Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2020; 9(1): 1394-1397
Received: 01-11-2019
Accepted: 03-12-2019

Chandini
Department of Agronomy, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh, India

Avijit Sen
Department of Agronomy, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh, India

VK Srivastava
Department of Agronomy, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh, India

Ardith Sankar
Department of Agronomy, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh, India

Monalisa Sahoo
Department of Agronomy, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh, India

Corresponding Author:
Chandini
Department of Agronomy, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh, India

Effect of planting dates on dry weight, flowering and yield of different rice varieties

Chandini, Avijit Sen, VK Srivastava, Ardith Sankar and Monalisa Sahoo

Abstract
Rice is the most important cereal crop after wheat and one of the most widely consumed and indispensable grains in the world. Thus, for the proper growth and development of rice optimum planting time is imperative to complete all growth phases successfully. Present experiment, "studies the effect of planting dates on dry weight, flowering and yield of different rice varieties". It was carried out following split-plot design keeping four rice varieties (Gargi, DRR 42, Sadabahar and NDR 97) in the main plot and three transplanting dates (5th August, 13th August and 21st August) in sub-plot. The results revealed that under delayed planting condition in this region, variety NDR 97, when planted on 5th August outyielded other varieties. And as the planting gets delayed beyond the first week of August the yield of rice decreases progressively. Thus, the influence of planting dates in rice cultivation is considered to be of pivotal significance.

Keywords: Delayed planting, rice varieties, planting dates, yield

Introduction
Rice (*Oryza sativa*. L) is the most important cereal crop after wheat and one of the most widely consumed grains in the world. It is an indispensable food for more than half of the world's population within Asia and Africa. Asian countries are the largest producer (75% of the total global rice production) and consumer of rice [15]. In India, rice alone is grown in an area of 43.9 million hectares, producing around 106.77 million tonnes [9]. India is the second-largest consumer of rice with 100 million metric tonnes after the most populous country in the world China which consumes 143.8 million metric tonnes of rice [25]. Among all the states of the country, West Bengal leads in terms of rice production with 14.71 million tonnes followed by Uttar Pradesh with 12.22 million tonnes and Andhra Pradesh with 11.57 million tonnes [1].
The date of planting is an important non-monetary input and an indispensable agronomic factor for obtaining optimum rice yields [6]. It also assumes the much greater significance of cultivation under changing climatic conditions, because planting time in rice cultivation is indirectly responsible for soil temperature and weather conditions to which young rice seedlings and growing rice plants are exposed during different phenological stages [28]. Moreover, an optimum date of planting in a particular ecological setting provides an accumulation of desired heat units necessary for proper growth and development of rice crop [23]. Timely planting ensures greater yield attributing parameters and grain yield [13]. However, late transplanting results in reduced yield promoting parameters and also limits the growth duration which further leads to a reduction in leaf area, productive tillers and test weight [4].
Maximum productivity in rice can be achieved by simply adopting the optimum date of planting which is location-specific, and may vary from variety to variety [24]. Time of planting in rice crop is very important to be optimized because of the variation in the growth duration, photo sensitiveness, thermosensitivity and vegetative lag period of different varieties. [8] Reported that panicle initiation stage started late in early sown crop (5th and 10th June) and 50 per cent flowering was earlier in late crop (25th June) thus reducing the growth duration and the optimum photoperiod requirement. Experiments conducted at two locations viz. Crowley and St. Joseph in Louisiana showed that days from seedling emergence to 50 per cent panicle emergence decreased at both locations as planting was delayed [16].

Materials and Methods
The experiment was conducted at the Agricultural Research Farm of the Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, under irrigated condition during the *Kharif* season of 2018. The site falls under a sub-tropical zone of Indo-Gangetic plains. It is located on 25°15′17.92'' N latitude, 82°59′20.73'' E longitude and at an altitude of 75.7 meters above mean sea level. Varanasi is situated in the eastern part of U.P and falls in the belt

of semi-arid to sub-humid climate receiving a mean assured rainfall of 1100 mm and 1525 mm of potential evapotranspiration, thus causing a moisture deficit of 425 mm. The normal time of the onset of monsoon in this region is the late third week of June and it lasts up to the end of September or sometimes extends to the first week of October. Data on meteorological parameters were obtained from the meteorological observatory (AICRP on Dryland Agriculture), I.A.Sc., B.H.U, Varanasi.

