International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2019; 7(3): 3289-3292

Received: 19-03-2019
Accepted: 23-04-2019

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Study the effect of crop weather interaction on the growth and development of rice genotypes

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Abstract
From a morphological point of view, we attempted to estimate rice (*Oryza sativa* L.) yields by multiplication of three yield components considering seasonal changes in meteorological conditions. A field experiment was conducted during *kharif season* of 2017-18 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 5^{th}, July 15^{th} and July 25^{th} and three varieties viz., NDR-97, NDR-3112 and BPT-5204. 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 crop growth rate (CGR) was recorded in growing environment of July 5^{th} due to occurrence of long duration. Highest Leaf are index and Plant height was recorded in I^{st} date of transplanting on July 5^{th} at vegetative stage.

Keywords: LAI, plant height, CGR, RGR, harvest index

Introduction
The productivity of rice is largely affected by a set of weather variables among which rainfall, solar radiation and temperature play a significant role. Rice is one of the major crops feeding the world population and is most important ingredient in food composition in South Asia. It is most important cereal crop belong to the family Poaceae. It is the staple food for half of the world's population. Rice deserves a special status among cereals as world's most important wetland crop. (Gorantla *et al.*, 2005) [2].
Rice is an excellent source of carbohydrates and also rich in magnesium, thiamine, niacin, phosphorus, vitamin B_6, zinc and copper. Some varieties have iron, potassium and folic acid. Some varieties may provide 14g of protein per 100g. It is used for sweet dishes, for *risotto* in Italy, and many rice dishes, such as *arròsnegre*, in Spain. The challenge, above anything else, is to produce this additional rice with less land, less water, and less labour, in more efficient, environmentally-friendly production systems that are more resilient to climate change, among other factors. Uttar Pradesh is largest rice growing state after West Bengal in the country. Rice area with salt problem in state is estimated to be ≤ 2%. Inland salinity areas are mainly concentrated in Raibareilly, Azamgarh, Sultanpur, Faizabad, Lucknow, Unnao and Pratapgarh district. The area and production of rice in this state is about 5.87 million hectare and 12.22 million tonnes, respectively and productivity of 2082 kg per hectare (Anonymous, 2015-16) [1].
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. In environments with large temperature amplitudes, this effect should be considered when water-saving measures are applied in lowland rice fields. (Sun *et al*., 1999) [4]. Climate change and its impact would emerge as a new challenge in near future, in addition to many challenges that are already present to achieve higher productivity in rice crop (Krishnan *et al*., 2011) [3]. According to Zacharias *et al*. (2010), high temperature stress caused reduction in total dry matter, tiller mortality, reduced the number of panicles, grain per panicle, floret sterility and grain weight thus reducing the grain yield of rice. According to Waraich *et al*. (2012) [5] proper plant nutrition is one of the good strategies to alleviate the temperature stress

in crop plants. It is therefore important to determine how growth and yield response of rice crop are influenced by elevated temperature as it would have crucial implications on future food security of this highly-populated region of the world.

Materials and Methods

Experimental site

The experiment was carried out during the kharif season of 2017 at the Instructional farm of college of Agriculture, of N.D. University of Agriculture & Technology, Kumarganj, Faizabad (U.P.). The mean annual maximum temperature is 34°C while the mean annual minimum temperature is 22°C. The total rainfall received during the cropping period was 681.4 mm.

Experimental design and treatments

The experiment was conducted in Randomized block design (RBD) with three replications. The experiment consisted of nine treatment combination comprised of three transplanting dates viz. July 5th, July 15th and July 25th and three varieties viz., NDR-97, NDR-3112 and BPT-5204 of rice genotypes having different maturity groups. The details of experiment has been described elsewhere Sandeep Kumar Sharma 2016-17. Statistical analysis and interpretation of results were done by calculating values of CGR, RGR, CD and SEm.

Leaf area index

$$\text{Leaf area index(LAI)} = \frac{\text{Leaf area}}{\text{Ground area}}$$

Harvest Index (%)

$$\text{Harvest index\%} = \frac{\text{Grain yield}}{(\text{Grain yield} + \text{Straw yield})} \times 100$$

Crop Growth Rate ($gm^{-2}d^{-1}$)

Crop growth rate was calculated by following formula.

$$\text{Crop growth rate} = \frac{W_2 - W_1}{t_2 - t_1} - 1/L$$

Where,

W_1 and W_2 are the total dry matter production at the time T_1 and T_2 respectively.

Relative growth rate (mg/g/day dry matter)

The relative growth rate was calculated by following formula.

$$RGR = \frac{\text{Loge } W_2 - \text{Loge } W_1}{\text{Loge } W_1 \text{ - (Loge } t_2 - \text{Loge } t_1)}$$

Where

W_1 and W_2 are the total dry matter production at the time T_1 and T_2 respectively.

