and Awasthi, R. P. (1990). A disease assessment key for Alternaria black spot in rapseed mustard. *Can. Pl. Dis. Survey*, **70:** 19-22.

Sexena, Deepa. (1998). Management of *Alternaria* blight of mustard by Adjustment of sowing dates. International conference on pest and pesticide management for sustainable agriculture held on Dec. 11-13, 1998 at C.S.A.Uni. of Agri. and Tech, Kanpur.

Khan M.R., Singh, N.P. and Khan N. (1998). Incidence of Alternaria blight of mustard ,Cabbage and Cauliflower in the Aligarh district. *Chemical and Environmental Research* **7:** 111-116.

Chenulu , V.V.and Singh, A. (1964) A note on estimation of losses due to leaf blight of wheat caused by *Alternaria triticina .Indian Phytopath*.**17:** 254-56.

Sinha , R.K.P., Rai, B .and Sinha, B.B.P. (1992). Epidemiology of leaf spot of rapeseed and mustard caused by *Alternaria brassicae. Juornal of Applied Biology* **2:**70-75.

J. Farming Systems Research & Development **20** (1) : 82-90 (2014)

INTERNAL COST ADJUSTMENT IN VARIOUS EXISTING FARMING SYSTEMS OF SOUTHERN RAJASTHAN

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Abstract

India has made considerable progress in agriculture by increasing production of cereals, oilseeds, sugarcane, cotton and fruits & vegetables and other crops during past four decades. This success has been driven by several factors like policy support, research and extension, production strategies, higher use of inputs and public investment in infrastructure. It has helped the country to face many contemporary and future challenges of food security of its vast population.Farming system represents integration of farm enterprises such as cropping system, animal husbandry, fisheries, forestry and poultry etc. for optimal utilization of resources bringing prosperity to the farmer. Rajasthan, the largest state of Indian union occupies nearly 10.4 per cent geographical area of the country. The present investigation was under taken to work out internal cost adjustment in existing farming systems of Southern Rajasthan. A total sample of 120 household consisting of 60 under rainfed and 60 under irrigated situation was selected for the study. Four farming systems were existed in both the rainfed and irrigated areas of Chittorgarh and Banswara districts viz. FS-I: Crop+ Vegetables (C+V), FS-II: Crop + Dairy (C+D), FS-III: Crop + Dairy +Goat (C+D+G), FS-IV: Crop +Poultry (C+PO). The cost involved in different farming systems were divided into two parts i.e. cost incurred within the farming system and cost incurred from outside the farming system. Internal cost adjustments were more in FS –III in both the districts i.e 70.21 and 64.35 per cent in Chittorgarh district and 69.83 and 63.38 per cent in Banswara district in rainfed and irrigated conditions, respectively. In Chittorgarh district on per rupee investment basis FS-IV (1.55) in rainfed and FS-I (1.69) in irrigated area were more profitable than other systems. In Banswara district on return per rupee investment basis FS-IV ((1.57) in rainfed area and FS-I (1.63) in irrigated area were found more profitable than other farming systems. Return per rupee investment (return cost ratio) was more in FS-IV in rainfed condition while FS-I in irrigated condition among the other farming systems in both the districts.

Key Words: Internal Cost Adjustment , Cost, Farming System, Returns and Profitability.

Introduction

India has made considerable progress in agriculture by increasing production of cereals, oilseeds, sugarcane, cotton and fruits & vegetables and other crops during past four decades. This success has been driven by several factors like policy support, research and extension, production strategies, higher use of inputs and public investment in infrastructure. It has helped the country to face many contemporary and future challenges of food security of its vast population. Farming system represents integration of farm enterprises such as cropping system, animal husbandry, fisheries, forestry, poultry etc. for optimal utilization of resources bringing prosperity to the farmer. Farming system approach introduces a change in farming techniques for higher production from the farm as a whole with the integration of all the enterprises like dairy, poultry, piggery, fishery, sericulture etc. suited to the given agroclimatic condition and socio –economic status of farmer would bring prosperity to the farmer. Every farmer tries to choose the farm activities/enterprises depending upon physical and economic conditions prevailing in his ecosystem. Integration of various farm enterprises ensures growth and stability in overall productivity and profitability. The basic aim of integrated / sustainable farming system is to derive a set of resource development management and utilization practices that lead to a substantial and sustained increase in agriculture production. Since farming system differ in different situation such studies conducted on farming system showed that farming system approach is better than conventional farming (Ravishankar,et al.2007and Singh et.al 2007).Farming enterprise includes crop, livestock, poultry, fish, sericulture, vermicompost, dairy, goat, *etc*. A combination of one or more enterprises with cropping, when carefully chosen, planned, and executed, gave greater dividends than single enterprise especially for small and marginal farmers. Farm as a unit is to be considered and planned for effective integration of enterprises to be combined with crop production activity. Judicious mix of one or more of these enterprises with crop should complement the farm income.

Rajasthan, the largest state of Indian union, occupies nearly 10.4 per cent geographical area of the country. Agriculture and allied activities accounted for nearly one fourth of the State Domestic Product against 14 per cent at National Level. Therefore, agriculture despite all odds considered to be the main stay of rural masses in the state. The agriculture in most part of the state is rainfed and is prone to high production risk. In order to meet the farm and family requirement, the farmers in the state have evaluated different combinations of crop, livestock, horticulture, poultry etc. Food security always remains an uncompromising goal of farm level agriculture for rural masses in most part of the state. Accordingly, every region of the state has evaluated crop and livestock species suitable for the region. Out of 10 agro- climatic regions of the state, two region *i.e.* Sub Humid Southern Plains and Arravalli Hills Zone (IV A) and Humid Southern Plains Zone (IVB) falls in Southern Rajasthan and is relatively more diversified for crop and livestock production. In this region crops like maize, jowar, cotton, black gram, soybean, groundnut, cluster bean etc. are grown in *kharif* season and crops like wheat, rapeseed & mustard, gram, isabgol, etc. are grown in *rabi season*. There is substantial area under different vegetables in this region. Among livestock, cattle, buffalo, goat and sheep are the most dominating animals. The farming system models practiced by the farmers include various combinations of field crops, horticulture crops and livestock in southern Rajasthan.

METHODOLOGY

Southern Rajasthan comprises of eight districts viz., Udaipur, Chittorgarh, Bhilwara, Rajsamand, Dungarpur, Banswara, Pratapgarh and Sirohi. These districts fall in agro-climatic region IV A and IV B. Among these districts Chittorgarh is non tribal and Banswara is highly-tribal dominated district. Chittorgarh district from IV-A and Banswara district from IV-B was purposively selected for the study of integrated farming systems, as these districts have high potential for development of agriculture and livestock.

Multi stage random sampling plan was used. Two tehsils from each districts were selected in such a way that one having highest proportion of irrigated area and other one having highest share of rainfed area to total net sown area so that selected tehsils represented irrigated and rainfed farming systems in tribal areas. Fifteen farmers from each village were randomly selected. Thus a total sample of 120 households was selected from Chittorgarh and Banswara districts, representing 60 households from rainfed and 60 households from irrigated farming systems.

Both primary and secondary data were collected. The primary data were collected from selected farmers while the secondary data were collected from published sources. The data collected for the year 2012-13 were scrutinized, tabulated and analyzed by using different analytical tools.

