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Study of Phasic Development and Growth Attributes of Rice Cultivars at Variable Weather Condition

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A B S T R A C T

A field experiment was conducted during *kharif season* of 2014-15 at N.D. University of Agriculture and Technology, Kumarganj, Faizabad (U.P.) in sandy loan soil. The experiment consisted of 9 treatment combinations comprised of three transplanting dates *viz*., July 5 (D_1), July 15 (D_2) and July 25 (D_3) and three varieties viz., Sarjoo-52 (V_1), NDR-359 (V_2) and Swarna (V_3). It was observed that different phenophases of rice markedly varied with not only dates of transplanting but also different weather variables which ultimately creates the different crop growing environment to harvest the yield accordingly Among the three varieties it was also observed that different phenophases has taken higher days inV_1 as compare to V_2 and in different days of transplanting higher linear growth rate (LGR) was recorded in D_2than D_1 and D_3.Crop growth rate (CGR) in V_3 recorded highest CGR as compare to V_1 & V_2. V_3 maintained the superiorly of RGR and possess highest growth rate 0.40 mg/g/day over V_2 (0.36 mg/g/day) and V_1 (0.29 mg/g/day).

Introduction

Rice yields have been increasing since the 1960s, but since the 1990s, growth in rice production has been slower than population growth Indeed, it is anticipated that rice production will need to increase by 30% by 2025 in order to sustain those who need it for sustenance. However, climate change, especially access to water, soil erosion and other problems threaten rice yields. The impact of air temperature on rice growth would be 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). Such warming will thus reduce rice growth. In addition, higher temperatures will cause spikelet sterility owing to heat injury during panicle emergence. In temperate regions, increased air temperatures should hasten rice development, thereby shortening the time from transplanting (or direct seeding) to harvesting and reducing the total time for photosynthesis yield development (Neue and Sass, 1994). Rice is very sensitive to higher temperature during reproductive stage especially flowering and anthesis. It is necessary to identify genetic donors for heat stress from high temperature rice growing environments. Temperature stress affects at

reproductive stage by adopting three different planting dates with 15 days interval at different temperature regimes from 35.6 degrees C (E1) to 39.2 degrees C (E3) at reproductive stage. The elevated temperature at the time of flowering and maturity determines the yield *per se* of the genotypes. Under high temperature stress, the response of genotypes depended on developmental stage, but highest sensitivity was recorded at reproductive stage. The time of sowing, days to flowering (duration group), heat escape (early morning flowering) and inbuilt tolerance were the crucial factors in determining the performance of genotypes to varying temperature. Hence, it is necessary to select genotypes by keeping in view the above factors for different temperature stress within and across the environment Raju *et al.*, (2013).

Materials and Methods

The experiment comprised three different types of rice varieties Sarjoo-52, NDR-359 and Swarna at three dates of transplanting *viz* 5 July, 15 July and 25 July during 2014. The experiment was conducted in split plot design (SPD) and replicated the three times. The details of experiment has been described elsewhere Rajan Chaudhari 2015. The different growth parameters studied were measured as follows;

Days taken to different phenophases: Total numbers of days taken from date after transplanting to different phenophases of rice crop were recorded visually as to know the effect of various treatments on the phenophasic duration.

Linear growth rate (LGR): Linear growth rate (LGR) was calculated by using following formula.

$$\text{Linear growth rate (LGR)} = \frac{L_2 - L_1}{t_2 - t_1}$$

L_1 & L_2 are the length of plant height at time t_1 & t_2 respectively.

Crop growth rate: Crop growth rate represented total dry matter productivity of the community per unit land area over a certain time spam. The crop growth rate have been calculated by using following equation given by Watson (1947) and reported as kg m^{-2} $week^{-1}$ or kg m^{-2} $month^{-1}$.

$$CGR = \frac{W_2 - W_1}{t_2 - t_1} \times \frac{1}{L}$$

W_1 and W_2 are plant dry weight of biomass at times t_1 and t_2 L is land area.

Relative growth rate: Relative growth rate was determined by measuring the plant dry weight 15 days interval of crop growth rate *viz.* at 30, 45, 60, 75, 90 and 105 days of transplanting . It was computed by using the formula given below and expressed as mgg^{-1}/day^{-1} (Red Ford, 1967).

$$RGR = \frac{\text{Log } 10\ W_2 - \text{Log } 10\ W_1}{(t_2 - t_1)}$$

Where W_1 and W_2 are the plant dry weight at time t_1 and t_2 respectively.

