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National Academy of Agricultural Science (NAAS)
Rating : 3. 03

Evaluating the Characteristics of Contrasting Rice Varieties for Suitability in Rainfed Lowland Areas of Bihar

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Abstract: *Field experimentto evaluatethe rice cultivars for drought tolerance under rainfed lowland conditions of Biharwas carried out in the* Kharif*season of 2014 and 2015 on a silty clay loam soil with low to medium fertility at Agricultural farm of Bihar Agricultural University, Sabour, Bihar. The experiment was laid out in completely randomised block design (RBD) with fivetreatments as drought tolerant rice varieties with four replications. Twenty five days old seedlings were used to transplant at 20cm ×15cm spacing during the third week of July, 2014 and 2015. Among the varieties, there were non-significant differences with respect to normalized difference vegetation index (NDVI) values, number of tillers per square meter, number of panicles per square meter and panicle length.The SPAD (Soil Plant Analysis Development) value was increasedsignificantly inRajendraSuwasini (37.8) and was at par with Abhishek (35.9) and CR Dhan-40 (35.6). The plant height of CR Dhan-40 (134.5cm) and RajendraSuwasini (124.3cm) were at par with each other, but significantly greater than other varieties. No significant difference in yield contributing characters namely panicle length, number of panicles per square metre and number of tillers per square meter were found among various varieties. However, number of grains per panicle was found significant among the varieties. The highest number of grains per panicle was found in CR Dhan-40 (224 grains) followed by SahbhagiDhan (208 grains). Similarly significant differences were also observed in terms of grain yield and straw yield. The highest grain yield was recorded with RajendraSuwasini (42.4q/ha) and at par with all other varieties except CR Dhan-40 (39.8q/ha). The highest straw yield was recorded with Abhishek (60.3q/ha) and at par with RajendraSuwasini (55.7q/ha) and SushkSamrat (54.6q/ha) respectively.Variety Abhishek recorded highest root length followed by RajendraSuwasini and SabourArdhjalin both years of study.*

Key words: *Rice, Drought tolerant variety, Grain yield and straw yield.*

INTRODUCTION

Rice is the main food staple in Asia. Many rural poor rely on rice farming under rainfed conditions where farmers' estimates of losses to drought can be as high as 45% annually. A large portion of the Southern part of Bihar is under rainfed cropping system where the soil moisture is unpredictable and droughts are common. The crop adaptation strategy being used involves three mechanisms that influence yield in the drought prone areas: yield potential as an important mechanism for mild drought (where yield loss is less than 50%), drought escape (appropriate phenology) and drought tolerance traits of leaf water potential, sterility, flower delay and drought response index for more severe drought conditions. Genotypes are exposed to manage drought environments for selection of drought tolerant genotypes with better cropping management. The target population of environments (TPE) is the set of all environments, fields and season in which an improved variety is targeted to perform well..This investigation was planned to evaluate the performance of four contrasting varieties under rainfed conditions and

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see what mechanisms of adaptation to drought of varying intensity and duration are available through a study of the root characteristics of the five varieties.

Bihar always face drought and flood problem and literature shows that maximum areas in north Bihar is affected due to flood and south Bihar namely, Banka, Jamui, Gaya, Rohtas and Kaimur are the districts, considered in rain fed situation. Southern portion of adjoining districts of Jharkhand are vulnerable zone of drought situation (level 3 very low moisture) during summer, however, level1and level 2 in map consist rather than high moisture due to low land having rain fed condition (Fig. 1).

