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IMPACT OF DIFFERENT TRANSPLANTING DATES ON BASMATI VARIETIES OF RICE IN AGRO-ECOLOGICAL ZONE OF GUJRANWALA

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KeyWords

Impact; Basmati Cultivars; transplanting dates; July; Kissan Basmati; Adaptive Research; Gujranwala Zone, Punjab-Pakistan

ABSTRACT

Keeping in view the current scenario of climate change, optimum transplanting time and high yielding rice cultivar are pre-requisite to a successful rice crop production in a rice based cropping system. This study was conducted at Adaptive Research Farm Gujranwala to explore the impact of different transplanting dates (1st July, 10th July, 20th July and 30th July) on the agronomic traits and grain yield of different basmati rice cultivars (Super Basmati, Super Basmati-2019, Super Gold and Kissan Basmati) during summer seasons of three years from 2020 to 2022. Results indicated that the effect of Basmati cultivars was significantly different for all parameters studied. Basmati cultivars when averaged against different transplanting dates, the maximum (346) number of productive tillers m^{-2} was recorded in Super Basmati. However, during the year 2022 same number of productive tillers was produced by Super Basmati and Kissan basmati. The Maximum filled number of grains per panicle (147, 148 and 129), 1000-grains weight (25g, 24g and 24g), total dry biomass (20.37 tha^{-1}, 20.75 tha^{-1} and 20.83 tha^{-1}) and grain yield (5602 $kgha^{-1}$, 5158 $kgha^{-1}$ and 5639 $kgha^{-1}$) was recorded in Kissan Basmati during the years 2020-2022 respectively. The crop transplanted on 10th and 20th July exhibited 3-9% more productive tillers than 1st and 30th July transplanting dates during three successive years. Similarly more grain yield and total dry biomass were recorded in 10th and 20th July transplanting dates when averaged against different basmati cultivars. Varieties × transplanting dates interaction remained significantly different for grain yield, total dry biomass and panicle sterility (%). Kissan basmati transplanted on 10th July produced more grain yield (6247 $kgha^{-1}$) with less spikelet sterility % than other basmati cultivars and transplanting dates. Spikelet sterility was higher in 1st and 30th July transplanting dates during the years 2020-2022. In crux, it is recommended that kissan basmati transplanted on 10th July is a best option for the farmers of agro ecological zone of Gujranwala.

Introduction

Rice (Oryza sativa L.) is utilized as second source of food in Pakistan after wheat and is the main source of food in most of the countries. The studies described that management practices and environmental factors can impact the efficiency of rice wheat cropping system. An appropriate rice variety is crucial in enhancing crop production resulted to increase economic benefits (Alam *et al*., 2008). The studies suggested that morphological and physiological characteristics significantly influence crop yield in specific cropping zones (Hussain *et al*., 2014). The studies evaluated that new rice varieties showed resistance against pests, diseases and a biotic stresses may influence crop yield (Khush, 2005). The researchers revealed that several factors i.e. consumer liking, crop growth, phenology, product quality and grain yield may be the reasons of adaptability and fitness of different varieties (Zheng *et al*., 2016).

The favorable environmental conditions showed its impact on various growth stages resulted to achievement of optimum yield. The variety performed better depends upon the growth period of the crop (Waha *et al*., 2020). Cropping intensity may be increased by adopting the short statured crops (Chen *et al*., 2020). The long duration varieties provides better grain yield (Balaji Naik *et al*., 2016). Varieties having long growth period can be more susceptible to harsh climatic conditions and required more inputs especially when grown late (Chen *et al*., 2020). Furthermore, the scientists reported that adoption of variety in a cropping zone depends upon its ability to resist against pests and diseases (Hong-Xing *et al*., 2017). Similarly, rice varieties are grown in a cropping zone on the basis of consumers' liking and product quality (Cuevas *et al*., 2016).

Enhancement of productivity and quality are two main goals of rice crop in Pakistan. Higher yield of rice can be obtained by selecting the optimum date of sowing. Different environmental factors such as precipitation, temperature and growth period impact the plant growth according to planting dates (Habibullah *et al*., 2007). Maximum yield of the crop can be obtained by sowing the crop neither too late nor too early by providing the extended period of growth which reduces the chances of high temperature during reproductive phase of the crop (Baloch *et al*., 2006; Laborte *et al*., 2012). There are lots of environmental factors that affect the paddy yield; however temperature is the significant factor which determines production potential of the crop among them. Basmati rice has photosensitive behavior so it is affected by day length (Akhter *et al*., 2011).