Results and Discussion

Days taken to attain different phenophases of rice cultivars at different days of transplanting have been depicted in table: 1. From table it was revealed that days taken to attain maximum tillering at Ist date of transplanting on July5 (D_1), was 30 days after transplanting (DAT) while panicle initiation started at 58 days, 50% flowering at 74days, milking started at 83 days, dough at 92 days and physiological maturity at 102 DAT. At IInd date of transplanting on July15 (D_2), different phenophases *viz.* maximum tillering attained

at 26 DAT, panicle initiation at 56 days, 50% flowering attained in 72 DAT while milking and dough was at 80 and91 DAT respectively, followed by physiological maturity which attained in 106 days after transplanting. Similarly at IIIrd date of transplanting on July25 (D_3), for maximum tillering to physiological maturity the days taken to attain different phenophases were lower as compared to the either D_1 or D_2. Quantitatively the values for days taken was 25 DAT for maximum tillering, 51 DAT for panicle initiation, 67 DAT for 50% flowering, 74 DAT for milking, 85 DAT for dough and 95 days after transplanting for physiological maturity. From the table it was also observed that different phenophases has taken higher days in D_1 as compared to D_2 and D_3 except physiological maturity for which D_2 has taken higher days as compare to D_1.

Among the varieties, variety for Sarjoo-52 (V_1) the days taken to attain maximum tillering was 26 DAT while panicle initiation started at 52 DAT, 50% flowering at 67 DAT, milking at 74 DAT, dough at 84 DAT and physiological maturity at 98 DAT. Similarly variety NDR- 359 (V_2), has taken 24 DAT for maximum tillering, panicle initiation attained at 48 DAT, 50% flowering at 64 DAT, milking at 72 DAT, dough at 82 DAT and physiological maturity at 89 DAT. Similarly IIIrd variety Swarna (V_3), from maximum tillering to physiological maturity the days taken to attain different phenophases were more than the either V_1 or V_2 as 31 DAT took for maximum tillering against the 26 and 24 DAT for V_1 andV_2. Panicle initiation started at 65 DAT for V_3, 50% flowering at 82 DAT, milking 91 DAT, dough 102 and physiological maturity at 116 DAT. Among the three varieties it was also observed that different phenophases has taken higher days inV_1 as compare to V_2.

Linear Growth Rate (LGR) (cm/day): Linear Growth Rate (LGR) (cm/day) of different rice cultivars at different days of transplanting has been depicted in table 2 & characteristics feature has been depicted in fig. 1.1. From table it was revealed that maximum linear growth rate at Ist date of transplanting on July5 (D_1), was 1.79cm/day at 45 DAT with further decrease and increase at 75 & 90 DAT. At IInd date of transplanting on July15 (D_2), maximum linear growth rate (LGR) was recorded 1.81 cm/day higher than at D_1at same 45 DAT. Similarly at IIIrd date of transplanting on July25 (D_3), linear growth rate (LGR) was lower than the either D_1or D_2. Quantitatively the maximum value of LGR was recorded at 45 to 60 DAT at all dates of transplanting may be due to maximum energy translocation in to PI stage of crop hence recorded the better growth rate. From the table it was also observed that different day of transplanting has taken higher linear growth rate (LGR) in D_2than $D_1$and D_3may be due to congenial crop growing environment at D_2transplanting. From the significant analysis, it was evident that among dates of transplanting 45 DAT, 75 DAT, and 105 DAT were significant among each other while 30 DAT, 60 DAT and 90 DAT were non-significant among each other.

Among the varieties for Sarjoo-52 (V_1) the maximum 1.73 cm/day linear growth rate (LGR) recorded at 45 DAT with further decrease in LGR up to 75 DAT. Similarly for NDR- 359 (V_2), maximum LGR1.83 cm/day was recorded at 45 DAT but higher than V_1at same 45 DAT. Similar trend of variation for was observed as that ofV_1.Similarly IIIrd variety Swarna (V_3), attained maximum linear growth rate (LGR) 1.58 cm/day at same DAT and also followed the similar trend but possess lower value than that of V_1& V_2 and possess the lowest growth rate among the varieties. From the significant analysis, it was evident that varieties were significant among each other all dates of transplanting. Crop growth rate (CGR) (gm^{-2} d^{-1}): Crop Growth Rate (CGR) gm^{-2} d^{-1} of different rice varieties