Costs and Returns Estimation

The following method for estimation of costs and returns was used:

Gross Cost = Total Variable Cost (TVC) + Total Fixed Cost (TFC)

Gross Return = (Quantity of produce × Prevailing price of produce + Quantity of by- produce × Price of by-produce)

Net return = Gross return – Total cost

Operational or Variable Costs: Operational costs were the actual costs incurred by the farmer along with incidental charges incurred towards labour and material costs. The various items of operational costs were seed, farmyard manure, fertilizers, plant protection chemicals, feeds and concentrates, fodder and straw, labour (hired labour and family human labour) etc. Labour in all enterprises were converted into man-days by multiplying female and child labour by 0.70 and 0.50, respectively. Bullock labour, both owned and hired were accounted at the prevailing hire rates. The operational costs in terms of labour (human, bullock and machine) and other outputs (main and by-products) of one activity utilized as an input in the other activity within the integrated farming system were worked out to assess the cost effectiveness of different integrated farming system.

Fixed Costs: The various items of fixed costs were land revenue, land rent and depreciation. The depreciation rates, life span and junk value for various agricultural implements and machinery were decided in consultation with the respondents. Consequently, the depreciation was calculated using the straight line method as shown below.

$$\text{Depreciation} = \frac{\text{Purchase Value} - \text{Junk Value}}{Life\ Span}$$

Interest on fixed capital was calculated at the prevailing bank rate (12 %) on the value of the farm and livestock assets.

Total Cost (TC) = Total Variable Cost (TVC) + Total Fixed Cost (TFC)

Returns: The returns from crop, livestock, goat rearing and poultry were estimated by multiplying the actual price realized to quantity sold by them and the quantities that was retained for seed or consumption was evaluated at the rates prevailing at the time of harvest. The same method was also followed for the evaluation of by-products of various enterprises.

Income Generation

Gross income from integrated farming system (GIIFS)

Income generation from Integrated Farming Systems were worked out as follows.

Value of main and byproduct received from various farming systems were:

$$\text{GIIFS} = \sum_{i=1}^{n} Qi.Pi$$

Where, Qi is the Physical output (main and by product) of i^{th} component of IFS and

Pi is the price of i^{th} output.

Paid out cost of Integrated Farming Systems (PCIFS)

The PCIFS was work out as:

$$\text{PCIFS} = \sum_{i=1}^{n} xi.pi$$

Where,

xi = the i^{th} external input in quantity term

pi = the price of i^{th} external input

NIIFS = GIIFS –PCIFS

Where,

NIIFS = Net Income from Integrated Farming System

Cost of Internally Adjusted Input (CIAI)

CIAI = TC-PCIFS

Where,

TC = Total Cost (Fixed Cost + Variable Cost).

PCIFS=Paid out Cost of Integrated Farming System.

Results and Discussion

Existing farming systems in the study area

There were four farming systems prevalent in the rainfed and irrigated condition of Chittorgarh and Banswara districts as shown in **Table** 1. Mostly FS-I describes crops plus vegetables and crops plus dairy cattle forms FS-II. Crops plus dairy plus goats constituted the FS-III. Crops either supported by poultry or orchards were the part of FS-IV in both the situations of the selected districts.

Internal Cost Adjustments in Various Farming Systems in Study Area

The various activities involved in different farming systems included goat, poultry and forestry. Each activity involves cost to perform them. The cost involved in their activities on different farming systems were divided into two parts i.e. cost incurred within the farming system and cost incurred from outside the farming system. Cost from within farming system included the value of all those inputs required for different enterprises and are supplied from within the system like FYM cost, owned labour, green/dry fodder, seed and feed. The value of the inputs brought from outside the farm (or farming system) for different enterprises were included in the cost incurred outside the farming system. From the total cost, the cost incurred within the farming system, show the utilization of resources within the

Table 1. Existing Farming Systems in Study Area

Farming System	Chittorgarh		Banswara	
	Rainfed	Irrigated	Rainfed	Irrigated
			Description	
FS-I	Crop + Vegetable (C+V)	Crop + Vegetable (C+V)	Crop + Onion Nursery (C+ON)	Crop + Vegetable (C+V)
FS-II	Crop + Dairy (C+D)	Crop + Dairy (C+D)	Crop + Dairy (C+D)	Crop + Dairy (C+D)
FS-III	Crop + Dairy + Goat (C+D+G)	Crop + Dairy + Goat (C+D+G)	Crop + Dairy + Goat (C+D+G)	Crop + Dairy + Goat (C+D+G)
FS-IV	Crop +Goat +Poultry (C+G+Po)	Crop + Goat + Orchard (C+G+O)	Crop + Poultry (C+Po)	Crop+Poultry+ Orchard (C+Po+O)

system. The system is more feasible and sustainable when there is more utilization of resources within the system than the other systems. Financial requirement to purchase the inputs from outside the farm is also minimum in such system. This also reduces the dependency of the households for cash in hand. Return/cost ratio or return on per rupee investment is also the criteria to select the best farming system among the existing one. Therefore, all the existing farming systems in rainfed and irrigated area in both the location i.e Chittorgarh district (non-tribal) and Banswara district (tribal) were studied, on the basis of cost incurred within and outside the farming system as well as on per rupee investment. Internal cost adjustments in various systems in the study area are presented in Table 2. Outside cost means farmers purchase inputs from outside. The rainfed area of Chittorgarh district having four farming systems of which FS – III showed maximum share of internal cost adjustment (70.21%) followed by FS – II (65.32%), FS – I (61.04%) and FS – IV had least share (56.51%). The FS – III shown more self dependence due to rearing of dairy and goat that's why in this system maximum cost was adjusted internally and only 30 percent cost inputs were purchased from outside. In irrigated condition of Chittorgarh district FS – III showed 64.35 percent internal adjustment and only 35.65 percent cost items were purchased from outer side or market. FS – II also showed same trend in these systems where dairy played an important role in cost adjustment. FS – I and FS – IV were more dependent on the outside cost items. Because FS–IV had required more investment or long term investment in setting up of orchards. In Chittorgarh district on per rupee investment basis FS-IV (1.55) in rainfed and FS-I (1.69) in irrigated area were more profitable than other systems. Thus, on cost adjustment basis, FS-III was more profitable in both the

