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Effect of temperature on the growth and yield of rice (*Oryza sativa* L.) cultivars

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Abstract
A field experiment was conducted during *kharif season* of 2015 on the topic entitled "Effect of growing environment on growth and development of rice (*Oryza sativa L.*) cultivars." in sandy loam soil of N.D. University of Agriculture and Technology, Kumarganj, Faizabad (U.P.). The experiment consisted of nine treatment combinations comprised of three transplanting dates *viz*., July 5th, July 15th and July 25th and three varieties viz., Sarjoo-52, NDR-359 and Swarna Sub-1. Plant height as affected by different growing environment of rice cultivars. The maximum plant height was recorded with IInd date of transplanting on July 15th (113.3 cm) at all the growth stages which remained at par to Ist date of transplanting July 5th (110.8cm) and significantly superior over IIIrd date of transplanting July 25th (99.5cm) at all the stages of crop. The maximum leaf area index (5.20) was recorded at 90 DAT at July 15th followed by July 5th (4.99) and July 25th (4.67) at the same 90 DAT respectively. From the significant analysis, it was evident that LAI were significant among the different date of transplanting except 15 DAT. Among the varieties NDR- 359 attained maximum leaf area index (5.16) at 90 DAT followed by varieties Swarna Sub-1 (4.98) and Sarjoo-52 (4.60) at the same 90 DAT. Different growing environment significantly affected the dry matter accumulation (gm^{-2}). Maximum dry matter accumulation was noticed with IInd date of transplanting (July15th) at 30, 45, 60, 75, 90 and 105 days after transplanting which remained at par to Ist date of transplanting July 5th and significantly higher over IIIrd date of transplanting July 25th at all the stages of crop. A perusal of data showed that different growing environment were recorded maximum no. of tillers (443) when crop was transplanting on July 15th, which was superior over July 5th, and July 25th, the minimum no. of effective tillers (m^{-2}) was recorded at July 25th.

Keywords: plant height (cm), leaf area index (LAI), total dry matter (g/m^2), no. of effective tillers (m^{-2})

1. Introduction
Rice (*Oryza sativa* L.) is one of the most cereal crop belong to the family Graminae. It is the staple food for half of the world's population. It is cultivated worldwide in area 156.80 million hectare having an annual production of 650.19 million tonns. In the latest report, the International Grains Council has projected India's rice crop had production to touch a new record at107 million tons in 2013-2014 and area planted under rice has increased to 46.00 million hectare. In Uttar Pradesh, it is grown in about 6.20m ha which comprise of 13.5% of total rice in India. (Anonymous, 2013-2014) [1]. Among the rice growing countries, India stands first in area and second in production next after China. Uttar Pradesh is largest rice Growing state after West Bengal in the country. Rice production in Asia has increased by 2.6 times since1961, primarily as a result of the "Green Revolution", which dramatically increased the rice productivity in the high input irrigated system (Khus, 1997) [4]. Rice is the most important staple food for a large part of the world's population, especially in East and South Asia, the Middle East, Latin America, and the West Indies. As the population increases rapidly in these regions, the demand for rice will grow to an estimated 2000 million metric tons by 2030 (FAO, 2002) [3]. The impact of air temperature on rice growth would be location specific because of the different sensitivity of different locations with regard to temperature. In tropical regions, the temperature increase due to the climate change is probably near or above the optimum temperature range for the physiological activities of rice (Baker *et al.*, 1992) [2]. Among the crop production tools, proper time and method of sowing are the prerequisites that allow the crop to complete its life phase timely and successfully under a specific agro-ecology. In rice, the optimum leaf areas for seedlings, optimum leaf shapes to maximize photosynthetic efficiency, deep, well-developed root systems, leaf area index (LAI) at flowering and crop

growth rate (CGR) during panicle initiation have been identified as the major determinants of yield (Sun *et al.*, 1999) [7].

2. Material and Methods

An experiment was conducted during Kharif season of 2015 on the topic entitled "To Study about the effect of temperature on growth and yield of rice (*Oryza sativa L.*) cultivars" at Agro-meteorology Research Farm of Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya (U.P.). The experimental site is located in the main campus of ANDUA&T, Kumarganj, Ayodhya situated at a distance of about 42 km. away from Ayodhya district headquarter on Ayodhya, Raibarelly road. The experiment was conducted in Randomized Block Design (RBD) and replicated the three times. The different growth parameters studied were rice as Days taken to different phenophases, Growing Degree Days, Plant height (cm), Leaf area index (LAI), Total dry matter (g/m^2), No. of effective tillers (m^{-2}).

