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Growth, Development, Yield Attributes and Yield of Upland Rice (*Oryza sativa*) under Various Environmental Conditions and Genotypes

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Abstract

Rice is major cereal crop of India and South Asia as well. To assess the response of prevailing environments and their interaction with photosensitive genotypes (mahsoori) and phptoinsensitive (ashwani and pant-4), a field experiment was conducted under semiarid condition of Kanpur. This study proved that the year (1998) was more favorable for growth and development and by virtue of this first year crops produced more biomass. It might be due to conducive environmental condition during vegetative phase and vice versa for reproductive phase. Moreover second year (1999) was better economic produce (grain yield), it may be because of congenial environmental conditions during reproductive phase when despite low biomass efficient conversion of photosynthates from source to sink was observed. During both the years photoinsensitive varieties viz. ashwani and pant-4 proved to be better. Delay in planting advanced the maturity significantly. Long duration genotype mahsoori recorded maximum plant height of 96.9 and 99.6 cm during the both years; 1,000-grain weight was not affected significantly due to environments, however significant differences were recorded due to genotypes during second year. Maximum above ground biomass production was recorded during first dates of planting (105.2 and 98.5 q/ha) and genotype mahsoori (106.4 and 97.1 q/ha). Harvest index being a typical genotypic character least affected by environmental fluctuations, variety ashwani produced boldest seed (28.0 and 28.4 g/1,000 seeds) and mahsoori produced cylindrical Seeds with lowest seed weight (19.4 and 20.6 g). For successful rice cultivation under Kanpur condition, best time for transplanting is 15 July selecting high yielding photoinsensetive varieties.

Key word : Upland rice, Growth, Development, Environmental condition, Genotypes.

Kanpur (26°.29′ N 80° 18′ E) being located in central Uttar Pradesh enjoys semi-arid climate. Rice (*Oryza sativa*) being miracle crop respond well to diverse agroecological/climatic situation. It is its unique capacity to adopt in any situation, makes its wonderful crop of modern agriculture. Present day rice is grown from tropics to temperate condition, below sea level in Kerla to above 5,000 m in Nepal and handsomely adopted to problematic soils viz. acidic to saline alkaline. Being one of the most important cereals, every day rice is sown and harvested in the global village. Rice is staple food for South East Asian countries; this region itself is consuming almost 90% of rice production. India is a second largest rice producer in world following by China. Globally rice is grown on about 145 million hectares with a production of 545 million tones. In India area under rice cultivation range 38 to 43 million hectares with a productivity of 2.6 ton/ha only. The productivity is not satisfactory if we compare with other producer like Egypt, Korea, Japan, Australia and China. The state of low productivity poses the challenge among the scientists to find out the causes and ways to remove them. Rice performance (growth, yield component and yield) is determined by the numerous factors. Grain yield is one of the most complex polygenic traits, which is expected to show higher magnitude of interaction variance. Rice, a member of graminaei, interacts well with existing environment. Planting time and selection of variety may play the deciding role in performance of rice, hence choice of correct variety and selection of right time of transplanting under particular agroclimatic

Table 1. Growth and development of rice. * At maturity stage.

Treatment	1998 LAI (at P.I.)	1998 *Plant ht (cm)	1998 *Shoots m^2	1998 *Dry matter (g/hill)	1998 Days to maturity	1999 LAI (at P.I.)	1999 *Plant ht (cm)	1999 *Shoots m^2	1999 *Dry matter (g/hill)	1999 Days to maturity
Planting Time										
15 Jul	4.21	98.4	290.3	28.25	117	3.40	103.67	289.7	27.16	114.3
25 Jul	4.26	87.8	283.7	25.50	113	3.29	91.67	283.6	26.74	109.6
5 Aug	4.22	77.5	278.3	24.89	110	3.17	80.21	269.8	25.61	106
CD (5%)	NS	3.1	6.2	0.94	3.3	NS	9.17	15.0	1.46	3.4
Varieties										
Ashwani	4.23	82.8	286.7	25.51	100.1	3.38	84.21	283.1	24.54	98.3
Pant-4	4.16	83.9	280.6	24.36	113	3.31	88.15	261.5	22.86	109.7
Mahsoori	4.29	96.9	285.6	28.81	126	3.61	99.64	274.1	26.91	122
CD (5%)	NS	5.4	NS	2.12	3.6	NS	8.03	NS	2.14	5

condition call for success of rice production because prevailing weather conditions play a vital role in the performance of rice crop. On the basis of foregoing narration it is clear that rice is quite responsive to its environment and considerable amount of response were also received from its genetic makeup i.e. varietals characteristics (1, 2).