at different days of transplanting has been depicted in table 3. From table it was revealed that maximum crop growth rate (CGR) 16.97 gm^{-2} d^{-1} was observed at 75 DAT in I^{st} date of transplanting on July5 (D_1), followed by 12.97 gm^{-2} d^{-1} at 60 DAT. After 75 DAT, CGR decreased up to 105 DAT. At II^{nd} date of transplanting on July15 (D_2), maximum crop growth rate (CGR) was observed at 75 DAT 17.90 gm^{-2} d^{-1}.Similarly in III^{rd} date of transplanting onJuly25 (D_3), also maximum CGR 16.13 gm^{-2} d^{-1} was recorded at 75 DAT lower than D_1or D_2.

The characteristics feature of CGR at different date of transplanting of different varieties has been depicted in fig. 4.2. From the table it was also observed that among the different dates of transplanting D_2 attained higher crop growth rate as compare to D_1 and D_3. From the significant analysis, it was evident that except 75 DAT, crop growth rate at other DAT'S were significant among each other while at 75 DAT non-significant value of CGR was recorded.

Among the varieties for the crop growth rate (CGR) Sarjoo-52 (V_1) attained maximum value at (16.53 gm^{-2} d^{-1}) 75 DAT, variety NDR-359 (V_2) attained highest value of CGR 16.87 gm^{-2} $d^{-1}$and III^{rd} variety Swarna (V_3) recorded in maximum crop growth rate 17.60 gm^{-2} d^{-1} at same 75 DAT.

Among the varieties from the table it was also observed that crop growth rate (CGR) in V_3recorded highest CGR as compare to V_1&V_2. From the significant analysis, it was evident that except 45 & 75 DAT all varieties at rest DAT were significant among each other while at 45 and 75 DAT varieties were non- significant among each other. Higher CGR during 60-75 DAT panicle initiation to flowering stage might be due to higher dry matter partitioning in different plant organs hence higher growth rate.

Relative growth rate (RGR)(mg/g/day x 10^{-2}): Relative Growth Rate (RGR) (mg/g/day) of different rice cultivars at different dates of transplanting has been depicted in table 4. From table it was revealed that relative growth rate (RGR) at I^{st} date of transplanting on July 5 (D_1), was highest8.5 mg/g/day at 30 DAT, subsequently decreased then after at all DAT. Minimum value of RGR 0.39mg/g/day was reported at 105 DAT at I^{st} date of transplanting (D_1). Similarly II^{nd} date of transplanting on July 15 (D_2), relative growth rate (RGR) at 30DAT the RGR value was same8.5mg/g/day as that ofD_1 with is minimum value 0.38 g/day at 105 DAT.

Table.1 Days taken to attain different phenophase of rice cultivars at different days after transplanting (DAT)

Treatment						
Date of transplanting	**Days after transplanting (DAT)**					
	Maximum tillering	**Panicle initiation**	**50(%) Flowering**	**Milking**	**Dough**	**Physiological Maturity**
(D_1)	30	58	74	83	92	102
(D_2)	26	56	72	80	91	106
(D_3)	25	51	67	74	85	95
Varieties						
(V_1)	26	52	67	74	84	98
(V_2)	24	48	64	72	82	89
(V_3)	31	65	82	91	102	116

Table.2 Linear Growth Rate (LGR) (cm/day) of different rice cultivars at different days of transplanting

Treatment	Linear Growth Rate (cm/day)					
Date of transplanting	Days after transplanting (DAT)					
	30	45	60	75	90	105
(D_1)	0.74	1.79	0.85	1.01	1.21	0.35
(D_2)	0.74	1.81	0.87	1.03	1.22	0.36
(D_3)	0.73	1.54	0.81	0.87	1.13	0.32
SEM±	0.019	0.045	0.022	0.023	0.028	0.008
CD (5%)	NS	0.157	NS	0.081	NS	0.029
Varieties						
(V_1)	0.76	1.73	0.83	0.98	1.18	0.35
(V_2)	0.70	1.83	0.92	1.06	1.25	0.37
(V_3)	0.75	1.58	0.78	0.85	1.09	0.32
SEM±	0.014	0.032	0.016	0.018	0.020	0.006
CD (5%)	0.042	0.096	0.049	0.054	0.061	0.018

