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Studies about the effect of environment on plant growth parameters of rice (*Oryza sativa L.*) cultivars

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Abstract
A field experiment was conducted during *kharif season* of 2015 in sandy loam soil of A.N.D.U.A. & T., Kumarganj, Ayodhya (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. Results reveal that different phenophases of rice markedly varied with only dates of transplanting but also different weather variables which ultimately create the different crop growing environment to harvest the yield accordingly. Highest Growing Degree days (GDD) was recorded in growing environment of July 15th (2365.9 ^{0}days) transplanting at all the phenophases followed by July 5th (2264.1 ^{0}days) and July 25th (2018.0 ^{0}days) transplanting while among the variety Swarna Sub-1 (2409.9 ^{0}days) recoded highest GDD due to occurrence of long duration Variety NDR-359 found suitable for higher productivity (55.55 q/ha) followed by Swarna Sub-1(53.06 q/ha) and Sarjoo-52 (50.89 q/ha). Among the varieties maximum crop growth rate ($gm^{-2}d^{-1}$) was observed in NDR-359 at 15-30, 30-45, 45-60, 60-75 and 75-90 days after transplanting which was superior over Swarna sub-1 and Sarjoo-52 at all growth stages of crop. Among the varieties maximum relative growth rate was observed in NDR-359 at 15-30, 30-45, 45-60, 60-75 and 75-90 days after transplanting followed by Swarna sub-1 and Sarjoo-52 at all growth stages of crop.

Keywords: Phenophases, GDD, CGR, RGR

Introduction
Rice *(Oryza sativa L.)* is one of the important foods for most people living in India. It is being grown under diverse agro-climatic condition at wide range of latitudes. It is essential to human diet in India as it is a richest source of carbohydrates and adds the proteins component in human diet too. Generally 6.8% protein, 78.2% carbohydrates, 0.5% fat and 0.6% mineral matters are found in rice hence it is primarily used as a staple food crop. The rice is cultivated worldwide in area 156.80 million hectare having a annual production of 680.19 million tonnes and an average productivity of 5.15 tonnes per hectare (Anonymous, 2014) [2a]. In the latest report, In India, during 2014-15, the rice crop had production of 103.04 million tonnes. In Uttar Pradesh it was grown on over all area 50.94 million hectare with production of 15.30 million tonnes. The average productivity of Uttar Pradesh is 257.3 kg/ha which is more than the average national productivity (Anonymous, 2014) [2b]. In Uttar Pradesh it is grown in about 6.20 m ha which comprises 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 to China. Uttar Pradesh is largest rice growing state after West Bengal in the country. In Uttar Pradesh it is grown on about 5.90 m ha which comprises of 13.5% of total rice cropped area of India.

Rice is grown under different conditions. Rice is the only cereal crop that can grow for long periods of time in standing water. 57% of rice is grown on irrigated land, 25% on rainfed lowland, 10% on the uplands, 6% in Deepwater, and 2% in tidal wetlands. Rice is one of the most important cereal crop belong to the family *Graminae*. It is the staple food for half of the world's population. Rice is cultivated of worldwide in area of 156.80 million hectare having an annual production of 650.19 million tonnes. 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 since 1961, primarily as a result of the "Green Revolution", which dramatically increased the rice productivity in the high input irrigated system (Khus, 1997) [5].

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]. To supply to this increasing demand, the methods of rice production will require significant improvement. Achieving this goal, however, is sure to be a challenge with respect to future climatic changes, which will basically be characterized by current global warming trends. The rise in temperatures and levels of carbon dioxide and uncertain rainfall associated with climate change may have serious adverse effects either directly or indirectly on the growth, development, and yield of rice crops (Lobell, *et al.*, (2011) [7].

Materials and Methods

An experiment was conducted during Kharif season of 2015 at Agrometeorology Research Farm of A.N.D.U.A. & T., 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 (GDD), Crop Growth Rate (CGR) and Relative Growth Rate (RGR).

Results and Discussion

Plant growth parameters

Days taken to phenophases as affected by different growing environment of rice cultivars

Data pertaining to days taken to attain maturity as affected by different growing environment of rice cultivars have been presented in table-1. A perusal of data showed that different growing environment influenced rice cultivars. Maximum days taken to maturity (118days) were recorded when crop was transplanted on July 15th followed by July 5th and July 25th. The minimum days taken to maturity was recorded (108 days) on IIIrd date of transplanting. Among the varieties days taken to maturity were affected by different cultivars. The maximum days taken to maturity were recorded with Swarna sub-1 (124 days) followed by Sarjoo-52 (108 days) and NDR-359 (106 days).

Table 1: Days taken to phenophases as affected by different growing environment of rice cultivars

Treatments	Phenophases		
Growing Environment	Days to panicle initiation	Days to 50% Flowering	Physiological Maturity
5th July	72	82	113
15thJuly	75	83	118
25th July	70	79	108
Varieties			
Sarjoo-52	65	81	108
NDR-359	63	79	106
Swarna Sub-1	77	93	124

Growing Degree Days (GDD)

Growing degree days (GDD) of rice cultivars taken in different phenophases at different growing environment has been depicted in table-2. From it is evident from the table that the highest value of growing degree days (2365.9 ^{0}days) was taken by IInd date of transplanting 15th July in followed by the July 5th (2264.1^{0}days) and lowest was recorded July 25th (2018.0 ^{0}days). Among the varieties it is evident that GDD was highest in cultivar Swarna Sub-1 (2409 ^{0}days) followed by Sarjoo-52 (2096.0 ^{0}days) and NDR-359 (2091.0 ^{0}days).