The present research studies the effects of delayed dates of planting on dry matter production, flowering and yield of different rice varieties. The experiment was carried out in split-plot design with three replications, comprising four rice varieties (Gargi, DRR 42, Sadabahar and NDR 97) in the main plot and three transplanting dates (5th August, 13th August and 21st August) in sub-plot. Four weeks-old seedlings were transplanted on the well-puddled soil at a hill spacing of 20 × 15 cm with 3-4 seedlings per hill. A recommended dose of nutrients i.e., 120 kg N, 60 kg P_2O_5, 60 kg K_2O ha^{-1} were applied through broadcasting. One-third dose of nitrogen and a full dose of P and K were applied as basal and the remaining dose of nitrogen was top-dressed in two equal splits. Water management and weed control measures were adopted as per the recommendations and crop need. The crop was harvested at maturity and threshed as per schedule. The data on dry matter production, flowering and yield of rice varieties were recorded and analysed.

Results and Discussion

Dry weight per hill

Dry weight per hill of different rice varieties vary significantly by dates of planting. It increased notably from 30 DAT to harvest stage, irrespective of the treatment. Gargi (V1) recorded maximum dry weight at all the growth stages followed by DRR 42 (V2), NDR 97 (V4) and Sadabahar (V3). And among the dates of planting it increased from 5th August (D1) to 21st August (D3) at all the succeeding growth stages. The interaction effect revealed that, at 30 and 60 DAT, Gargi (V1) when planted on 5th August (D1) attained maximum dry weight per hill whereas Sadabahar (V3) planted on 21st August (D3) attained minimum. However, at harvest, DRR 42 (V2) planted on 5th August (D1) has attained maximum dry weight whereas Sadabahar (V3) planted on 21st August attained minimum. Maximum dry weight per hill of Gargi planted on 5th August might be due to higher remobilization of photosynthates in the early planted crop (in the form of greater crop height, higher number of tillers and green leaves per hill) which probably was related to the higher dry weight of the crop at anthesis representing potential source for remobilization [27, 20].

Table 1: Meteorological observations (Standard week-wise) during the crop season 2018

Week No.	Month & Date	Rainfall mm	Temperature ^{0}C		R.H. %		Wind Speed km/hr	Sunshine hours per day	Evaporation mm per day
			Max.	Min.	Max.	Min.			
27	July 02-08	8.0	35.5	27.9	77	57	3.6	6.4	4.4
28	09-15	11.6	35.5	26.0	83	58	4.4	7.8	5.8
29	16-22	78.4	33.3	25.4	86	66	4.5	4.9	4.4
30	23-29	91.4	28.4	23.6	88	87	2.5	0.3	1.7
31	30-05	86.8	28.1	22.8	93	88	4.2	0.1	1.4
32	Aug 06-12	26.6	31.8	24.7	92	77	2.0	4.8	2.7
33	13-19	20.4	33.3	25.3	88	70	2.4	5.9	2.8
34	20-26	154.8	31.1	24.0	91	81	2.4	6.27	2.6
35	27-02	118.4	32.0	24.3	93	77	1.7	3.27	2.6
36	Sep 03-09	94.6	30.6	23.6	91	79	2.3	4.7	2.4
37	10-16	0.0	32.4	23.6	88	68	2.7	7.75	3.8
38	17-23	53.4	32.5	22.8	88	65	3.7	6.75	3.1
39	24-30	0.0	33.4	25.9	88	63	1.1	8.52	3.5
40	Oct 01-7	0.0	34.2	20.8	83	51	0.8	9.1	3.7
41	08-14	0.0	31.0	20.0	89	61	1.4	6.02	2.9
42	15-21	0.0	33.4	16.5	84	40	1.6	9.4	2.8
43	22-28	0.0	31.5	14.4	89	41	1.0	9.14	2.6
44	29-04	0.0	31.1	16.7	91	48	0.6	8.65	2.3
45	Nov 05-11	0.0	28.2	12.2	87	44	1.4	7.72	2.0
46	12-18	0.0	29.0	11.7	89	45	1.8	7.88	1.8
47	19-25	0.0	27.9	10.1	88	44	1.3	8.38	2.0

Table 2: Effect of date of planting on dry weight per hill, days to 50% flowering and grain yield of different rice varieties

Treatments	Dry weight per hill			Days to 50% Flowering	Grain yield (q/ha)
	30 DAT	60 DAT	At harvest		
Gargi (V_1)	3.74	13.07	25.50	57.83	21.74
DRR 42 (V_2)	2.85	9.24	22.11	58.00	19.59
Sadabahar (V_3)	2.22	8.24	21.16	38.33	15.60
NDR 97 (V_4)	2.75	9.10	21.36	50.00	16.85
Sem±	0.11	0.35	0.78	1.87	0.85
C.D.(p=0.05)	0.38	1.20	2.70	6.47	2.93
5th August (D_1)	3.78	12.14	29.93	61.25	24.24
13th August (D_2)	2.86	9.34	22.04	48.25	17.86
21st August (D_3)	2.03	8.25	15.62	43.63	13.24
Sem±	0.08	0.26	0.63	1.33	0.69
C.D.(p=0.05)	0.25	0.78	1.88	4.00	2.06
Sem±	0.17	0.52	1.25	2.67	1.38
V × D C.D.(p=0.05)	0.51	1.56	3.76	NS	4.12