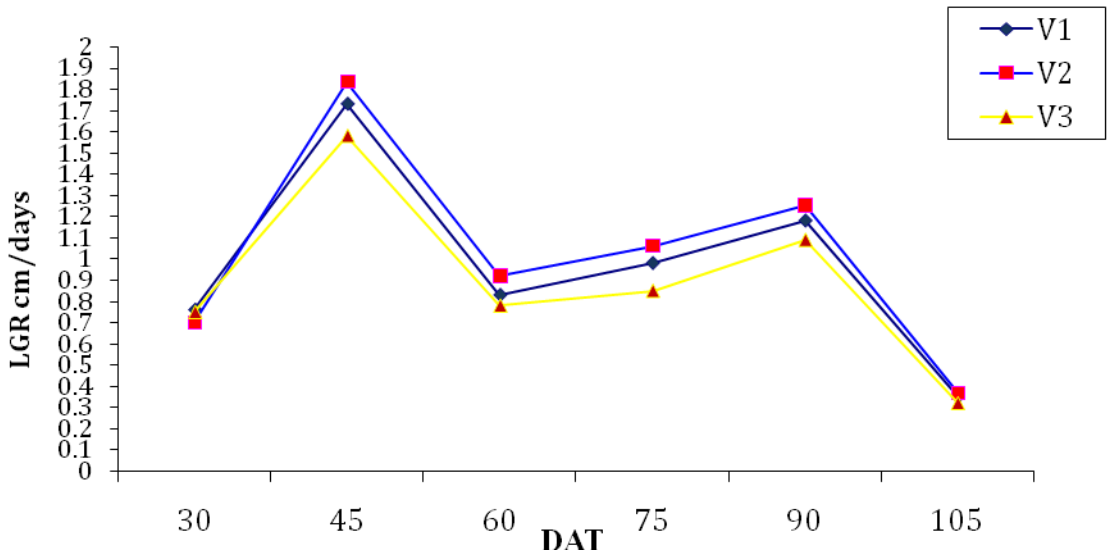
Table.3 Crop Growth Rate (CGR) of rice cultivars at different dates of transplanting.

Treatment	Crop Growth Rate (CGR) (gm^{-2} d^{-1})					
Date of transplanting	Days after transplanting (DAT)					
	30	45	60	75	90	105
(D_1)	6.37	7.87	12.97	16.97	6.23	5.28
(D_2)	6.77	8.53	13.97	17.90	6.60	5.64
(D_3)	5.73	7.30	11.83	16.13	5.60	4.88
SEM±	0.14	0.20	0.33	0.44	0.15	0.13
CD (5%)	0.49	0.70	1.14	NS	0.51	0.38
Varieties						
(V_1)	5.73	7.63	12.40	16.53	5.13	4.98
(V_2)	6.27	7.90	12.70	16.87	5.70	5.26
(V_3)	6.87	8.17	13.67	17.60	7.60	5.62
SEM±	0.14	0.16	0.28	0.33	0.14	0.12
CD(5%	0.41	NS	0.83	NS	0.41	0.41

Table.4 Relative Growth Rate (RGR) of rice cultivars at different dates of transplanting

Treatment	Relative Growth Rate (RGR) (g/day dry matter x10^{-2})					
Date of transplanting	Days after transplanting (DAT)					
	30	45	60	75	90	105
(D_1)	8.5	4.2	3.8	3.0	0.83	0.39
(D_2)	8.5	4.3	3.8	2.9	0.82	0.38
(D_3)	8.6	4.4	3.8	3.1	0.81	0.28
SEM±	0.002	0.001	0.0009	0.0007	0.0001	0.0001
CD (5%)	NS	NS	NS	NS	NS	NS
Varieties						
(V_1)	8.2	4.4	3.9	3.1	0.73	0.29
(V_2)	8.3	4.3	3.8	3.0	0.77	0.36
(V_3)	9.1	4.2	3.9	3.0	0.97	0.40
SEM±	0.001	0.0007	0.0006	0.0005	0.0001	0.0002
CD (5%)	0.005	NS	NS	NS	0.0004	NS

Fig. no. 1 Linear growth rate (LGR) of different rice cultivars at different days of transplanting (DAT)