3. Results and Discussion

Data with respect to plant height as affected by different growing environment of rice cultivars have been presented in table-1. Different growing environment significantly affected the plant height. The maximum plant height was recorded with IInd date of transplanting on July 15th (113.3 cm) at all the growth stages which remained at par to Ist date of transplanting July 5th (110.8cm) and significantly superior over IIIrd date of transplanting July 25th (99.5cm) at all the stages of crop. Among the varieties the maximum plant height was recorded with NDR-359 (113.8cm) at all the growth stages of crop, which remained at par to Swarna sub-1(107.3cm) and significantly superior over Sarjoo-52 (99.8cm) at all growth stages. Plant height increased with the advancement of the crop growth in all the three varieties of rice. The similar results found by Singh, *et al.*, (2009) [5]. The maximum plant height were recorded NDR-359 (113.8 cm) variety 105 DAT followed by Swarna Sub-1 (107.3cm) then Sarjoo-52 (99.8cm).

Leaf area index (LAI) as affected by different growing environment of rice cultivars has been depicted in table-2. From table it was revealed that maximum leaf area index (5.20) was recorded at 90 DAT at July 15th followed by July 5th (4.99) and July 25th (4.67) at the same 90 DAT respectively. From the significant analysis, it was evident that LAI were significant among the different date of transplanting except 15 DAT. Among the varieties NDR- 359 attained maximum leaf area index (5.16) at 90 DAT followed by varieties Swarna Sub-1 (4.98) and Sarjoo-52 (4.60) at the same 90 DAT. From the significant analysis, it was evident that varieties were significant among each other for LAI at all dates of transplanting presented data in table-2. Similar result is reported by Yoshida, *et al.*, (2007) [8]. Leaf Area Index was affected at all the stages due to varieties. Highest leaf Area Index NDR-359 (5.16) data also revealed that Sarjoo-52 variety recorded lowest LAI (4.61) at all the growth stages.

Dry matter accumulation as affected by different growing environment of rice cultivars have been presented in table-3. Different growing environment significantly affected the dry matter accumulation (gm^{-2}). Maximum dry matter accumulation was noticed with IInd date of transplanting (July15th) at 30, 45, 60, 75, 90 and 105 days after transplanting which remained at par to Ist date of transplanting July 5th and significantly higher over IIIrd date of transplanting July 25th at all the stages of crop. Among the varieties maximum dry matter accumulation (gm^{-2}) was observed in NDR-359 at 30, 45, 60, 75, 90 and 105 days after transplanting which was significantly superior over Swarna sub-1 and Sarjoo-52 at all growth stages of crop. The interaction effect of varieties and date of sowing on dry matter accumulation was found non- significant.

A perusal of data has been presented in table 4. A perusal of showed that different growing environment were recorded maximum no. of tillers (443) when crop was transplanting on July 15th, which was superior over July 5th, and July 25th, The minimum no. of effective tillers (m^{-2}) was recorded at July 25th.Among the varieties maximum no. of effective tillers (m^{-2}) was recorded with NDR-359 (447.7) followed by Swarna sub-1 (419.1) and then Sarjoo-52 (405.2). Test weight (g.) as affected by different growing environment of rice cultivars have been presented in Table-4. A perusal of data showed that different growing environment influenced significantly to the test weight. Maximum test weight (23.5) was recorded when crop was transplanting July 15th which was superior over July 5th and July 25th. The minimum test weight (21.5) was recorded when transplanting was done at July 25th. Among the varieties maximum test weight (23.5) was recorded with Sarjoo-52 variety followed by NDR-359 (23.5) and then Swarna sub-1.Grain yield (q ha^{-1}) as affected by different growing environment of rice cultivars. A perusal of data showed that different growing environment influenced significantly to the grain yield. Maximum grain yield (54.75) was recorded when crop transplanting dates was July 15th which was significantly superior over July 05th, and July 25th. The minimum grain yield (44.56) was recorded when transplanting was done on July 15th.Among the varieties maximum seed yield (55.55) was recorded with NDR-359 variety followed by Swarna sub-1(53.06) and then Sarjoo-52 (50.89). Harvest index (%) as affected by different growing environment of rice cultivars. The data showed that different growing environment transplanting (41.5) influenced non-significantly to the harvest index. IInd date of transplanting maximum harvest index (41.5) was recorded was transplanting on July 15th followed by July 5th and July 25th. Among the varieties data recorded that growing environments influenced non-significantly to the harvest index. Maximum harvest index (41.9) was recorded with NDR-359 followed by Swarna sub-1 and Sarjoo-52. Similar results are reported by Singh, (2005) [6]. Test weight was significantly affected by different varieties. Maximum test weight (25.0) was recorded with Sarjoo-52 variety followed by NDR-359 (23.5) and then Swarna Sub-1.