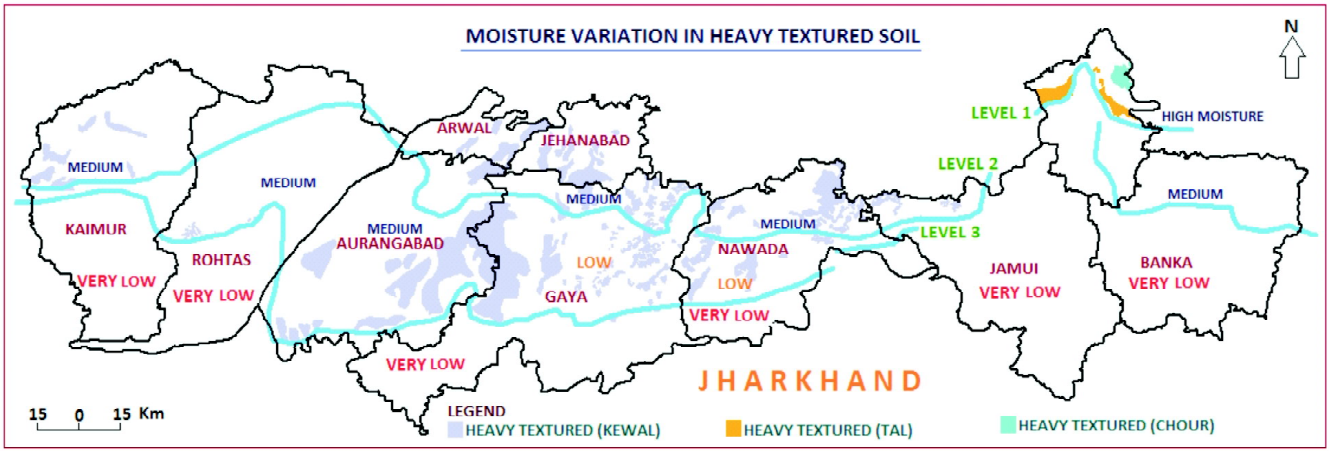

Figure 1: Moisture level under rainfed

MATERIAL AND METHODS

Experimental site

A Field experimentwas carried out in the *Kharif*season of 2014 and 2015 at Agricultural research farm of Bihar Agricultural University, Sabour, Bhagalpur at 25°152 402 2 N latitude, 87°22 422 2 E longitude and an elevation of 37.0 m *a.s.l.*The soil of the location is silty clay loam in textureand low in fertility status. The climate of Bhagalpur is characterized by hot and humid summer (April and June), rainy during June- July to September, moderately hot and dry autumn (October and November), cool and dry winter (December and January) and moderate spring (February and March). The site receives annual average rainfall of 1200 mm of which 70-75% occurred in the monsoon months (June to October). The average temperature varies from 19°C in December/January to 29.6°C in May/June.

Treatment detail

The treatment comprised was laid out in randomised block design (RBD)and replicated four timeswith five varieties of rice namely *ShushkSamrat* (V_1), *SahbhaiDhan*(V_2), *Abhishek*(V_3), *CR-Dhan-40* (V_4) and *RajendraSuhasini* (V_5) in a first year but in second year one variety was replace from SabourArdhjal (V_5) were evaluated for their performance in an on station trial at BAU, Sabour in a randomised block design with four replications. 25 day old seedlings of the these varieties were transplanted at a R-R spacing of 20 cm and a plant to plant spacing of 15 cm during the third week of July, in both the year.

Details of layout

Total number of treatments = 05 (Variety)

Total number of plots (5 x 4) = 20

Plot size: Gross – 6 x 5.6 m = 33.6 m2

Main/Sub irrigation channel = 1.50 m/1.0 m

Variety

All drought tolerant varieties are of short duration (105-115 days) suitable for bunded uplands and rainfed drought prone shallow low lands in eastern India. It has a potential to reduce losses from

intermittent drought while ensuring stable rice yield even in drought periods. Based on soil type and moisture availability, SahbhagiDhan can be transplanted or directly sown. This variety was demonstrated along with SahbhagiDhan in Aurangabad district in 2013. The initial yield results and farmer feedback has been positive. The demonstration results are being analysed further to decide on scale up.

Under the field preparationthe field was ready after the harvest of previous crop. Planking was done after each ploughing to level the field. Plots were laid out as per the plan. The amount of fertilizer as die-ammonium phosphate (46% P_2O_5 and 18% N) and murate of potash (60% K_2O) to supply phosphorus and potassium was calculated as per treatment and placed just before the transplanting or at the time of puddling. A seed rate of 25 kg/ha was used for raising the nursery. The seed was treated before sowing with 'Ceresan' (an organ-mercurial fungicide) @ 3 g/kg of seed. Transplanting was done with the help of manual labour by putting the seedling in the plot with spaced 20 cm row spacing apart at a depth of 4-5 cm.