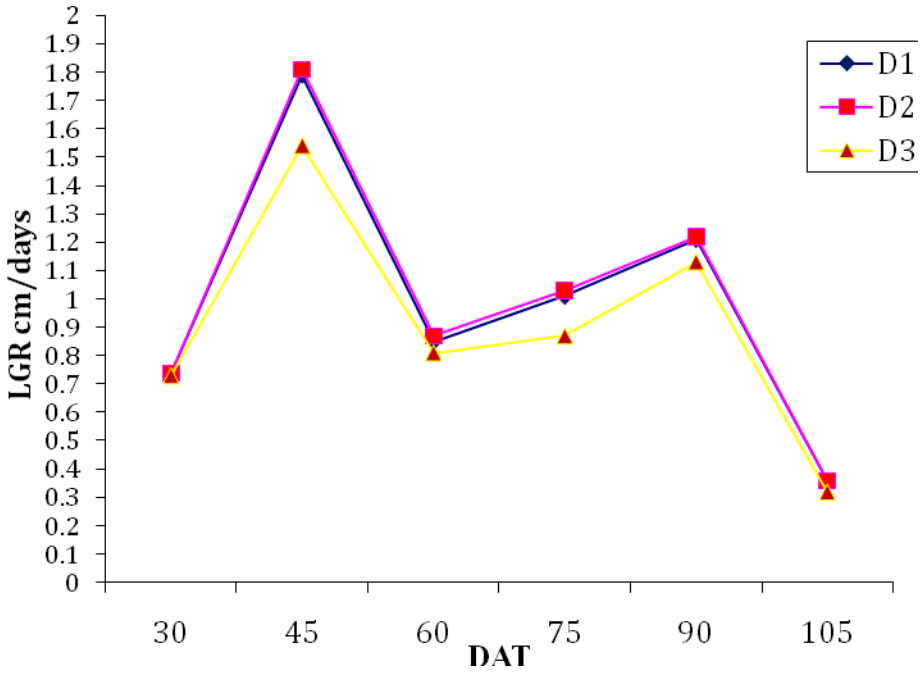
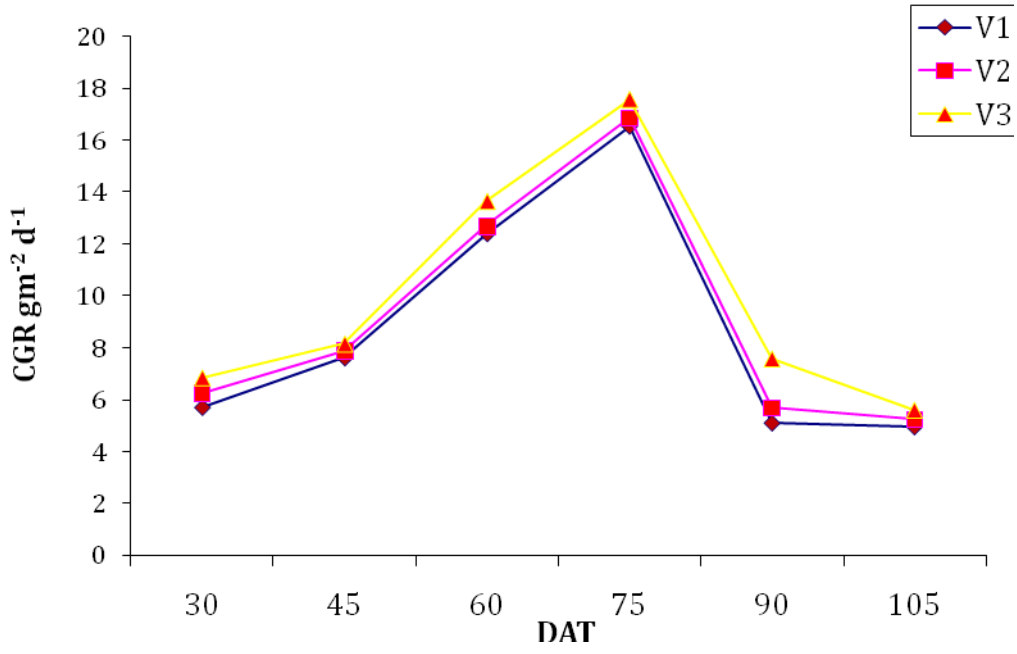