Many researchers worked on different sowing dates in different crops to find various temperature regimes and concluded that the optimum planting date produced maximum grain yield due to favorable environmental conditions during vegetative as well as reproductive phase of the crop (Safdar *et al*., 2008; Basal *et al*., 2009). Therefore, the present study was scheduled to determine the effect of four transplanting dates on growth and yield of four basmati varieties of rice crop at Adaptive Research Farm, Gujranwala during the years, 2020 to 2022.

Materials and methods

Experimental site and design

The present study was scheduled to determine the effect of four basmati rice varieties; Super Basmati, Super Basmati-2019, Super Gold and Kissan Basmati transplanted in different times at Adaptive Research Farm Gujranwala, Pakistan. Soil samples (depth 0-30 cm) were collected to check the physical and chemical properties before the sowing and submitted in water and soil testing Lab, Gujranwala. The soil texture was heavy loam with 7.7 PH, 0.89 organic matter, 0.06% total N, 10.6 mg/kg available P and 141 mg/kg available K. Split plot design was used to conduct experiment and replicated three times to avoid any biasness.

Crop husbandry

The rice crop was transplanted on four different dates i.e. 1st July, 10th July, 20th July and 30th July during the kharif season 2020 to 2022. The fungicide thiophenate methyl was used @ 2.5gkg^{-1} seed to treat the seed. For nursery raising, 25 kgha^{-1} paddy seed was used. Mechanical transplanter was used for nursery transplantation in puddled soil within the standing water upto 1 cm on 1st, 10th, 20th and 30th July in each year. P x P and R x R distance was kept at 22.5 cm. The dose of N (Nitrogen), P (Phosphorus) and k (Potash) was used @ 118:86:62 kgha^{-1}. The complete dose of P, K and 1/3rd of N was used at the time of puddling as basal dose. The remaining dose of N was applied equally 30 and 45 DAT (days after transplanting). The dose of Zinc Sulfate (33%) was kept 15 kgha^{-1} which was applied 15 days after transplanting of the rice nursery.

The depth of irrigation water was kept 3.5 cm for first 15 days then slowly increasing up to 5 cm for next 10 days. The last irrigation was applied 15 days before harvesting of the crop. To avoid biasness, all types of agronomic and plant protection practices were kept constant.

Measurements

Twenty (20) plants were selected randomly at the time of maturity to measure the plant height from tip to soil level with the help of meter rode. The productive tillers were selected randomly in one m^2 ring and five plants were selected randomly to calculate grains $panical^{-1}$. From each replication we counted and weighed 1000-grains weight. The yield of rice was calculated manually threshing and weighing paddy with the help of electronic weight balance.

Statistical analyses

Fisher's Analyses of Variance (ANOVA) was used to analyze the data statistically. Tukey's test was used for comparison of treatments at 5% probability level (Steel *et al*., 1997).

Results and Discussion

Table.2 depicts the data of study conducted during kharif seasons of three consecutive years, 2020-2022. Different yield and yield related traits i.e 1000-grains weight, productive tillers/m^2, number of grains/panicle, spikelet sterility %, grains yield ($kgha^{-1}$) and total dry biomass (tha^{-1}) differed significantly ($p \leq 0.05$) for varieties during three years of study. The impact of different transplanting dates differed significantly ($p<0.05$) with maximum productive tillers m^{-2} by super basmati in 10th July during 2020 and 2022. Similarly, the interaction of transplanting dates and basmati varieties in terms of productive tillers was statistically significant ($p<0.05$) during the kharif season of 2022 and Kissan Basmati produced maximum number of productive tillers/m^2 (329) transplanted on 10th July.

The data regarding filled number of grains $panical^{-1}$ indicated that the interaction of varieties and transplanting dates was significant ($p<0.05$) during 2020. The interaction reveals that kissan basmati transplanted on 30th July gave maximum grains/panicle (156) which was statistically at par with 10th July (150) and 20th July (151) transplanting dates. The main effect of basmati varieties on grains/panicle was recorded significant ($p<0.05$) during 2021 and 2022. Kissan Basmati gave maximum grains/panicle which was statistically similar with super basmati 2019 (119), Super Gold (116) and super basmati (110) during the year 2021. Similarly, during the year 2022, Kissan Basmati produced maximum numbers of filled grains $panicle^{-1}$ (129) followed by super basmati 2019 (114), Super Gold (107) and super basmati (107). Among transplanting dates, 20th July transplanting gave maximum grains/panicle (127) and 10th July (grains/panicle 126) transplanting date was statistically at par with 20th July transplanting date during second year of study (2021). The data of table 1 showed that during third year of study (2022), statistically non-significant effect of transplanting dates on grains/panicle was recorded.