Results and Discussion

Plant height (cm): Data with respect to plant height as affected by different growing environment of rice cultivars have been presented in Table-1 and fig.1 Different growing environment significantly affected the plant height. The maximum plant height was recorded with Ist date of transplanting on July 5th (103.68 cm) at all the growth stages which remained at par to IInd date of transplanting July 15th (101.35cm) and significantly superior over IIIrd date of transplantingJuly25th (90.70cm) at all the stages of crop. Among the varieties the maximum plant height was recorded with NDR-3112 (106.34cm) at all the growth stages of crop, which remained at par to BPT-5204 (100.84cm) and significantly superior over NDR-97 (88.56cm) at all growth stages. Plant height increased with the advancement of the crop growth in all the three varieties of rice. Result in reveal that timely transplanting variety is response better than delay date of transplanting rice cultivar.

Table 1: Different growing environment responsible for Plant height in cultivars of rice

Treatment	Plant height (cm)						
Growing environment.	15 DAT	30 DAT	45 DAT	60 DAT	75 DAT	90 DAT	105 DAT
5th July	27.81	46.35	77.26	85.84	95.38	103.67	103.68
15thJuly	27.19	45.32	75.53	83.92	93.24	101.35	101.35
25th July	24.33	40.55	67.59	75.10	83.44	90.70	90.70
SEm±	0.946	1.336	2.242	2.671	3.017	3.507	3.565
CD (5%)	2.836	4.004	6.721	8.008	9.046	10.515	10.689
Varieties							
NDR-97	24.00	40.00	66.66	74.07	82.29	89.45	88.56
NDR-3112	28.82	48.03	80.04	88.94	98.82	107.41	106.34
BPT-5204	26.52	44.20	73.46	81.85	90.95	98.86	98.58
SEm±	0.946	1.336	2.242	2.671	3.017	3.507	3.565
CD (5%)	2.836	4.004	6.721	8.008	9.046	10.515	10.689

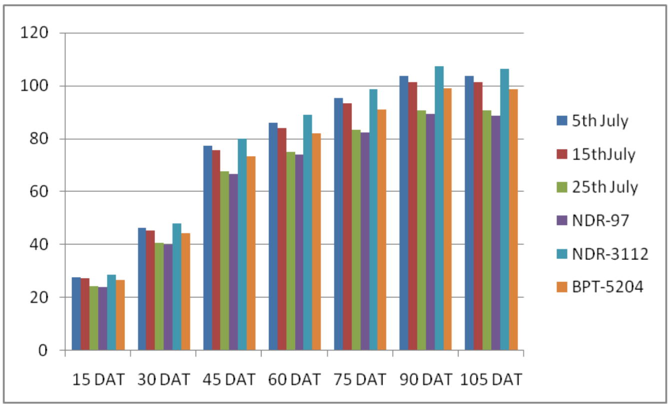

Fig 1: Different growing environment responsible for Plant height in cultivars of rice

Leaf area index (LAI)

Data pertaining to Leaf area index (LAI) as affected by different growing environment of rice cultivars has been depicted in table 2. It was revealed that maximum leaf area index (2.48) was recorded at 105 DAT at July 5th followed by July 15th (2.38) and July 25th (2.27) at the same 105 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-97 attained maximum leaf area index (2.49) at 105 DAT followed by varieties NDR-3112(2.44) and BPT-5204 (2.20) at the same 105 DAT.

Table 2: Different growing environment responsible for Leaf Area Index in cultivars of rice

Treatments / Growing Environment	Leaf area index (LAI)						
	15 DAT	30 DAT	45 DAT	60 DAT	75 DAT	90 DAT	105 DAT
5th July	0.97	2.16	3.70	4.43	4.52	3.85	2.48
15thJuly	0.94	2.07	3.54	4.25	4.34	3.69	2.38
25th July	0.89	2.25	3.85	4.61	4.71	4.00	2.27
SEm±	0.037	0.060	0.103	0.123	0.128	0.121	0.066
CD (5%)	NS	NS	NS	NS	NS	NS	NS
Varieties							
NDR-97	1.02	2.26	3.88	4.64	4.75	3.83	2.49
NDR-3112	0.95	2.22	3.80	4.55	4.65	4.15	2.44
BPT-5204	0.83	2.00	3.42	4.09	4.18	3.56	2.20
SEm±	0.037	0.060	0.103	0.123	0.128	0.121	0.066
CD (5%)	0.112	0.181	0.310	0.370	0.383	0.362	0.197

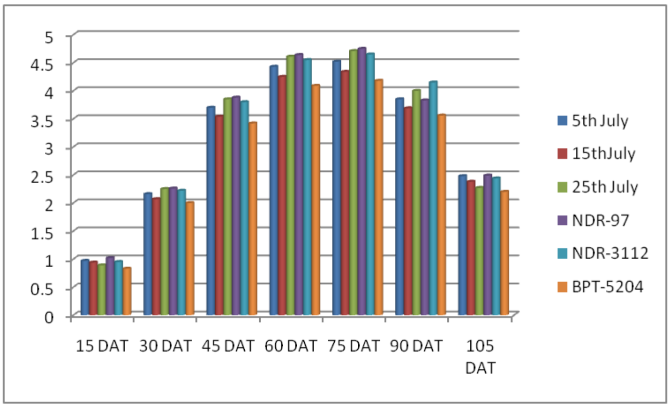

Fig 2: Different growing environment responsible for Leaf Area Index in cultivars of rice