Methods

To assess the cause and effect relationship between environment and genotype under semi-arid upland condition, a field experiment was carried out at student's instructional farm of Department of Agronomy, Chandra Shekhar Azad University of Agriculture and Technology. Kanpur during *kharif* season of 1998 and 1999 in a medium fertile sandy loam soil with pH value of 7.7. Experiment was laid down in split plot design (SPD) with four replications keeping environment (planting time i.e. 15 July, 25 July and 5 August) in a main plot and genotypes (i.e. varieties Ashwani, Pant-4 and Mahsoori) in sub-plots. Three environments (i.e. planting times early, middle and late were compared with three genotypes of different maturity groups i.e. early (Ashwani medium (Pant-4) and late Mahsoori. All the threatment were randomly allocated to main and sub-plots in both the years. Transplanting of seedling to the main field was done at the age of 21 days in each case. Recommended doses of fertilizers were applied and plant protection measures were taken following standard package of practices (3, 4).

According to (8, 9) Growth and development parameters viz. leaf area index at panicle initiation stage, plant height (cm) at maturity, shoots/m^2, dry matter production (g/hill), days taken to maturity and yield attributes viz. panicle length (cm) and rachilae/panicle, grain weight/panicle (g) and thousand seed weight (g) were recorded (4, 5). Above ground biomass (q/ha), stover yield (q/ha), grain yield (q/ha) and harvest index (%) were worked out.

Results and Discussion

Response of rice genotype to its prevailing environmental/weather condition was studied by several workers under different agro-ecosystems with various degree of interaction magnitudes. This study was carried out under semi-arid upland agroecosystem. Various degree of environmental conditions were provided for different phonological stages by providing different sets of planting time to all the three varieties and the main effects of environment and genotype were presented separately to assess the responses of each component.

Performance of any crops depends on various variables but environmental condition is one of the vital components to make cropping successful and vice versa. Under normal weather conditions at Kanpur normal time of rice planting is 15—25 July and plant-

Table 2. Yield attributes of rice.

Treatment	1998 Panicle m^2	1998 Panicle langth (cm)	1998 Rachilae panicle	1998 Grain wt/ panicle (g)	1998 1000-seed wt (g)	1999 Panicle m^2	1999 Panicle length (cm)	1999 Rachilae panicle	1999 Grain wt/ panicle (g)	1999 1000-seed wt (g)
Planting Time										
15 Jul	236.3	22.88	10.21	2.48	24.9	245.4	23.55	11.28	2.63	25.11
25 Jul	228.1	22.28	10.11	2.40	24.7	233.2	22.91	10.70	2.55	24.89
5 Aug	216.7	21.15	9.67	2.29	24.5	223.8	21.81	9.92	2.48	24.21
CD (5%)	6.2	NS	0.37	0.07	NS	9.8	1.29	1.25	0.15	NS
Genotypes										
Ashwani	238.4	22.37	10.15	2.51	28.0	251.8	22.95	11.18	2.73	28.4
Pant-4	235.7	21.79	9.98	2.38	26.8	239.4	21.55	10.68	2.58	26.9
Mahsoori	211.7	21.14	9.60	2.28	19.4	221.5	23.77	10.04	2.42	20.6
CD (5%)	10.4	NS	NS	0.10	0.7	13.01	NS	1.01	0.14	2.6

ing can be done as early as last week of June and its goes up to first week of August or even further depending upon several factors. In this study three normal planting times was selected to study the effect of varying environmental conditions.

Effect on Growth and Developments

Table 1 reveals that days taken to complete life cycle (maturity) was reduced with each successive delay in planting in both the years, however first year crops taken more time than second year and early maturity (approximately 3.3 days) was recorded, it might be due to the environmental condition that was not same for both year (1, 6, 7). All the growth and developmental parameters were also influenced by various environments. Each of the parameters were reduced with delay in planting except leaf area index (LAI), which was marginally increased in the second planting dates in the first year, but over all effect was non-significant for both the years. Other parameters showed its significant variation with the same trend. Early planting availed more time to complete lifecycle i.e. mturity in both the years (117 and 114 days). maximum dry matter was produced when crop was planted earlier in both the years (28.25 g and 27.16 g respectively) but maximum plant height was observed (103.67 cm) in the first year at early dates of planting. More leaf area index (LAI) was recorded in the first year in all three environments (Table 1). Shoots/m^2 were also recorded to be maximum (289.7) during first year and at early planting dates. Over all first year and early planting dates prove to be more congenial to growth and development compared to other tested environments.

Effect on Yield Attributes

Table 2 shows that all the yield deciding components were reduced drastically with (variable environment) each delay in transplanting except panicle length and 1,000-seed weight in second year. The entire yield components which were studied performed better during the second year as compared to first year. The same trend was also reported earlier (1, 2, 6, 7). This result indicates that second year environments were more conducive during reproductive phase while first year was good for vegetative growth i.e. dry matter production.