Different basmati varieties have significant ($p<0.05$) effect on 1000-grains weight. Kissan Basmati produced maximum 1000-grains weight (25 g, 24g and 24g) during three years consecutive study however; other basmati varieties produced statistically lower 1000-grains weight as compared to Kissan Basmati. The impact of transplanting dates on 1000-grains weight was recorded non-significant during 2020 and 2021. It was recorded significant ($p<0.05$) during 2022 with maximum 1000-grains weight was recorded in 1st and 10th July transplanting dates that was statistically at par with 20th July transplanting date. The impact of interaction of varieties and transplanting dates was recorded non-significant during three year consecutive years.

The present experiment showed that all basmati varieties are different regarding their yield and yield contributing factors i.e. 1000-grains weight, grains/panicles and productive tillers/m^{-2} (Table 2) that could be due to their unique genetic material (Yang *et al*., 2007; Yang and Hwa, 2008). The result of this study showed that Super Basmati produced maximum productive tillers/m^2 but produced lower number of grains/panicle and 1000-grains weight due to smaller sink size (Table 2; Wang *et al*., 2014). The smaller sink size of Super Basmati also showed that there may more competition between the tillers (Badshah *et al*., 2014). These results were confirmed from the results of other varieties i.e. Kissan Basmati, Super Gold and Super Basmati 2019 which had higher grains per panicle and more 1000-grains weight (Table 2). Earlier findings have shown that different basmati varieties had genetic variation in their yield forming traits (Ashrafuzzaman *et al*., 2009).

Many factors such as management practices, environmental factors and genotypes affect the filling and un-filling of spikelet. Sterile pollens are unable to fertilize the eggs which cause the spikelet sterility. Data about spikelet sterility (%) are shown in Table 2. The impact of transplanting dates, basmati varieties and their interaction was recorded significant during study years, 2020-2022. An overview of data showed that most of the basmati varieties increased their spikelet sterility % with early (1st July) and delayed sowing (30th July) however, decreased their spikelet sterility % at 10th and 20th July transplanting dates during three years consecutive study. Super gold exhibited less panicle sterility % (7%, 7.6% and 9%) during the years 2020, 2021 and 2022, respectively which was statistically at par with super basmati-2019 (8%, 8.3% and 10%). In case of interaction effect during 2020, less spikelet sterility % was recorded in super basmati (5%), kissan basmati (6%) and super gold (5%) during 10th July transplanted rice that was statistically at par with 20th and 30th July transplanted rice. During 2021, minimum spikelet sterility % was recorded in Super Gold (6.8%) and Kissan Basmati (7%) transplanted on 10th July however, maximum spikelet sterility % was recorded in Kissan Basmati (13%) transplanted on 1st July. Less spikelet sterility % was exhibited by super basmati-2019 (8%), super gold (8%) and kissan basmati (8%) on 10th July transplanting date that was similar with 20th July (9%) transplanting date while maximum spikelet sterility % was recorded in Kissan Basmati (12%) transplanted on 1st and 30th July during 2022. Higher spikelet sterility (%) in Kissan Basmati rice in early transplanting date (1st July) was caused by high temperature at anthesis stage as compared to Super Gold and super Basmati 2019 (Table 1 and 2). This shows that Kissan Basmati is more thermosensitive than other basmati varieties. Table 2 indicated that rice verities transplanted at 10th and 20th July produced lowest spikelet sterility due to favorable temperature at anthesis stage. Low temperature chilling injury or high temperature stress may increase the pollen sterility which led to spikelet sterility in basmati rice varieties. More spikelet sterility (%) in early and late planted rice was recorded by many researchers (Jalil, *et al*., 2017).

Transplanting dates, basmati varieties and their interaction have significant ($p<0.05$) effect on total dry biomass of rice during 2020-2022. Kissan basmati recorded maximum total dry biomass (22.10 tha^{-1}) in 10th July transplanting date that was statistically similar with 20th July transplanting date (20.71 tha^{-1}) however; minimum total dry biomass was noted in Super Basmati 2019 (15.52 tha^{-1}) and Super Gold (15.6 tha^{-1}) during 2020. During second year of study (2021), Kissan basmati recorded maximum total dry biomass (22.43 tha^{-1}) in 10th July transplanting date that was statistically at par ($p<0.05$) with 1st July transplanting date (21.61 tha^{-1}) however, minimum total dry biomass was noted in Super Basmati (13.13 tha^{-1}). During third year of study (2022), Kissan basmati recorded maximum total dry biomass (22.02 tha^{-1}) in 10th July transplanting date that was statistically at par ($p<0.05$) with 20th July transplanting date (21.28 tha^{-1}) and minimum total dry biomass was noted in Super Gold (13.88 tha^{-1}).