Table 2. Internal Cost Adjustments in Various Farming Systems in Study Area

Integrated	Cost				Cost Share (%)		
Farming systems	Gross return (`)	Within Farming System (`)	Out Side Farming System (`)	Total Cost (`)	Within Farming System (`)	Out Side Farming System (`)	Return/ Cost Ratio
				Chittorgarh – Rainfed			
FS-I	138716.34	61773.42	39428.12	101201.54	61.04	38.96	1.37
FS-II	188109.33	95147.36	50516.08	145663.44	65.32	34.68	1.29
FS-III	257079.15	124224.73	52708.37	176933.10	70.21	29.79	1.45
FS-IV	194058.50	70628.43	54355.52	124983.95	56.51	43.49	1.55
Overall	194490.83	86803.60	50391.91	137195.51	63.27	36.73	1.42
				Chittorgarh – Irrigated			
FS-I	394983.16	137943.70	95424.09	233367.79	59.11	40.89	1.69
FS-II	389835.25	179403.25	103611.82	283015.07	63.39	36.61	1.38
FS-III	409432.06	180535.51	100016.96	280552.47	64.35	35.65	1.46
FS-IV	407128.71	156345.83	111461.34	267807.17	58.38	41.62	1.52
Overall	400344.80	163191.75	102993.87	266185.63	61.3075	38.6925	1.50
				Banswara – Rainfed			
FS-I	84650.53	36092.97	23614.18	59707.15	60.45	39.55	1.42
FS-II	161595.6	75004.29	40315.96	115320.25	65.04	34.96	1.40
FS-III	224317.7	116418.31	50298.44	166716.75	69.83	30.17	1.35
FS-IV	150087	p55258.57	40080.58	95339.15	57.96	42.04	1.57
Overall	155162.71	69190.29	40080.54	109270.83	63.32	36.68	1.42
				Banswara – Irrigated			
FS-I	379576.51	137980.24	94309.73	232289.97	59.4	40.6	1.63
FS-II	376280.9	165466.13	106547.89	272014.02	60.83	39.17	1.38
FS-III	410509.01	185329.00	107080.27	292409.27	63.38	36.62	1.40
FS-IV	369815.75	142186.67	106826.76	249013.43	57.1	42.9	1.49
Overall	384045.54	157323.04	104108.63	261431.67	60.1775	39.8225	1.47

conditions while on per rupee investment criteria FS-IV in rainfed and FS-I in irrigated condition of Chittorgarh gave more return. The rainfed area of Banswara district also had four farming systems of which FS – III showed maximum share of internal cost adjustment (69.83%) followed by FS – II (65.04%), FS – I (60.45%) and FS – IV had least share (57.96%). The FS – III shown more self dependence than others farming systems because in this system maximum cost was adjusted internally and only 30.17 percent cost inputs were purchased from outside. In irrigated condition of Banswara district FS – III showed 63.38 percent internal adjustment and only 36.62 percent cost items were purchased from outside or market. FS-II also showed same trend here dairy and goats also play important role like Chittorgarh district FS-I and FS-III still depended on other sources of cost. FS-IV required more investment or long term in setting-up of orchards. In Banswara district on return per rupee investment basis FS-IV ((1.57) in rainfed area and FS-I (1.63) in irrigated area were found more profitable than other farming systems. If the funds are limited with the household, the return per rupee investment are more appropriate tool to decide the suitability of a farming system. On the other hand, when funds and other resources are not constraint with the household, then highest net return should be the criteria to select a farming system. Mostly the farmers of sample studied were the resource constraint farmers. Thus, it can be concluded that internal cost adjustment was more in FS-III among all the farming systems in rainfed and irrigated condition in both the districts while the return per rupee investment (return cost ratio) was more in FS-IV in rainfed condition and in FS-I in irrigated condition among the other farming systems in both the districts.

CONCLUSIONS

The present investigation was under taken to work out internal cost adjustment in existing farming systems of Southern Rajasthan. A total sample of 120 household consisting of 60 under rainfed and 60 under irrigated situation was selected for the study. There were four farming systems prevalent in the rainfed and irrigated condition of Chittorgarh and Banswara districts**.** FS-I describes crops plus vegetables and crops plus dairy cattle forms FS-II. Crops plus dairy plus goats constituted the FS-III. Crops either supported by poultry or orchards were the part of FS-IV in both the situations of the selected districts. The cost involved in various activities on different farming systems were divided into two parts *i.e.* cost incurred within the farming system and cost incurred from outside the farming system. Cost from within farming system included the value of all those inputs required for different enterprises and are supplied from within the system like FYM cost, owned labour, green/dry fodder, seed and feed. The value of the inputs brought from outside the farm (or farming system) for different enterprises were included in the cost incurred outside the farming system. The system is more feasible and sustainable when there is more utilization of resources within the system than the other system. On cost adjustment basis, FS-III was more profitable in both the conditions while on per rupee investment criteria. FS-IV (‘ 1.55) in rainfed and FS-I (‘ 1.69) in irrigated condition of Chittorgarh gave more return. On cost adjustment basis, FS-III showed maximum share of internal cost adjustment in rainfed (69.83%) and irrigated (57.96%) condition of Banswara district. Thus, internal cost adjustment was more in FS-III among all the farming systems in rainfed and irrigated condition while the return per rupee investment (return-cost ratio) was more in FS-IV in rainfed condition and in FS-I in irrigated condition among the other farming systems in both the districts.

References

Baishya, A., M.C. Kalita, D.K. Mazumdar, J.P.Hazarika and S. Ahmed 2007. Characterization of farming systems in Borpeta and Kamrup districts of lower Brahmaputra valley zone of Assam. Extended summaries 3rd national Symposium on integrated farming systems, October 26 -28 .

Nanda, S.S., Mishra, S.N. and Mohanty, M. 2007. On farm farming system for income and employment generation in Kalahandi district of Orrisa. *Journal of Farming System Research & Development* **13 (1):** 56-59.

Narasimhan, S., Raju, V. T. and Sharif, 2003. Cost and returns paddy in Yanam Region of Union Territory of Pondicherry.

Neelappa Shetty, T., 2002. Technical and allocative efficiency of paddy production in TBP area–An Economic Analysis. Unpublished *M.Sc. (Agri.) Thesis*, Univ. Agric. Sci., Dharwad.

Norman, D. and Collinson, M., 1985. Farming systems research in theory and practice. *Proceedings of the International Workshop held at Hawkesbury Agric. College, Richmond, N.S. W. (Australia):* pp.16-30.

Ravi Shankar, N. Pramanik, S.C. Jaya Kumar, J. Singh, D.R. Bibi, N. Nawaz, S. and Biswas, T. K. 2007. Study on integrated farming system (IFS) under different resource condition of Island Ecosystem. *Journal of Farming System Research & Development,* **13(1):** 1-9.

Sharma, A.K. Koushal, Sanjay and Kaehroo, Dileep. 2007. Study on integrated farming system for mid hills of Jammu region. Extended summaries 3rd national symposium on integrated farming system October 26-28 2007.

Sharma, A.K., Koushal, Sanjay and Kaehroo, D. 2007. Study on integrated farming system for mid hills of jammu region. Extended summaries 3rd national symposium on integrated farming system October 26-28 2007.

Singh Hari, Jain N.K. and Dashora, L.N 2010. Characterization and Constraint Analysis of Udaipur District of Rajasthan *J. Farming Systems Research &Development* **16(1&2):** 57-62.

Singh, J.P., Gangwar, B., Kochewad, S.A. and Pandey, D.K. 2012. Integrated farming system for improving livelihood of small farmers of western plain zone of Uttar Pradesh, India. SAARC Journal of Agriculture; **10:1**, 45-53.

Singh, K., Bohra, J. S., Singh, T. K., Singh, J. P., Yogeshwar Singh and Singh, C. S., 2007. Productivity and economics of integrated farming system in irrigated agro-ecosystem of eastern Uttar Pradesh, *Indian J. Agron.* **52 (1)** : 11- 15

Singh, K., Bohra, J. S., Singh, T. K., Singh, J. P., Yogeshwar Singh and Singh, C. S. 2007. Productivity and economics of integrated farming system in irrigated agro-ecosystem of eastern Uttar Pradesh, *Indian Journal of agronomy*, **52(1):** 11- 15.