Table 2: Growing Degree Days (GDD) as affected by different growing environment of rice cultivars

Treatments	Growing Degree Days (Degree Days)		
Growing environment	Days to panicle initiation	Days to 50%Flowering	Physiological Maturity
5th July	1515.0	1665.0	2264.1
15thJuly	1530.0	1699.6	2365.9
25th July	1440.0	1648.8	2018.0
Varieties			
Sarjoo-52	1474.6	1669.8	2096.0
NDR-359	1378.7	1662.9	2091.0
Swarna Sub-1	1541.1	1793.1	2409.9

Growth and Yield components

Crop growth rate (CGR) (gm^{-2} d^{-1})

Data pertaining to dry matter accumulation as affected by different growing environment of rice cultivars have been presented in table-3 Different growing environment affected the crop growth rate (gm^{-2}d^{-1}). Maximum crop growth rate was noticed with IInd date of transplanting (July15th) at 30-45, 45-60, 60-75 and 75-90 days after transplanting which remained at par to Ist date of transplanting (July 5th) and higher over IIIrd date of transplanting (July 25th) at all the stages of crop. Among the varieties maximum crop growth rate (gm^{-2}d^{-1}) was observed in NDR-359 at 15-30, 30-45, 45-60, 60-75 and 75-90 days after transplanting which was superior over Swarna sub-1 and Sarjoo-52 at all growth stages of crop.

Table 3: Crop Growth Rate (CGR) as affected by different growing environment of rice cultivars

Treatments	Crop Growth Rate (gm^{-2} d^{-1})				
Growing environment	15-30 DAT	30-45 DAT	45-60 DAT	60-75 DAT	75-90 DAT
5th July	5.84	6.11	8.13	14.77	18.24
15thJuly	5.91	6.23	8.54	15.42	18.80
25th July	5.29	5.54	7.68	13.66	16.73
Varieties					
Sarjoo-52	5.55	4.45	7.48	13.51	16.79
NDR-359	5.78	8.10	7.98	16.02	19.50
Swarna Sub-1	5.71	5.33	8.89	14.32	17.47

Relative growth rate (RGR) (mg/g/day dry matter x 10^{-2})

The relative growth rate (RGR) as affected by different growing environment of rice cultivars have been presented in table-4. Maximum Relative growth rate was noticed with IInd date of transplanting (July 15th) at 30-45, 45-60, 60-75 and 75-90 days after transplanting followed by Ist date of transplanting (July 5th) and IIIrd date of transplanting (July 25th) at all the stages of crop. Among the varieties maximum relative growth rate was observed in NDR-359 at 15-30, 30-45, 45-60, 60-75 and 75-90 days after transplanting followed by Swarna sub-1 and Sarjoo-52 at all growth stages of crop. The similar result is reported by Kumar, *et al.*, (2006) [6] the maximum days to 50% flowering were recorded with Swarna Sub-1 (93 days) followed by Sarjoo-52 and then NDR-359. Yoshida, *et al.*, (2007) [8] The Higher relative growth rate (3.89 mg/g/day dry matter) were recorded with NDR-359 variety followed by Swarna sub-1 (3.85 mg/g/day dry matter) and then Sarjoo-52. Halder, *et al.*, (2010) [4] among the variety highest was recorded Growing degree days Swarna Sub-1

(2409.9^{0}days) followed by Sarjoo-52 (2096.0^{0}days) then NDR-359 (2091.0^{0}days).

Table 4: Relative Growth Rate (RGR) as affected by different growing environment of rice cultivars

Treatments	Relative Growth Rate (mg/g/day dry matterx10^{-2})				
Growing environment	15-30 DAT	30-45 DAT	45-60 DAT	60-75 DAT	75-90 DAT
5th July	2.86	2.90	3.02	3.57	3.85
15thJuly	2.91	2.95	3.05	3.60	3.87
25th July	2.83	2.88	2.99	3.50	3.84
Varieties					
Sarjoo-52	2.82	2.82	2.52	3.58	3.82
NDR-359	2.90	2.94	3.05	3.62	3.89
Swarna Sub-1	2.84	2.83	2.75	3.60	3.85

Conclusion

Maximum days taken to maturity (118 days) were recorded when crop was transplanted on July 15th followed by July 5th and July 25th. The minimum day taken to maturity was recorded (108 days) on IIIrd date of transplanting. the highest value of growing degree days (2365.9 ^{0}days) was taken by IInd date of transplanting 15th July in followed by the July 5th (2264.1^{0}days) and lowest was recorded July 25th (2018.0 ^{0}days).). Maximum crop growth rate was noticed with IInd date of transplanting (July15th) at 30-45, 45-60, 60-75 and 75-90 days after transplanting which remained at par to Ist date of transplanting (July 5th) and higher over IIIrd date of transplanting (July 25th) at all the stages of crop. Maximum Relative growth rate was noticed with IInd date of transplanting (July 15th) at 30-45, 45-60, 60-75 and 75-90 days after transplanting followed by Ist date of transplanting (July 5th) and IIIrd date of transplanting (July 25th) at all the stages of crop.

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