Effect on Above Ground Biomass and Grain Yield

Thus second year environmental condition was much better for grain production than first year which was good for vegetative growth. Delay in planting significantly reduced the above ground biomass, grain yield and stover yield, but it was more pronounced in

Table 3. Above ground biomass and grain yield.

Treatment	1998 Above ground biomass (q/ha)	1998 Grain yield (q/ha)	1998 Stover yield (q/ha)	1998 Harvest index (%)	1999 AGBM (q/ha)	1999 Grain yield (q/ha)	1999 Stover yield (q/ha)	1999 Harvest index (%)
Planting Time								
15 Jul	105.2	36.1	69.1	34.3	98.5	39.6	58.8	40.7
25 Jul	97.1	33.8	63.1	34.7	87.0	33.4	53.6	38.8
5 Aug	82.9	28.0	54.1	34.0	78.8	30.1	48.7	40.0
CD (5%)	2.8	1.8	4.4	NS	5.3	3.2	6.4	NS
Genotypes								
Ashwani	94.4	37.4	61.5	39.6	89.4	39.3	50.1	44.1
Pant-4	84.3	32.9	56.6	39.0	77.7	35.2	42.6	46.3
Mahsoori	106.4	27.6	68.7	25.9	97.1	28.7	68.5	29.9
CD (5%)	6.0	2.4	2.8	2.2	10.8	3.4	10.6	6.3

second year. The production of above ground biomass and stover yield was more in first year and grain yield and harvest index in second year. Maximum above ground biomass (105.2 q/ha) was recorded during first year whereas highest grain yield (39.6 q/ha) was recorded in second year at early dates of planting. The same trend was also observed earlier (1, 6—8).

Performance of any living organism is governed by two parameters i.e. genetic makeup and prevailing environmental conditions. The role of genotype and its response with environment is discussed briefly.

Effect of Genotypes on Growth and Development

Genotype behaviors in response to its environments were recorded in this study. Early maturing Ashwani look less time to attain maturity (100.1 and 98.3 days) during both the years compared to other varieties viz. *Pant*-4 (113 and 109.7 days) and Mahsoori (126 and 122 days) respectively. During second year (1999) crops took less time and completed its life cycle in quick succession. Genotype *Mahsoori* accumulated maximum dry matter (28.81 and 26.91 g/hills) than other genotypes. However, genotype Ashwani produced more dry matter (25.51 and 24.54 g/hill) than varieties Pant-4 (24.36 and 22.86 g/hill) during both the years.In general all the growth and development parameters were recorded to be higher in first year except leaf area index (LAI) and shoot/m^2. Other parameters show significant differences among the genotypes (2, 6, 8).

Effect of Genotypes on Yield Attributes

Table 2 reveals that genotype *Ashwani* produced significantly highest panicle/m^2, grain weight/panicle and 1,00-seed weight in both the years and numerically higher value for other yield determining components. Though the quantum was more pronounced in the second year for almost all the yield characters. Genotype Ashwani (28 and 28.4 g) and Pant-4 (26.8 and 26.9 g) produced significantly higher 1,000-seed weights than long maturing photo sensitive Mahsoori (19.4 and 20.6 g) in the both years. Most of the parameters had higher values for variety Ashwani, genotype Mahsoori proved to be poor performer under upland semi-arid condition being long duration genotype adapted well to low land water regime (2, 7, 9).

Effect of Genotypes on Above Ground Biomass and Grain Yield

Genotype Mahsoori produced significantly higher above ground biomass during both the years to the tune of 106.4 and 97.1 q/ha compared to other varieties viz. Ashwani (94.4 and 89.4 q/ha) and Pant-4

(84.3 and 77.7 q/ha). Similar trend was also observed for stover yield in both the years (Table 3). However, trend for grain yield was just reverse and genotype *Ashwani* significantly out vielded during both the years and produced 37.4 and 39.3 q/ha than other varieties viz. Pant-4 (32.9 and 35.2 q/ha) and Mahsoori (27.6 and 28.7 q/ha). Genotypes Pant-4 and *Ashwani* performed better to convert photosythates to economic produce and due to this their harvest index was 39.0 and 46.3 and 39.6 and 44.1 respectively during both the years, which were significantly higher than genotype Mahsoori (25.9 and 29.9). Obviously, the response of all the genotypes improved in the second year, which might be due to favorable environmental conditions during reproductive stages (2, 6—8).

Summary

Rice performance basically depends on interaction magnitudes of environmental conditions and genetic makeup of a particular genotype. This study proved that in the second year (1999) environmental condition proved better for economic produce (grain yield) and first year (1998) was better for growth and development. Photo-insensitive varieties viz. Ashwani and Pant-4 proved to be better performers during both the years. Hence for successful cultivation under Kanpur condition, best time is around 10—20 July with high yielding genotypes.

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