Days to 50% flowering

The variation in days to 50% flowering of different rice varieties was significantly influenced by the dates of planting. Sadabahar (V3) attained 50% flowering at the earliest (38.33 days), followed by NDR 97 (V4), Gargi (V1) and DRR 42 (V2) which reached the stage at (50, 57.83 and 58 days) respectively. It decreased gradually from the first date of planting 5th August (D1) to last date of planting 21st August (D3). 5th August planting took (61.25 days) for reaching 50% flowering whereas 13th August and 21st August planting took (48.25 and 43.63 days) respectively. The difference in attainment of days to 50% flowering due to delayed dates of planting was attributed to maximum days available for conversion from one phenological phase to other and maximum accumulated heat unit for the earliest planting on 5th August than other succeeding dates [22, 18, 5, 11]. Thus, the last date of planting attains earliest 50% flowering or in the least time duration because of unfavourable weather condition and less crop growth duration. The present findings were similar to those observed by [19, 26].

Grain yield (q/ha)

All the varieties were significantly different from each other in terms of grain yield. The highest grain yield (21.74 q/ha) was observed in Gargi (V1) followed by DRR 42 (V2), NDR 97 (V4) and Sadabahar (V3) having (19.59, 16.85 and 15.60 q/ha) respectively. Gargi (V1) registered 28.24% more grain yield over Sadabahar (V3). The maximum grain yield was recorded with the first date of planting i.e., 5th August (24.24 q/ha) followed by 13th August (17.86 q/ha) and 21st August (13.24 q/ha) respectively.

The grain yield is the sum of various growth as well as yield contributing parameters controlled both genetically and environmentally. Grain yield is a function of various important yield attributes such as a number of filled spikelet/panicle, productive tillers and 1000 grain weight. Rice yield is a complementary interaction between the source (photosynthesis and assimilate availability) and sink (storage of photosynthates) [21] has explained that high dry matter accumulation before heading and high translocation rate after heading are the main strategies in high yielding rice cultivars.

The varieties were found to interact significantly with the dates of planting in influencing the grain yield. The maximum grain yield was produced by NDR 97 when planted on 5th August (25.83 q/ha) while Sadabahar recorded the minimum when planted on 21st August (7.12 q/ha). The maximum yield of NDR 97 might be attributed to its maximum biomass production at the early date of planting (5th August) with the higher number of tillers, leaves and proper partitioning of photosynthates which was evident from higher yield attributes like panicle weight, test weight and the number of fertile spikelets. The findings were similar to that of [3, 14, 10]. The lowest yield in Sadabahar when planted on 21st August was due to positive correlation between the mean daily temperature, solar radiation and yield. Hence due to reduced conversion of solar energy to photosynthates, there was the poor expression of vegetative as well as reproductive characters which ultimately led to lower grain yield [7, 12, 2, 8, 17]. Other reasons for reduced Sadabahar yield on 21st August planting was lesser sunshine hours available for photosynthetic and respiratory activities [29] and reduced pre- and post-anthesis dry weight per hill due to delayed planting. Therefore, increased biological yield played a key role in the higher grain yield of the early planted crop [30].

Table 3: Interaction effect of varieties and dates of planting on grain yield of rice

Treatment	V1	V2	V3	V4	Mean
D1	25.40	21.73	23.99	25.83	24.24
D2	21.23	19.46	15.69	15.06	17.86
D3	18.59	17.57	7.12	9.67	13.24
Mean	21.74	19.59	15.60	16.85	
				Sem±	C.D. (p=0.05)
Subplot at same/different mainplot				1.38	4.12
Mainplot at same/different subplot				1.99	4.45

Conclusion

Based on the above findings following conclusion can be drawn that the optimum date of sowing is the most crucial factor that decides the rice yield to a greater extent. Under delayed planting condition in this region variety NDR 97, when planted on 5th August outyielded other varieties. And as the planting gets delayed beyond the first week of August the yield of rice decreases progressively. The decreasing trend in grain yield with delayed sowing date might be associated with the reported significant lower dry weight per hill at different growth stages and lesser days in attainment 50% flowering which is due to the lesser sunshine hours available for photosynthetic and respiratory activities. Also, it can be concluded that the synchronisation of the critical phenophases with the favourable weather regime ensures promising crop yield which is only possible by adjusting the sowing date. Therefore, it is imperative to confirm the optimum sowing date for rice higher yield levels and food security.

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