The main effect of different transplanting dates, basmati varieties and their interaction have significant ($p<0.05$) effect on grain yield in the whole span of experiment during 2020-2022. Kissan basmati transplanted on 10th July gave maximum grain yield (6247 $kgha^{-1}$ and 6100 $kgha^{-1}$) in 2020 and 2022 respectively. kissan basmati transplanted on 20th July gave higher grain yield (5563 $kgha^{-1}$) that was statistically similar ($p<0.05$) with 10th July transplanted date (5303 $kgha^{-1}$) during 2021. Minimum grain yield was recorded in Super Basmati 2019 (3830 $kgha^{-1}$) on 1st July transplanting date during 2020. During second year of study (2021), Super Basmati produced minimum grain yield (3167 $kgha^{-1}$) on 1st July transplanted rice. During third year of study (2022), Super Basmati produced minimum grain yield (3310 $kgha^{-1}$and 3350 $kgha^{-1}$) on 1st July and 30th July transplanted rice which statistically at par with Super Basmati 2019 transplanted on 30th July. Kissan Basmati produced higher paddy yield as compared to other basmati varieties due to higher value of grains/panicle and more 1000-grains weight (Table 2). Difference in grains yield of various basmati varieties of rice might be due to unique gene pole of varieties (Ashrafuzzaman *et al*., 2009). Similarly, Uzzaman *et al*., (2015) reported that different tested rice accessions showed variation in yield contributing factors. Gaballah *et al*., (2022) reported that grains/panicle, productive tillers m^{-2} and grain size are the main yield contributing factor in rice crop.

Heat tolerance performance of different rice varieties at various growth stages can be checked by sowing the rice varieties at different dates (Safdar *et al*., 2008). Rice plant required specific day length to shift from vegetative to reproductive phase because it is a photoperiod sensitive plant. Therefore, the duration of different growth stages of late sown (30th July) basmati varieties was negatively affected which ultimately reduced the grain yield. In early sown (1st July) basmati verities, heat stress at reproductive phase reduced the grain yield and total dry biomass (Safdar, *et. al*., 2013). Rauf *et al*., (2007) and Safdar *et al*., (2008) reported that early sowing dates reduced paddy yield due high temperature at reproductive phase. Hassan *et al*., (2003) and Pal *et al*., (1999) also reported that transplanting dates effected the paddy yield and yield related traits. Too early transplanting date (1st July) could hinder the crop growth due to more heat stress and low net effective accumulated temperature which ultimately reduced the grain yield. Moreover, 10th July and 20th July gave higher paddy yield due to more net effective accumulated temperature at reproductive growth stages.

Conclusion and recommendations

Transplanting date of basmati varieties of rice should be selected in such a way that their reproductive stage should match with favorable temperature because it ultimately enhances the grain yields. On the basis of this experiment we may recommend that Kissan Basmati transplanted on 10th July is the best option for the farmers in Agro Ecological Zone of Gujranwala to produce maximum grain yield.

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Table 1: Year wise mean monthly maximum and minimum Temperature (°C)

Year/Month	Year 2020		Year 2021		Year 2022	
	(Mean) Maximum (Temp)	(Mean) Minimum (Temp)	(Mean) Maximum (Temp)	(Mean) Minimum (Temp)	(Mean) Maximum (Temp)	(Mean) Minimum (Temp)
August	34.3	26.5	35.6	26.5	34.6	26.8
September	35.7	24.2	33.7	24.5	34.4	24.4
October	33.5	17.2	31.8	18.6	31.7	18.6

Source: Metrological Department Punjab

Table 2: Impact of different transplanting dates on basmati varieties of rice in agro-ecological zone of Gujranwala