Singh, K.P. 2002. Integrated farming systems for small holders- A key issue for research. Education-Extension linkage in semi arid tropical conditions. Paper Submitted to 17th symposium of International Farming Association, Nov. 17-20-2002. Orlando, Florida.

Singh, M. and Joshi, A. S. 2008. Economic analysis of crop production and dairy farming on marginal and small farms in Punjab. *Agricultural Economics Research Review*, **21**: 251-257.

Singh, M.K. 2004. Economics of efficiency in vegetable business system of Mahakoshal Region in Madhya Pradesh. *Indian Journal of Marketing*, **36(3):** 3-7.

Singh, M.K., 2004. Economics of efficiency in vegetable business system of Mahakoshal Region in Madhya Pradesh. *Indian J. Mark.*, **36(3):** 3-7.

Singh, S., Kaur, M. and Kingra, H. S. 2009. Inadequacies of institutional agricultural credit system in Punjab state. *Agricultural Economics Research Review*. **22(2):** 309-318.

J. Farming Systems Research & Development **20** (1) : 91-99 (2014)

DEVELOPMENT AND EVALUATION OF NITROGEN (LIQUID UREA) APPLICATION METERING MECHANISM FOR POINT INJECTION IN STRAW MULCH FIELDS

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ABSTRACT

The existing method of broadcasting urea on straw mulched direct seeded wheat crop is susceptible to nitrogen losses. Nitrogen (liquid urea) applicator could be used to forestall the hazards of nitrogen loss and a metering mechanism for nitrogen (liquid urea) is currently not available. Hence, a nitrogen (liquid urea) metering mechanism was developed and tested in the laboratory. The operating pressure and rotational speed of metering system were found to have statistically significant effect on the discharge rate of metering mechanism. The discharge rate of the metering system was directly correlated with operating pressure and indirectly correlated with rotational speed of the metering system. Based on the performance parameters, a rotational speed of 19 rpm and operating pressure of 3.0 kg/cm^2 was selected for field operation of nitrogen (liquid urea) applicator. The outcome of this study will encourage the use of point injected nitrogen (liquid urea) applicator on straw mulched crops.

Key words: Discharge rate, metering mechanism, nitrogen (liquid urea) application, rotational speed, operating pressure

Rice- wheat constitutes the most productive cropping system in India, covering approximately 10–12 million hectares. Punjab contributes 40–50% of the rice and 50–70% of the wheat in the central pool, from only 1.5% of the land (*Saunders et al, 2012*). The scarcity of labour and time has led to the adoption of mechanized farming in highly intensive rice-wheat system in the state. The area under combine harvested rice and wheat in Punjab during 2008-09 was about 91 % and 82 %, respectively of the total area (*Singh et a,. 2009*). After combine harvesting, the rice residues comprise standing stubbles, from the soil. Incorporation of rice residue requires nearly five or more tillage operations. Keeping in view these aspects, a machine ('Happy Seeder') was developed by Punjab usually 30–60 cm high, plus a substantial quantity of loose straw. The loose residues interfere with tillage and seeding operation for the next crop. More than 90% of the of rice stubble in Punjab are burnt each year, resulting in thick smoke blanketing the region (*Singh et al, 2008*). The burning also results in the loss of nutrients and organic matter Agricultural University, Ludhiana, which could direct drill wheat into heavy rice residue loads, without burning in a single operation. The yield of wheat sown into rice residues using the 'Happy Seeder' was comparable to or higher than yields with conventional sowing (*Sidhu et al, 2007*).

In high residue no-till farming, efficient nitrogen fertilizer application

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remains a challenge because of slower nitrogen mineralization, greater nitrogen immobilization and higher de-nitrification and ammonia volatilization losses. The presence of crop residues on the soil surface containing urea increases the potential for ammonia volatilization in no-till systems (*Barreto and Westerman, 1989*). About 25% of the nitrogen applied as urea is lost via ammonia volatilization (*Scharf and Alley, 1988*).

Reducing fertilizer nitrogen contact with the straw mulch by placing it into the soil surface can reduce nitrogen immobilization and ammonia volatilization which can increase grain yield, plant N uptake and nitrogen use efficiency (*Blackshaw et al, 2002; Singh et al, 2008; Rochette et al, 2009*). Therefore, a need was felt to have a nitrogen (liquid urea) applicator that can apply nitrogen fertilizer (liquid urea) into the soil surface without disturbing straw mulch in directly sown combine harvested wheat. For the development of such nitrogen applicator, the main component i.e. nitrogen (liquid urea) metering mechanism is required. Fertilizer metering mechanisms for granular fertilizers are commercially available. So, there is a need to develop a metering mechanism for proper and efficient application of nitrogen (liquid urea) in straw mulched crops.

MATERIALS AND METHODS

Description of the nitrogen (liquid urea) metering mechanism

A nitrogen (liquid urea) application metering mechanism was developed and evaluated at Department of Farm Machinery and Power Engineering, Punjab Agricultural University, Ludhiana. It consists of spoke wheel, distribution hub, injectors and cut-off mechanism (Fig. 1). The liquid urea solution is supplied to the spoke wheel with pressure with the help of a piston type double cylinder pump with a

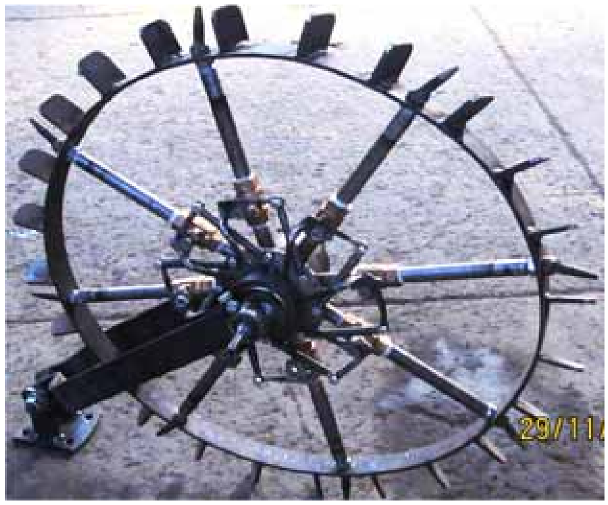

Fig. 1. View of developed nitrogen (liquid urea) metering mechanism

pressure regulator. All the injectors attached to the distributor hub are under pressure of nitrogen (liquid urea). As and when the injector touches the soil surface, a specially designed stationery cam actuated crank lever mechanism open the flow control valve of that injector to inject the nitrogen (liquid urea) on the soil surface. The brief specifications of the newly developed nitrogen (liquid urea) metering mechanism are given in Table 1. The description of major components is given below:

Distribution Hub

The distribution hub acts as a reservoir in which liquid urea is supplied longitudinally from one side and exit tangentially out of eight spokes mounted on the periphery of the distribution hub. A distribution hub is made with a mild

Table 1. Specifications of the developed nitrogen (liquid urea) metering mechanism

	Components	Specifications
1.	Distribution hub	
i)	Shape and size	Cylindrical, 50 x 125 mm
ii)	No. of spoke on hub	8
2.	Fertilizer injector	
i)	Type	Cone shaped
ii)	Length of injector	60 mm
iii)	Orifice diameter of injector	3 mm
3.	Nitrogen (liquid urea) metering mechanism	
i)	Type	Rotary valve metering
ii)	Diameter of spoke	9.5 mm
4.	Cut-off mechanism	
i)	Type	Cam actuated flow control valve
ii)	Size of valve	¾ inch

steel cylinder of 5 mm thickness, 50 mm diameter and 125 mm length. Eight numbers of hollow spokes are extended radially outward from the circumference of the distribution hub. The distribution hub includes an axle, two ball bearings and a cylindrically shaped housing with an axially aligned open centre portion in which the axle bearings are secured. Rubber seals are provided on inner side of the bearings to make it leakage free. The axle has two radial hole of 6 mm diameter on its periphery for supply of liquid urea to different spokes of the wheel. A 40 mm hollow pressure pipe has been used to serve as an axle. The axle positions the two ball bearings to permit rotational movement of the distribution hub with respect to the axle. The closed inner end and open end of the axle is connected to the liquid urea supply line. The axle surface is stair-stepped outwardly to enlarge its diameter at the centre for proper fitting of ball bearings with seal on both ends and the space between two bearings acted as housing for liquid urea.