Table 1: Plant height as affected by different growing environment of rice cultivars

Treatment / Growing environment	Plant height (cm)						
	15 DAT	30 DAT	45 DAT	60 DAT	75 DAT	90 DAT	105 DAT
5th July	31.6	39.1	75.9	89.3	99.3	107.9	110.8
15thJuly	32.9	40.6	77.7	91.4	101.6	110.4	113.3
25th July	29.8	36.2	68.0	80.0	88.8	96.5	99.5
SEm±	0.74	0.93	1.88	1.10	2.34	2.75	2.78
CD (5%)	NS	3.25	6.30	7.29	8.12	9.53	10.53
Varieties							
Sarjoo-52	30.6	38.0	68.8	81.0	90.0	97.8	99.8
NDR-359	32.1	39.7	78.6	92.5	102.8	111.8	113.8
Swarna Sub-1	31.8	39.3	74.1	87.1	96.8	105.3	107.3
SEm±	0.55	0.68	1.25	1.52	1.72	2.07	1.87
CD (5%)	NS	NS	3.73	4.51	5.13	6.17	7.3

Table 2: Leaf area index (LAI) as affected by different growing environment of rice cultivars

Treatments / Growing Environment	Leaf area index (LAI)					
	15 DAT	30 DAT	45 DAT	60 DAT	75 DAT	90 DAT
5th July	1.00	2.06	3.95	4.61	4.75	4.99
15thJuly	0.97	2.39	4.16	4.85	5.00	5.20
25th July	0.91	2.09	3.63	4.23	4.37	4.67
SEm±	0.024	0.050	0.09	0.10	0.19	0.12
CD (5%)	NS	0.19	0.34	0.36	0.41	0.42
Varieties						
Sarjoo-52	0.86	2.06	3.52	4.22	4.31	4.60
NDR-359	1.07	2.36	4.04	4.84	4.95	5.16
Swarna Sub-1	0.96	2.24	3.84	4.59	4.70	4.98
SEm±	0.017	0.042	0.073	0.089	0.089	0.098
CD (5%)	0.051	0.12	0.216	0.264	0.265	0.275

Table 3: Total dry matter as affected by different growing environment of rice cultivars

Treatments / Growing environment	Total dry matter (g/m^2)						
	15 DAT	30 DAT	45 DAT	60 DAT	75 DAT	90 DAT	105 DAT
5th July	112.8	200.5	292.1	414.0	635.5	909.1	1209.3
15thJuly	118.0	206.7	300.2	428.3	659.5	941.5	1253.0
25th July	105.5	182.8	267.9	383.0	588.0	838.9	1113.4
SEm±	2.92	5.11	6.57	9.48	14.56	20.6	27.37
CD (5%)	NS	15.67	22.73	32.80	50.40	71.32	87.58
Varieties							
Sarjoo-52	109.3	192.6	265.3	377.4	580.1	832.0	1105.2
NDR-359	114.2	200.9	314.0	447.4	687.6	980.1	1306.3
Swarna Sub-1	112.9	198.5	280.8	400.5	615.3	877.4	1168.2
SEm±	2.18	3.88	5.11	6.92	10.65	15.51	21.15
CD (5%)	NS	13.19	15.18	22.56	31.66	46.09	65.17

Table 4: Yield and yield contributing characters as affected by different growing environment of rice cultivars

Treatments	Yield and yield contributing characters			
Growing environment	No. of effective tillers/m^2	Test weight (g)	Grain yield (qt./ha)	Harvest index (%)
5th July	435	23.3	50.19	41.1
15thJuly	443	23.5	54.75	41.5
25th July	403	21.5	44.56	40.8
SEm±	8.8	0.62	1.45	0.98
CD (5%)	31.64	NS	4.63	NS
Varieties				
Sarjoo-52	405.2	25.0	50.89	40.9
NDR-359	447.7	23.5	55.55	41.9
Swarna Sub-1	419.1	22.1	53.06	41.5
SEm±	7.73	0.57	0.87	0.72
CD (5%)	27.82	1.39	2.69	NS

4. Conclusion

The maximum plant height was recorded with IInd date of transplanting on July 15th (113.3 cm) at all the growth stages which remained at par to Ist date of transplanting July 5th

(110.8cm) and significantly superior over IIIrd date of transplanting July 25th (99.5cm) at all the stages of crop. Among the varieties the maximum plant height was recorded with NDR-359 (113.8cm) at all the growth stages of crop. Maximum leaf area index (5.20) was recorded at 90 DAT at July 15th followed by July 5th (4.99) and July 25th (4.67) at the same 90 DAT respectively. Maximum dry matter accumulation was noticed with IInd date of transplanting (July15th) at 30, 45, 60, 75, 90 and 105 days after transplanting different growing environment were recorded maximum no. of tillers (443) when crop was transplanting on July 15th, which was superior over July 5th, and July 25th.

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