Fig. no. 2 Crop Growth Rate (CGR) of rice varieties at different days of transplanting



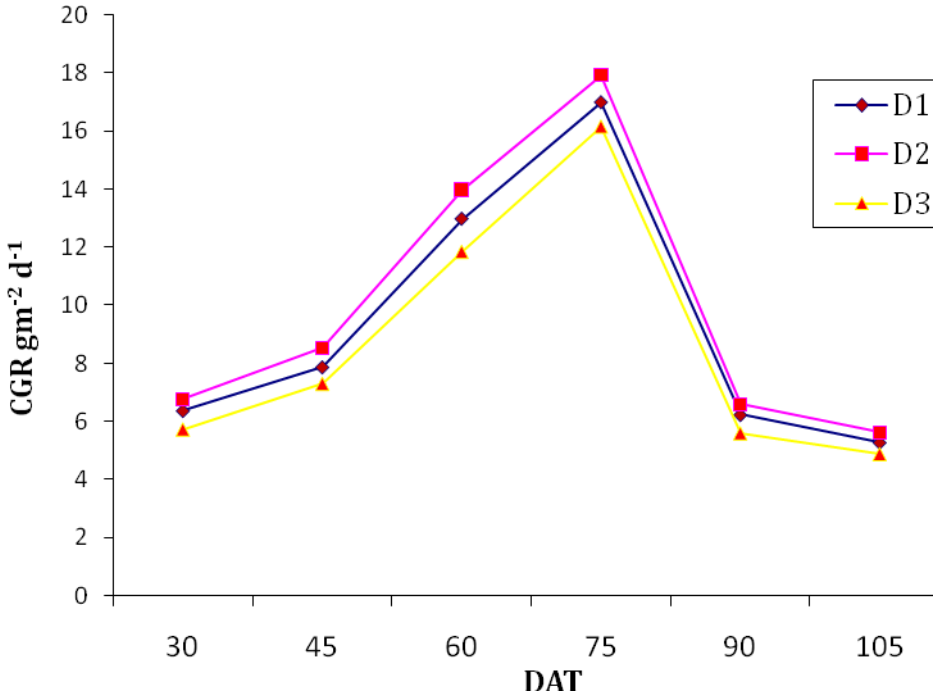
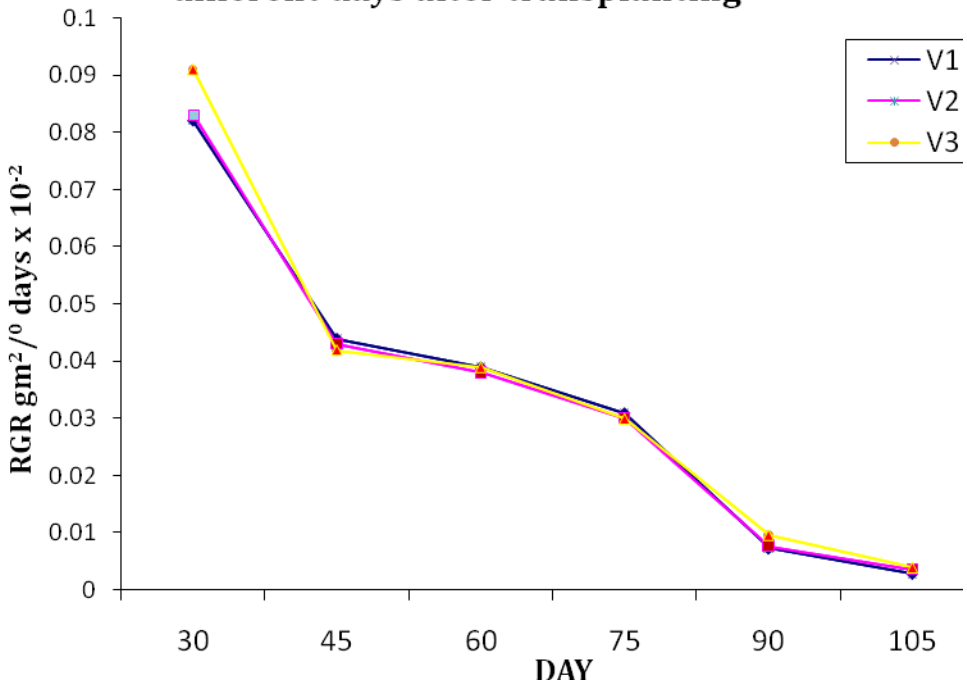
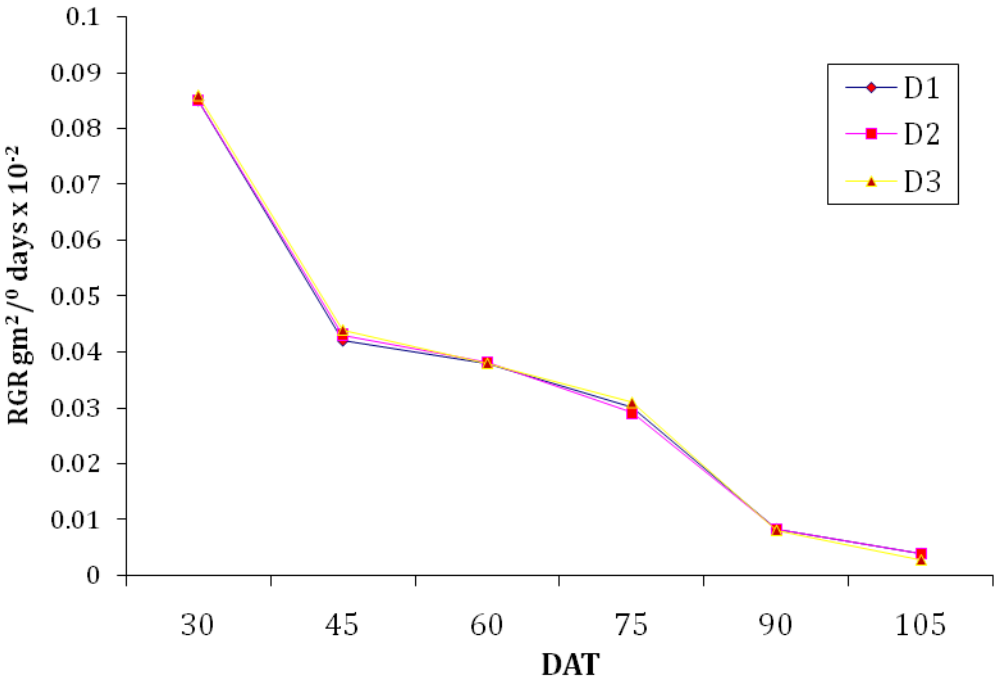