Injector

Injectors are made from high carbon steel rod of " 12.5 mm and provide a cone shape at one end for easy penetration in straw mulch mat and soil surface. The injectors are fitted in slanting position with the spoke to avoid entangle of straw mulch. A bore of " 3 mm is bored inside the injector. The other end of the injectors with external threads is fitted inside spoke of " 9.5 mm.

Cut-off mechanism

The nitrogen (liquid urea) cut-off mechanism consists of an inline mounted flow control valve to regulate the liquid urea flow between distributor and injector. Each flow control valve fitted in spoke assembly is provided with independent cutoff lever. A specially designed crank lever regulates the opening and closing of flow control valve. The load arm of the lever is attached with a helical tension spring; which kept the flow control valve in closed position.

The effort arm of the crank lever is actuated by a stationery cylindrical cam fitted tangentially on a plate with the rotary wheel. With the rotation of rotary wheel, the effort arm of the lever strikes with the cam and is pushed back; which results into the opening of the flow control valve. As the lever arm passes the cam, the flow control valve comes to its closed position by the tension of the spring and liquid urea supply to the injectors is disconnected.

Laboratory evaluation

The metering mechanism was evaluated in the laboratory conditions for discharge rate, application rate, spread diameter of wetted soil, depth of injection, discharge variation within injectors and discharge variation with simultaneously injectors opening. The standard test rig with variable drive was used to test the nitrogen (liquid urea) metering mechanism. The operating pressure of liquid urea was monitored by an engine operated piston type pump. A stationery view of pump with pressure regulator of the experimental set up is shown in Fig. 2. The metering mechanism was evaluated for three levels of operating pressures (2.5, 3.0 and 3.5 kg/cm^2) and three levels of rotational speed (15, 19 and 23 rpm). Rectangular trays were used to collect the liquid urea discharged from each injector for one minute duration. Application rate of liquid urea (*l*/ha) was calculated from discharge rate and assuming row to row spacing of 40 cm and perimeter of injectors. Parameters like depth of injection and spread diameter of wetted soil were measured by operating the nitrogen applicator in field cum lab condition.

The data for discharge rate, application rate, spread diameter and depth of injection was statistically analyzed according to the factorial randomized block design (RBD).

Fig. 2. View of the laboratory evaluation of nitrogen (liquid urea) metering mechanism

Results and Discussion

Effect of operating pressure and Rotation speed of metering system on

a. Discharge rate

The effects of operating pressure and rotation speed on the discharge rate of the metering system was significant at 5% level of significance (Table 2). Discharge rate from a particular injector increased with the increase in operating pressure and decreased with increase in rotation speed. Increase in operating pressure results in increase in flow speed of the liquid through orifice of the cut-off valve which results in increase in discharge rate whereas with increase in rotation speed, the time for opening of the flow control valve decreases resulting in lesser discharge. The interaction of both the variables was also significant at probability level of 0.05.

b. Application rate

The effects of operating pressure and rotational speed on the application rate was significant at 5% level of significance (Table 2). Application rate increased with the increase in operating pressure and decreased with increase in rotation speed. Increase in operating pressure results in increase in flow speed of the liquid through orifice of the cut-off valve which results in increase in application rate whereas with increase in rotation speed, the time for opening of the flow control valve decreases resulting in lesser discharge. The interaction of both the variables was also significant at probability level of 0.05.

Table 2. Effect of rotation speed and operating pressure on the discharge rate, application rate, spread diameter of wetted soil and depth of injection

Independent variables		Dependent Variables			
Operating pressure, kg/cm^2 (A)	Rotational speed, rpm (B)	Av. discharge rate, ml/min	Av. Application rate, l/ha	Av. spread dia. of wetted soil (mm)	Av. Depth of injection (mm)
2.5	15	3628.7	2476.6	120.5	28.0
	19	3257.0	1775.1	107.3	27.7
	23	3060.0	1390.9	99.1	27.4
3.0	15	4041.0	2758.0	160.7	35.6
	19	3844.7	2095.4	151.2	34.9
	23	3648.7	1658.5	140.5	34.2
3.5	15	4993.3	3407.9	170.6	38.9
	19	4673.3	2547.0	160.5	37.6
	23	4333.3	1969.7	150.4	37.3
$C.D_{(0.05)}$					
A		37.57	21.7	0.73	0.73
B		37.57	21.7	0.73	N.S.
A x B		65.07	37.5	1.26	N.S.

c. Spread diameter of wetted soil

The effect of operating pressure and rotational speed on spread diameter of wetted soil was significant at 5% level of significance (Table 2). Spread diameter increased with the increase in operating pressure and decreased with increase in rotation speed. Increase in operating pressure results in increase in flow speed of the liquid through orifice of the cut-off valve which results in increase in spread diameter whereas with increase in rotation speed, the time for opening of the flow control valve decreases resulting in lesser spread diameter of wetted soil. The interaction of both the variables was also significant at probability level of 0.05.

d. Depth of injection

The effect of operating pressure on depth of injection was significant at 5% level of significance however; the effect of rotational speed was not significant at 5% level of significance. Depth of injection increased with the increase in operating pressure. The rotation speed had not significant effect on depth of injection.

Effect of Variables on discharge variation within injectors

The mean discharge rate for different injectors within a spoke wheel varied from 382.0 to 453.5 ml/min at operating pressure of 2.5 kg/cm^2; 456.8 to 505.1 ml/min at 3.0 kg/cm^2 and 542.1 to 623.4 ml/min at 3.5 kg/cm^2 operating pressure (Table 3). The lowest discharge variation was found at operating pressure of 3.0 kg/cm^2 and rotational speed of 19 rpm with highest uniformity of fertilizer application of 98.5%. The highest discharge variation among different injectors within a rotary wheel was

Table 3. Effect of rotational speed and operating pressure on discharge variation among different injectors within a rotary wheel