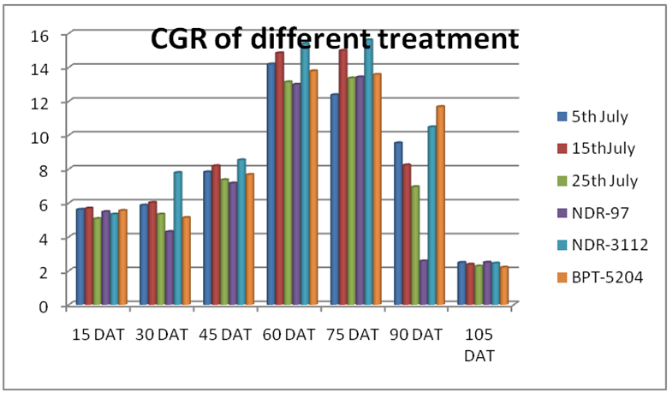

Fig 3: Different growing environment responsible for CGR in cultivars of rice

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 and fig 3. Maximum crop growth rate was noticed with Ist date of transplanting (July 5th) at 30-45, 45-60, 60-75, 75-90 and 90-105 days after transplanting which remained at par to IInd date of transplanting (July 15th) 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-3112 at 15-30, 30-45, 45-60, 60-75 and 75-90 days after transplanting which was superior over BPT-5204 and NDR-97 at all growth stages of crop .

Table 3: Different growing environment responsible for CGR in cultivars of rice

Treatments / Growing environment	Crop Growth Rate ($gm^{-2} d^{-1}$)					
	15-30 DAT	30-45 DAT	45-60 DAT	60-75 DAT	75-90 DAT	90-105 DAT
5th July	5.61	5.86	7.82	14.18	12.37	9.53
15thJuly	5.68	6.02	8.18	14.84	14.99	8.23
25th July	5.07	5.33	7.36	13.13	13.36	6.95
Varieties						
NDR-97	5.48	4.30	7.16	12.99	13.42	2.57
NDR-3112	5.33	7.78	8.53	15.39	15.61	10.48
BPT-5204	5.55	5.13	7.67	13.78	13.57	11.67

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

Data pertaining to relative growth rate (RGR) as affected by different growing environment of rice cultivars have been presented in Table-4 and fig.4. Maximum Relative growth rate was noticed with Ist date of transplanting (July 5th) at 30-45, 45-60, 60-75, 75-90 and 90-105 days after transplanting followed by IInd date of transplanting (July 15th) and IIIrd date of transplanting (July 25th) at all the stages of crop. Among the varieties maximum relative growth rate was observed in NDR-3112 at 15-30, 30-45, 45-60, 60-75 and 75-90days after transplanting followed by BPT-5204 and NDR-97at all growth stages of crop .

Table 4: Different growing environment responsible for RGR in cultivars of rice

Treatments / Growing environment	Relative Growth Rate (mg/g/day dry matterx10^{-2})					
	15-30 DAT	30-45 DAT	45-60 DAT	60-75 DAT	75-90 DAT	90-105 DAT
5th July	38.29	24.88	23.28	28.57	17.51	11.00
15thJuly	37.36	24.88	23.61	28.83	20.23	8.66
25th July	37.29	24.61	23.80	28.58	20.26	8.20
Varieties						
NDR-97	37.62	19.41	23.43	28.68	20.57	3.30
NDR-3112	37.69	32.59	23.58	28.66	20.23	10.79
BPT-5204	37.63	22.38	23.68	28.63	17.20	13.78

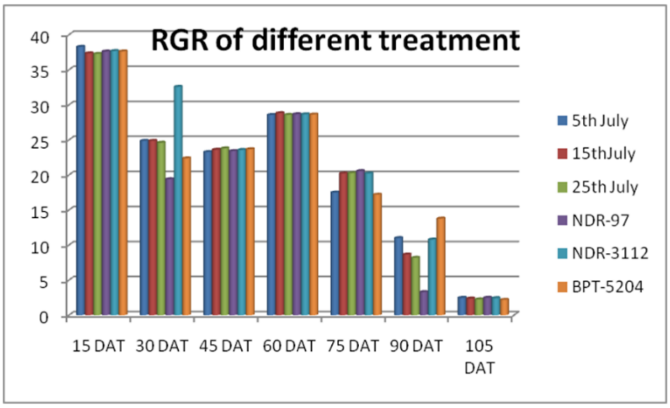

Fig 4: Different growing environment responsible for RGR in cultivars of rice

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