Fig. no. 3 Relative Growth Rate (RGR) of rice cultivars at different days after transplanting





Similarly at III[rd] date of transplanting on July 25 (D_3), value of RGR at 30,45 & 60 DAT were non-significantly higher over D_2 but at 90& 105 DAT the value of RGR at D_3 were non-significantly lower. This showed that there is no specific trend in RGR variation in respect of dates of transplanting. From the table it was also observed that different dates of transplanting has achieved non-significantly higher relative growth rate (RGR) in D_3 than D_2 and D_1 up to 75 DAT, then after posses lowest value as compared to D_1&D_2. From the significant analysis, it was evident that dates of transplanting were non-significant among each other.

Among the varieties for Sarjoo-52 (V_1), the relative growth rate (RGR) attained highest value at 30 DAT (8.2mg/g/day) and lowest at 105 DAT (0.29 mg/g/day).Variety NDR- 359 (V_2), attained highest value 8.3 mg/g/day at 30 DAT and lowest value of RGR 0.36 mg/g/day at 105 DAT. Similarly III[rd] variety Swarna (V_3), achieved highest growth rate 9.1mg/g/day as compare to 8.3 mg/g/day in V_2 and 8.2 mg/g/day V_1at 30 DAT. At 105 DAT also variety V_3maintained the superiorly of RGR and possess highest growth rate 0.40 mg/g/day over $V_2$0.36 mg/g/day and $V_1$0.29 mg/g/day. From the significant analysis, it was evident that at 30 DAT, and 90 DAT varieties were significant among each other while at rest DAT, 45 DAT, 60 DAT, 75 DAT and 105 DAT varieties were non-significant among each other.

It is concluded that present study in different dates of transplanting (DAT), maximum growth to the II[nd] dates of transplanting (15 July) and suitable varieties of NDR-359. Hence for linear growth rate (LGR) and crop growth rate (CGR) of maximum on II[nd] dates of transplanting (15 July), variety is NDR-359.

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