Rotational speed, rpm	Injector Discharge (ml/min) Injector No.								Mean discharge (ml/min)	S.D.	C.V.	Uniformity of fertilizer application (%)
	1	2	3	4	5	6	7	8				
A.Operating Pressure: 2.5 kg/cm2												
15	450	460	454	447	442	455	460	460	453.5	9.6	2.11	97.9
19	406	410	408	400	410	415	400	408	407.1	6.7	1.65	98.4
23	395	380	386	390	375	380	375	375	382.0	8.4	2.19	97.8
B.Operating Pressure: 3.0 kg/cm2												
15	505	510	506	515	495	500	495	515	505.1	8.3	1.63	98.4
19	476	490	480	495	470	475	480	475	480.1	7.2	1.50	98.5
23	450	460	455	460	455	465	448	455	456.8	8.4	1.83	98.2
C.Operating Pressure: 3.5 kg/cm2												
15	620	615	615	625	630	625	635	630	623.4	12.9	2.08	97.9
19	580	590	595	585	585	575	590	575	584.4	10.2	1.74	98.3
23	540	550	545	540	548	540	535	540	542.1	11.5	2.12	97.9

observed at operating pressure of 2.5 kg/cm^2 and rotational speed of 23 rpm. The coefficient of uniformity for all the operating pressure viz. 2.5, 3.0, and 3.5 kg/cm^2, was over 97 % with a range of 97.8 % to 98.5 %. The highest coefficient of uniformity in discharge rate was observed at operating pressure of 3.0 kg/cm^2 and rotational speed of 19 rpm. This discharge variation was considered small and reasonable.

Discharge variation due to simultaneous injectors opening

The effect of operating pressures and number of simultaneous injectors opening on discharge variation is given in Table 4. There was some discharge variation with the number of injectors opening. With increase in number of simultaneous injectors opening, discharge variation increased. The highest discharge variation was recorded at operating pressure of 3.5 kg/cm^2 with coefficient of variation of 1.14 while the lowest discharge variation was found at operating pressure of 3.0 kg/cm^2 with coefficient of variation of 0.88.

Selection of the optimum rotation speed and operating pressure

Based on the laboratory test results, the spread diameter of wetted soil was highest at an operating pressure of 3.5 kg/cm^2 and rotation speed of 15 rpm, which is close to the spread diameter used in determination of longitudinal and lateral (across row) spacing for

Table 4. Effect of operating pressure and number of injector opening on discharge

No. of injector opens at a time	Average discharge rate (ml/min)						
	Rotary Wheel No.				Mean	S.D.	C.V (%)
	1st	2nd	3rd	4th			
A. Operating Pressure: 2.5 kg/cm^2							
1	3888.33	0.00	0.00	0.00	3888.33	46.65	1.22
2	3885.00	3825.00	0.00	0.00	3855.00		
3	3846.70	3811.70	3770.00	0.00	3809.47		
4	3833.33	3795.00	3763.00	3743.30	3783.66		
B. Operating Pressure: 3.0 kg/cm^2							
1	5190.00	0.00	0.00	0.00	5190.00	44.98	0.88
2	5165.00	5110.33	0.00	0.00	5137.67		
3	5105.33	5100.67	5097.69	0.00	5101.23		
4	5099.10	5091.18	5089.20	5081.32	5090.20		
C. Operating Pressure: 3.5 kg/cm2							
1	6368.30	0.00	0.00	0.00	6368.30	71.73	1.14
2	6353.30	6305.00	0.00	0.00	6329.15		
3	6308.30	6295.00	6288.30	0.00	6297.20		
4	6234.21	6229.43	6209.32	6128.64	6200.4		

injection. But the application rate at these variables is quite high than the application rate estimated for the design purpose. At operating pressure of 3.0 kg/cm^2 and rotation speed of 19 rpm, the spread diameter of the wetted soil and fertilizer application rate are close to the spread diameter and application rate used for design purpose. Also, the discharge variation within injectors is low. Therefore, a rotational speed of 19 rpm and operating pressure of 3.0 kg/cm^2 were selected as optimum rotary wheel speed and operating pressure of metering mechanism for the field operation of nitrogen (liquid urea) applicator.

CONCLUSION

The operating pressure of the pump and rotation speed of metering system had significant impact on the discharge rate of the metering mechanism which further affects the application rate of nitrogen (liquid urea) to be applied. The discharge rate of the metering mechanism decreased as the rotational speed of mechanism increased from 15 to 23 rpm and increased as the operating pressure of the pump increased from 2.5 to 3.5 kg/cm^2. The lowest discharge variation within injectors was found at operating pressure of 3.0 kg/cm^2 and rotational speed of 19 rpm with highest uniformity of fertilizer application of 98.5%. There was some discharge variation with the number of simultaneously injector opening. With the increase in number of simultaneously injector opening, discharge variation increases.

REFERENCES

Barreto, H.J. and Westerman R.L. 1989. Soil urease activity in winter wheat residue management systems. *Soil Science Society of America Journal* **53**:1455-1458.

Blackshaw, R E, Semach, G. and Janzen, H.H. 2002. Fertilizer application method affects nitrogen uptake in weeds and wheat. *Weed Science* **50**: 634–641.

Rochette, P., Angers, D. A., Chantigny, M.H., MacDonald, J.D., Bissonnette, N. and Bertrand,N. 2009. Ammonia volatilization following surface application of urea to tilled and no-till soils: A laboratory comparison. *Soil and Tillage Research* **103**: 310–315

Saunders, C., Davis, L. and Pearce, D. 2012. Rice–wheat cropping systems in India and Australia, and development of the 'Happy Seeder' .ACIAR (Australian Centre for International Agricultural Research). Annual report. Pp 1-49. Canberra.

Scharf, P.C. and Alley, M.M. 1988 Nitrogen loss pathways and nitrogen loss inhibitors- a review. *Journal of Ferilizert* **5**: 109-125.

Sidhu, H. S, Singh, M., Humphreys, E., Singh, Y., Singh, B., Dhillon, S. S., Blackwell, J., Bector, V., Singh, M. and Singh, S. 2007. The Happy Seeder enables direct drilling of wheat into rice stubble. *Australian Journal of Experimental Agriculture* **47**: 844–854.

Singh, Y., Sidhu, H. S., Singh, M., Humphreys, E., Kukal, S.S. and Brar, N. K. 2008. Straw mulch, irrigation water and fertilizer N management effects on yield, water use and N use efficiency of wheat sown after rice. *Proc. Permanent beds and rice residue management for rice-wheat systems in the Indo-Gangetic plain* pp171-181Centre for International Agricultural Research, Canberra.

Singh, Y., Sidhu, H. S., Singh, M., Dhaliwal, H. S., Blackwell, J. and Singh, R. P. 2009. Happy Seeder: A conservation agriculture technology for managing rice residue. *Tech Bull 01*. Pp 1-16. Deptt. of Soil, PAU, Ludhiana.

J. Farming Systems Research & Development **20** (1) : 100-106 (2014)

IMPACT OF FRONT LINE DEMONSTRATIONS ON YIELD, ADOPTION AND HORIZONTAL SPREAD OF OILSEED CROPS

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ABSTRACT

The front line demonstrations were conducted in Lanja and Rajapur Talukas of Ratnagiri district during 2008 to 2012. Total 93 farmers from two villages namely Asage and Gawane for demonstration of groundnut crop and 26 farmers from Gawane village for demonstration of niger crop were selected. The demonstrations were laid out on farmers' field as per package of practices recommended by Dr Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli. The farmers' practice was considered as control plot in demonstration cluster. The results revealed that significant raise in yield of groundnut over the control by 60.15%, 53.23%, 47.0%, 46.0% and 74.0% for the year 2007-08, 2008-09, 2009, 2009-10 and 2012, respectively. The yield of Niger was 2.75 q ha^{-1} in the year 2008-09 which was increased to 3.11 q ha^{-1} in the year 2009-10. The overall adoption level of groundnut production technology was increased by 181.72 per cent and niger was 233.38 per cent due to FLDs. The varieties of groundnut such as SB-11 and local were replaced by Konkan Tapora and Konkan Gaurav, and local variety of Niger was replaced by IGP 76 & Phule Karala in demonstration cluster.