Observations recorded

The pre-harvest and post-harvest observations except active tillering stage, panicle initiation and at harvest were recorded in selectedvarieties of paddy. The height (cm) of five plants (randomly selected and tagged) was recorded from the ground to the top of the main shoot periodically at active tillering and at harvest in paddy. The samples were then dried in an over at 70^0C for 48 hours to get constant weight, and there after the dry weight / m^2 (g) were recorded. At harvest, tagged five plants of paddy from each plot were utilized for yield attributes. The plants from the net plot were harvested to record grain and straw yields. The counting of grains was done manually and the average was calculated. The mean number of grains/panicle was recorded. 1000 grains were counted from the composite samples drawn from the weight was recorded for each treatment. Grain yield from each net plot was obtained after threshing the produce of crop. The grains were then sun dried to record grain yield/net plot, which was converted into grain yield in q/ha. The straw obtained from obtained from each plot was sun dried and weighed. The values were converted into straw yield in q/ha. The harvest index was obtained by dividing the economic yield (grain yield) by total biological yield (grain + straw) and multiplying the fraction thus obtained with 100 (Singh and Stoskopf, 1971).

$$HI\,(Harvest\ Index) = \frac{Grain\ Yield}{Biological\ Yield} \times 100$$

The data in respect of various varieties of paddy characters were subjected to statistical analysis by adopting appropriate method of 'Analysis of variance' as described by (Cochran and Cox, 1963).

Root studies

The performance of some rice variety in rainfed condition in terms of root morphological characters we have used of protocol PVC, pipe method for the root study, under this study following materials was used-

1. Pipe: PVC tube of 80- 100cm length and 15-20 cm in diameter
2. Soil and normal dose of organic manure
3. Pit: the depth of the pit is the same as length of PVC tube
4. four replication and RBD design adopted withall accessories in the field like- A shallow washing tank or stand where PVC tubes can be immersed prior to sampling roots,measuring tape with a minimum graduation of 1.0 mm,Paper bags in which to place roots and shoots, hot-air oven (for dry weight measurement),A long iron road,weighing balance, Marker, pencils and tags etc.

RESULT AND DISCUSSION

Among the varieties, there were non-significant differences with respect to NDVI (Normalized Difference Vegetation Index) values, number of tillers per square meter, number of panicles per

square meter and panicle length. The SPAD (Soil Plant Analysis Development) value was increased significantly with RajendraSuwasini (37.8) and on par with Abhishek (35.9) and with CR Dhan-40 (35.6) (Table 1). The plant height of CR Dhan-40 (134.5 cm) and R. Suwasini (124.3 cm) were at par with each other, but significantly greater than other varieties. No significant difference in yield contributing characters namely panicle length, number of panicles per square metre and number of tillers per square meter were found among various varieties. The plant height of CR Dhan-40 and Rajendra Suwasiniwere at par with each other but significantly greater than other varieties. No significant difference in the yield contributing characters namely panicle length, number of panicles per square metre and number of grains per panicle was found among various varieties. However, the test weight of CR dhan-4 was found to be significantly lower than the other four varieties.Similarly significant differences were also observed between the performance of some of the varieties in terms of straw yield with ShushkSamrat and RajendraSuhasini leading the group and Abhishek with the least straw yield. The differences among various varieties in terms of the grain yield harvest indices obtained under rainfed conditions were however non-significant (table 1).

However, number of grains per panicle was found significant among the varieties. The highest number of grains per panicle was found in CR Dhan-40 (224) followed by Sahbhagi Dhan (208). Similarly significant differences were also observed in terms of grain yield and straw yield. The highest grain yield was recorded with RajendraSuwasini (42.4 q/ha) and at par with all other varieties except CR Dhan-40 (39.8 q/ha). The highest straw yield was recorded with Abhishek (60.3 q/ha) and at par with RajendraSuwasini (55.7 q/ha) and ShushkSamrat (54.6 q/ha) respectively (Table 1). Similarly non-significant differences were also observed between the performance of some of the varieties in terms of Harvest Index with ShushkSamrat and RajendraSuwasini. In second year of kharif – 2015, the plant height of CR Dhan-40 (131.7 cm) and ShuskSamrat (119.3 cm) were at par with each other, but significantly greater than other varieties. No significant difference in yield contributing characters namely panicle length, number of panicles per square metre was found among various varieties (table 2).