	2020					2021					2022				
	1st July	10th July	20th July	30th July	Mean	1st July	10th July	20th July	30th July	Mean	1st July	10th July	20th July	30th July	Mean
Productive tillers (m^{-2})															
Super Basmati	344	353	352	335	346A	294	326	330	314	316A	300abcd	318ab	323ab	317ab	315A
Super Basmati-2019	306	324	324	328	321B	297	319	321	298	309AB	293bcd	320ab	301abcd	283cd	299B
Super Gold	280	288	291	306	291C	288	305	304	300	299B	304abc	315ab	299bcd	271d	297B
Kisan Basmati	267	279	259	240	261D	263	277	285	262	272C	313abc	329a	318ab	307abc	317A
Mean	299B	311A	307AB	302AB		286	307	310	294		303BC	321A	310AB	295C	
Filled Number of grains per panicle															
Super Basmati	98fg	102efg	112d	104ef	104C	107	111	115	107	110D	106	109	109	106	107B
Super Basmati-2019	97g	99efg	100efg	100efg	99D	118	121	122	116	119B	115	118	114	109	114B
Super Gold	105e	112d	112d	121c	112B	112	117	117	116	116C	108	109	107	105	107B
Kisan Basmati	132b	150a	151a	156a	147A	141	153	152	146	148A	130	133	128	123	129A
Mean	108C	116B	119A	120A		120B	126A	127A	121B		115	117	115	111	
1000-grains weight (g)															
Super Basmati	23	24	22	22	23C	22	22	21	20	21C	22	21	21	20	21C

Super Basmati-2019	24	24	25	24	24B	21	21	21	20	21C	22	21	21	20	21C
Super Gold	22	22	23	23	22C	23	23	23	23	23B	24	23	23	22	23B
Kisan Basmati	25	26	26	24	25A	24	24	24	23	24A	24	24	24	23	24A
Mean	23	24	24	23		23	23	22	22		23A	23A	22AB	21B	
Spikelet sterility %															
Super Basmati	11b	5e	7de	13a	9B	11bc	6i	6.7hi	11.7ab	9AB	10.5bcde	9.5defg	8h	11.5abc	9.8AB
Super Basmati-2019	8cd	8cd	9c	9bc	8B	8efghi	8efgh	8.3efg	9de	8.3BC	11abcd	8gh	9efg	11.8ab	10AB
Super Gold	8cd	5e	7de	7de	7C	9def	6.8ghi	7.1fghi	8.2efgh	7.6C	10def	8gh	9efg	10cdef	9B
Kisan Basmati	13a	6de	9bc	13a	10A	13a	7.0fghi	7.4efghi	10.2cd	9.3A	12a	8gh	9fgh	12a	10.4A
Mean	10A	6C	8B	10A		10A	7B	7B	10A		11A	9B	9B	12A	
Total dry biomass t ha^{-1}															
Super Basmati	16.86def	17.08def	17.21def	16.90def	17.01B	13.13j	14.30hij	14.95ghi	13.75ij	14.03C	15.30efg	16.24de	16.64d	16.16def	16.09B
Super Basmati-2019	15.52f	17.15def	18.07cde	18.85bcd	17.40B	17.11def	17.18de	15.42fghi	13.95ij	15.92B	16.20def	16.80d	15.92defg	14.95gh	15.97B
Super Gold	15.60f	16.29ef	16.73ef	17.89cde	16.63B	16.23efg	16.10efgh	15.38ghi	13.76ij	15.37B	16.06defg	15.94defgh	15.00fgh	13.88h	15.22C
Kisan Basmati	18.82bcd	22.10a	20.71ab	19.83bc	20.37A	21.60ab	22.43a	20.31bc	18.64cd	20.75A	20.77b	22.02a	21.28ab	19.24c	20.83A
Mean	16.70B	18.16A	18.18A	18.37A		17.02B	17.50A	16.52C	15.03D		17.08A	17.75A	17.21A	16.06B	
Grain yield kg ha^{-1}															
Super Basmati	4317hi	4347ghi	4473fgh	4260hi	4349BC	3167f	3443ef	3880d	3543def	3508B	3310f	3510ef	3717de	3350f	3472C
Super Basmati-2019	3830j	4280hi	4690ef	4940de	4435B	3317ef	3697de	3693de	3447ef	3539B	3770d	3950d	3710de	3313f	3686B
Super Gold	4020ij	4230hi	4300hi	4687efg	4309C	3580de	3693de	3654de	3587de	3629B	3730de	3730de	3523ef	3023g	3502C
Kisan Basmati	5123cd	6247a	5707b	5330c	5602A	4720c	5303ab	5563a	5047bc	5158A	5490b	6100a	5730b	5237c	5639A
Mean	4323B	4776A	4793A	4804A		3696C	4034B	4198A	3906B		4075C	4323A	4170B	3731D	

Figures sharing the same case letter, for a parameter, in a year do not differ significantly at $p = 0.05$

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