Key Words: FLDs, Yield, Adoption, Varietal replacement, Horizontal Spread

The Indian Council of Agricultural Research (ICAR) has established Krishi Vigyan Kendras (KVKs) all over the country is an institutional innovation for application of agricultural science and technology on the farmer's field with the help of a multi-disciplinary team i.e. Subject Matter Specialists (SMS).

The KVKs are playing strategic role in technology backstopping, knowledge management and advisory to the different stakeholders like farmers, farm-women, rural youths and extension personnel. The emphasis is given to provide critical knowledge and skills to the participants to enhance the agricultural productivity and also become economically self-reliant through gainful-employment. An important activity of KVK is to demonstrate the flagship technologies developed by NARS on farmer's field to enhance to productivity and profitability of principle crops grown in the district. It is, therefore, KVK should know that to what extent the productivity of these crops are raised due to demonstrations, to what extent demonstrations helped for horizontal spread of technologies in their operational area and extent of adoption of technologies by the farmers. With this background, present study was undertaken by KVK, Lanja to assess the impact of Front Line Demonstrations (FLDs) on yield enhancement of oilseed crops and to study the extent of horizontal spread of oilseed technology through FLDs.

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Materials and Methods

The FLDs were conducted in Lanja and Rajapur Taluka of Ratnagiri district during 2008 to 2012. Total 93 farmers from two villages namely Asage and Gawane for Groundnut and 26 farmers from Gawane village for Niger crop demonstration were selected. The demonstrations were laid out on farmer's field according to recommended package of practices of Dr Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli. The farmer practice was considered as control plot in demonstration cluster. All critical inputs viz., seed, fertilizer, IPM and bio-fertilizers were supplied to the farmers. The demonstrations plot was supervised by the KVK, scientists. The data of FLD was collected by KVK scientists and used to assess the impact on yield. However, data about adoption and horizontal spread of technologies were collected from the farmers with help of interview schedule. Data was subjected to suitable statistical methods. The following formulas were used to assess the impact on different parameter of oilseed crops.

$$\text{Impact on Yield (\% Change)} = \frac{\text{Yield of Demonstration Plot} \times \text{Yield of Control Plot}}{\text{Yield of Control Plot}} \times 100$$

$$\text{Impact on Adoption (\% Change)} = \frac{\text{No. of Adopters before Demonstration} - \text{No. of Adopters after Demonstration}}{\text{No. of Adopters after Demonstration}} \times 100$$

$$\text{Impact on Horizontal (Spread \% Change)} = \frac{\text{Before Area (ha)} - \text{After Area (ha)}}{\text{After Area (ha)}} \times 100$$

Results and Discussion

Impact of Front Line Demonstrations (FLDs) on Yield

The findings of impact of Front Line Demonstrations (FLDs) on yield enhancement of different crops are presented here under. It is evident from Table 1 that the pod yield of demonstration plot of groundnut was 22.70 q ha^{-1} (2007-08), 21.30 q ha^{-1} (2008-09), 19.51 q ha^{-1} (2009-10), 23.17 q ha^{-1} (2009-10) and 16.20 q ha^{-1} in 2012. This showed that there was significant raise in yield of groundnut over the control by 60.15%, 53.23%, 47.00, 46.00 and 74.00 % for the year 2007-08, 2008-09, 2009, 2009-10 and 2012, respectively. Similar trend of FLD was reported by Mishra *et. al.* (2009) on potato crop.

It is revealed from Table 2 that the yield of demonstration plot of niger was 2.75 q/ha in the year 2008-09 and 3.11 q/ha in the year 2009-10 which was significantly higher by 52.0% and 43.0% over control plot during 2008-09 and 2009-10, respectively. This showed the positive impact of FLD of Niger crop. Yield enhancement in different crops in Front Line Demonstration was showed by Haque (2000), Tiwari and Saxena (2001), Tiwari et al. (2003) and Tomer *et al.* (2003).

The yield level of control plot was threatened due to use of low yielding local varieties, improper fertilizer use and improper plant protection measures. However, in case of demonstration plot, the factors leads to enhance the yield of crop were timely sowing, use of recommended varieties, balanced nutrient management and strong technology backstopping from KVK scientists.

Impact of Front Line Demonstrations (FLDs) on Adoption of Groundnut Production Technology

Data about adoption of production

Table 1. Impact of Front Line Demonstrations (FLDs) on Yield of Groundnut Crop

Crop	Year	Technology Interventions	Number of Farmers	Demon-strated Area (Ha)	Average Yield ($q\ ha^{-1}$) Control plot	Demon-strated plot	Impact (%) Change)
Ground nut-	*Rabi*-2007-08	TG-26 Variety + Seed treatment + *Rhizobium*, PSB & *Trochoderma* + Earthing up operation after one month	25	10.00	14.04	22.70	+61.00
	Kharif-2008	TG-26 Variety + Seed treatment + *Rhizobium*, PSB & *Trochoderma* + Earthing up operation after one month	13	5.00	13.90	21.30	+53.00
	Kharif-2009	*Konkan* Gaurav Variety + Seed treatment + *Rhizobium*, PSB & *Trochoderma* before sowing	20	7.00	13.24	19.51	+47.00
	Rabi-2009-10	*Konkan* Gaurav Variety + Seed treatment + *Rhizobium*, PSB & *Trochoderma* before sowing	25	10.00	15.81	23.17	+46.00
	Kharif-2012	*Konkan* Tapora + Seed treatment + *Rhizobium*, PSB & *Trochoderma* before sowing	10	2.50	9.26	16.20	+ 74.00
	TOTAL		93	34.50	13.25	20.57	+ 56.20

Table 2. Impact of Front Line Demonstrations (FLDs) on Yield of Niger Crop

Crop	Year	Technology Interventions	Number of Farmers	Demon-strated Area (Ha)	Mean/Average Yield ($q\ ha^{-1}$) Control plot	Demon-strated plot	Impact (%) Change)
Niger	*Kharif*-2008	IGP 76 varierty + seed treatment of fungicide	13	5.00	1.80	2.75	+52.00
	Kharif-2009	Phule Karla varierty	13	5.00	2.17	3.11	+43.00
	TOTAL		26	10.00	1.98	2.93	+47.50

technology of groundnut by the farmers is depicted in Table 3.