However the performance of some rice variety in rainfed condition in terms of root morphological characters we observed that the maximum root length was recorded in Abhiishek followed by RajendraSuwasini. Similarly in terms of highest number of root/ hill of ShuskShamrat was found significant higher then CR dhan-40 in a first yearstudy (table 3). But in second year in terms of number of roots/hillsignificantly higher variety ShuskSamrat followed by CR-dhan-40 and Abhishek respectively. Similarly the root dry matter (g/hill) recorded significant higher in Abhishek followed by SabourArdhjal and other three varieties (table 4). These advantageous characteristics are explored and discussed in terms of benefits of soil

Table 1
Growth and yield parameters of five varieties of rice cultivated under rainfed conditions at BAU farm, SabourinKharif - 2014

Variety	*NDVI value*	*SPAD Value*	*Plant height (cm)*	*No. of panicle/ m^2*	*Grains/ Panicle*	*Panicle length (cm)*	*Test weight (g)*	*Grain yield (q/ha)*	*Straw yield (q/ha)*	*Harvest Index*
Shushk Samrat	0.61	35.2	118.5	218	170	27.0	21.0	42.0	54.6	0.43
Sahbhagi Dhan	0.57	30.8	111.0	197	208	26.5	22.0	39.1	47.5	0.45
Abhishek	0.60	35.9	119.8	230	187	27.3	22.4	41.1	60.3	0.41
CR Dhan-40	0.61	35.6	134.5	181	224	26.5	20.3	39.8	52.9	0.43
R. Suvasini	0.61	37.8	124.3	213	188	27.3	22.8	42.4	55.7	0.43
CD (5%)	NS	5.1	6.8	NS	30	NS	1.8	NS	12.8	NS

Table 2
Growth and yield parameters of five varieties of rice cultivated under rainfed conditions at BAC farm, Sabour– Kharif -15

Variety	*NDVI value*	*SPAD Value*	*Plant height (cm)*	*No of panicles/ m-2*	*Grains/ Panicle*	*Panicle length (cm)*	*Test weight (g)*	*Grain yield (q/ha)*	*Straw yield (q/ha)*	*Harvest Index*
Shushk Samrat	0.65	34.2	119.3	209	179	26.0	22.0	44.7	59.2	0.43
Sahbhai Dhan	0.62	33.8	114.7	200	211	23.3	23.5	32.8	46.8	0.41
Abhishek	0.68	37.5	117.3	233	175	23.3	22.0	38.2	50.1	0.43
CR Dhan-40	0.64	35.2	131.7	172	188	24.0	19.7	37.8	48.1	0.44
SabourArdhjal	0.66	36.6	108.3	245	178	24.7	23.0	36.0	51.8	0.41
CD (5%)	0.02	1.8	4.2	NS	22	NS	3.3	NS	13.8	NS

Table 3
Root parameters of five varieties of rice cultivated under rainfed conditions at BAC farm, Sabourin Kharif -2014

Variety	*Maximum root length (cm)*	*Number of roots/ hill*	*Root dry matter (gm/hill)*	*Shoot dry matter (g/hill)*
Shushk Samrat	22.87	165	3.11	7.37
Sahbhagi Dhan	28.95	121	3.10	14.27
Abhishek	34.92	132	9.98	9.17
CR Dhan-40	26.72	155	9.13	7.85
RajendraSuwasini	29.97	128	11.38	12.47
CD (5%)	1.45	8.7	1.25	1.45

Table 4
Root parameters of five varieties of rice cultivated under rainfed conditions at BAC farm, Sabourin*Kharif* -2015

Variety	*Maximum root length (cm)*	*Number of roots / hill*	*Root dry matter (gm/hill)*	*Shoot dry matter (g/hill)*
Shushk Samrat	23.30	172	3.46	7.12
Sahbhagi Dhan	29.60	115	3.31	12.92
Abhishek	50.65	128	11.98	8.80
CR Dhan-40	33.67	158	9.92	7.25
SabourArdhjal	48.67	119	11.61	11.35
CD (5%)	7.25	8.44	0.79	1.49

health and yield advantages. Further studies in this area are recommended to investigate the characteristics of drought prone rice varieties that may help pursue a more eco-friendly approach towards rice cultivation.

CONCLUSION

The growth performance of contrasting rice cultivars under rainfed conditions has suggested that NDVI and SPAD measurements can help in Real Time Nitrogen Management leading to decreasing the vulnerability to yield and economic losses under rainfed conditions. Studying the yield and yield contributing characteristics of various cultivars serves little towards characterising the cultivars for their suitability for cultivation under rainfed conditions. However, systematic root studies can throw light on the relative competence of the specific cultivars to varying intensities and duration for drought encountered by rainfed rice crops. Further studies involving a greater no of cultivars for characterisation of the root morphology is required to draw some meaningful conclusions towards the desired end.

Acknowledgement

International Rice Research Institute, Directorate of Research of Bihar Agricultural University and Chairman of Natural Resource Management are gratefully acknowledged for funding and their immense support and guidance.

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