It was found that adoption of recommended varieties of groundnut by the farmers was less before demonstration period and which was increased by 569.23 per cent after demonstration. This was followed by adoption of important operation of groundnut i.e. drum rolling during peg formation stage was increased significantly by 336.36 percent and seed treatment with Thirum, *Rhizobium*, PSB & *Trochoderma* was increased by 273.68 percent due to FLD. In addition, the percent of adopters of recommended technologies such as seed rate, fertilizer management, weed management, earthing up operation 30 DAS and land preparation and application of FYM were increased significantly. The overall adoption level of groundnut production technology was increased by 181.72

Table 3. Impact of Front Line Demonstrations (FLDs) on Adoption of Groundnut Production Technology

Sr. No.	Technology	Number of Adopters (N=93)		Change in number of Adopter	Impact (% Change)
		Before Demons-traion	After Demons-traion		
1.	Land preparation and application of FYM	75	93	+ 18	24.00
2.	Recommended Varieties (Konkan Gaurav, Konkan Tapora, TG-26)	13	87	+ 74	569.23
3.	Seed rate (100-120 Kg/ha)	34	66	+ 32	94.12
4.	Seed treatment + Rhizobium, PSB & *Trochoderma*	19	71	+ 52	273.68
5.	Sowing time and spacing (30×15 cm)	67	81	+ 14	20.90
6.	Fertilizer management (25:50:00)	44	91	+ 47	106.82
7.	Weed management	69	93	+ 24	34.78
8.	Earthling up operation 30 DAS	20	51	+ 31	155.00
9.	Drum rolling during peg formation stage	11	58	+ 47	336.36
10.	Recommended yield	24	71	+ 47	195.83
	Overall Impact				181.72

percent due to FLDs organized by KVK, Lanja. SImilar findings in case of jute crop were recorded by Chapke (2010).

Impact of Front Line Demonstrations (FLDs) on Varietal Replacement

The FLDs is proven extension intervention for making change in existing/traditional practice of farmers. It is, therefore, efforts were taken to know the varietal replacement has been happened due to FLD in selected cluster. It was found that the varieties of groundnut such as SB-11 and local were replaced by Konkan Tapora and Konkan Gaurav on large scale. The local variety of Niger was replaced by IGP 76 & Phule Karala in demonstration cluster. Replacement of local varieties with improved varieties of maize, paddy and wheat due to FLD was reported by Balai et. al. (2013).

Table 4. Impact of Front Line Demonstrations (FLDs) on Adoption of Niger Production Technology

Sr. No.	Technology	Number of Adopters (N=26)		Change in number of Adopter	Impact (% Change)
		Before Demons-traion	After Demons-traion		
1.	Land preparation and application of FYM	4	11	+7	175.00
2.	Recommended Varieties (IGP 76, Phule Karla)	00	11	+11	1100
3.	Seed rate (3-4Kg/ha)	5	9	+4	80.00
4.	Seed treatment	00	4	+4	400
5.	Sowing time	8	10	+2	25.00
6.	Spacing (30 cm)	7	11	+4	57.14
7.	Fertilizer management	6	9	+3	50.00
8.	Weed management	3	7	+4	133.34
9.	Recommended yield	5	9	+4	80.00
	Overall Impact				233.38

Table 5. Impact of Front Line Demonstrations (FLDs) on Varietal Replacement of Different Crops

Sr. No	Crop	Previous grown variety	New variety introduced
1	Groundnut	SB-11, Local	Konkan Tapora, Konkan Gaurav, TG-26
2	Niger	Local	IGP 76 & Phule Karala

Impact of Front Line Demonstrations (FLDs) on Horizontal Spread of Variety

In present study, efforts were made to study the impact of FLDs on horizontal spread of varieties of various crops.

The data presented in Table 6 indicated that FLD of organized on various crops helped to increase their area under recommended varieties. There was significant increase in area horizontally from 1.00 ha to 7.60 ha under *Konkan* Tapora variety of groundnut and Konkan Gaurav from 2.00 ha to 9.00 ha due to FLD. Similarly, area under Niger crop was increased from 0.40 ha ha to 2.00 ha due to FLD. The FLDs made positive impact on horizantal spread of varieties of groundnut and niger crop. This leads to conclude that FLDs organized by KVK, Lanja made significant impact on horizantal spread of technlogies.

Conclusions

The Front Line Demonstration (FLDs) enhanced the yield of crops vertically and ensured rapid spread of technologies horizontally. The FLDs made positive and significant impact on yield enhancement of Groundnut by 56.20 per cent and Niger by 47.50 per cent. Impact of FLDs on adoption of technologies showed increased trend in adoption of groundnut production technologies by 181.72 per cent and Niger production technologies by 233.38 per cent. In all, FLD made positive impact on use of improved varieties, earthing up & drum rolling operation of groundnut, and use of recommended varieties of Niger. Further, SB-11 and local variety of groundnut were replaced by Konkan Tapora, Konkan Gaurav and TG-26 on large scale in demonstration cluster. FLDs organized by KVK made significant impact on horizantal spread of technologies. The area under Konkan Tapora variety of groundnut was increased from 1.00 ha to 7.60 ha and Konkan Gaurav from 2.00 ha to 9.00 ha.

It means FLD is proven extension intervention to demonstrate the production potential of different crops on farmers' field. Therefore, it is recommended that stakeholders who are engaged in transfer and application of agriculture technologies on farmer's field should give priority to organize Front Line Demonstrations (FLDs) extensively in cluster approach for enhancing

Table 6. Impact of Front Line Demonstrations (FLDs) on Horizontal Spread of Variety of Different Crops

Sr. No.	Crop	Area (Ha)		Change in Area (Ha)	Impact (% Change)
		Before Demonstration	After Demonstration		
1.	**Groundnut**				
	Konkan Tapora	1.00	7.60	+6.60	660.00
	Konkan Gaurav	2.00	9.00	+7.00	350.00
	TG 26	4.00	6.00	+2.00	50.00
2.	**Niger**				
	IGP 76	0.40	2.00	+1.60	400.00

productivity potential of main crops and to make rapid spread of flagship technologies. Most of the low yielding-local varieties are replaced due to FLDs. Therefore, it is suggested that policy maker may provide adequate financial support to frontline extension system for organizing FLDs under close supervision of agricultural scientists and extension personnel. This may help to raise the agricultural productivity district, state and national level.

References

Balai, C.M., R.K. Bairwa, L.N. Verma, B.L. Roat and R. Jalwania. 2013. Economic impact of front line demonstrations on cereal crops in Tribal Belt of Rajasthan. *International Journal of Agricultural Sciences* Vol. **3 (7)**: 566-570.

Chapke, R.R. 2012. Impact of Frontline Demonstrations on Jute (*Corchorus olitorius*). *J. Hum Ecol*. **38(1)**: 37-41.

Haque M. S. 2000. Impact of compact block demonstration on increase in productivity of rice. *M. J. Ext. Edu*. **19 (1)**: 22-27.

Mishra, D. K., D. K. Paliwal, R. S. Tailor and A. K. Deshwal. 2009. Impact of Frontline Demonstrations on Yield Enhancement of Potato. *Indian Res. J. Ext. Edu*. **9 (3)**: 26-29.

Tiwari K. B. and A. Saxena 2001. Economic Analysis of FLD of oil seeds in Chindwara. *Bhartiya Krishi Anusandhan Patrika*. **16 (3&4)**: 185-189.

Tiwari R. B, V. Singh and Parihar Pushpa 2003. Role of front line demonstration in transfer of gram production technology. *Maha. J. Ext. Edu*. **22 (1)**: 19.

Tomer L. S., P. B. Sharma and K.Joshi. 2003. Study on yield gap and adaptation level of potato production technology in arid region. *Maha. J. Ext. Edu*. **22 (1)**: 15-18.

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