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Yield effect on succeeding lentil under rice-based cropping pattern due to different transplanting dates

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Abstract
This paper aims to determine the yield effect of lentil under rice-based cropping pattern by taking 3 varied transplanting dates *viz*. D_1: 10th July, D_2: 25th July and D_3: 10th August in major plots and 4 varieties *viz*. Tulaipanji, Khasa, Gobindobhog and Kalonunia in subplot in a design Split Plot Design at a farm of Uttar Banga Krishi Viswavidyalaya located at Pundibari, Cooch Behar, West Bengal (2016-2017 and 2017-2018). The two years average data showed that the crop transplanted on 10th July improved growth attributes (plant height, DMA, LAI, SPAD value), yield parameters (numbers of panicle m^{-2}, numbers of grain $panicle^{-1}$, 1000 grain weight), Yield (Grain and straw) of aromatic rice irrespective of the varieties. However, minimum data was revealed from a rice crop transplanting on 10th August. Regarding variety, 'Khasa' performed better in respect numbers of panicle m^{-2}, numbers of grain $panicle^{-1}$, Test weight (1000 grain weight), grain and straw yield. Growth parameters and grain yield of residual effect of succeeding lentil crop was observed maximum in plots transplanted at 10th July. However, Kalonunia variety transplanted plot recorded maximum yield of grain (1.135 t/ha) which was equivalent to the plot of Khasa variety (1.131 t/ha).

Keywords: Aromatic rice, date of transplanting, varieties, growth, yield, succeeding crop

Introduction
Rice is being grown in 117 countries and is consider as a main food for maximum percentage of the global population approximately around 70%. However, 90% of total area under rice is situated in wet tropical South and South-East Asia (Yumnam *et al*., 2015) [16]. At global level, an area under rice cultivation is about 163.2 M ha with a production of 719.7 MT. Among the rice growing countries, India is having the major share in area for rice in the world and in case of production it ranks second in the world, only after China. India produces about 120.32 MT from 42.62 MT with an usual productivity of 2.82 t/ha (FAO stat, 2014) [7]. At present, India is the world's largest rice exporting country (Ramakrishna *et al*., 2016) [14]. Amongst the varieties of rice, aromatic or else scented (fragrant) rice inhabits a leading site on version of its excellent quality characters and thereby having great export potentiality. Aromatic rice is very famous and exceedingly valued owing to its intrinsic smell, cooking appearances and had extended up to extremely observed in Indian civilization not only for the reason that of their outstanding quality but also because they had been considered propitious. It emits specific aroma in fields at the time of flowering, at harvest period, in packing even during milling, cooking and eating (Gibson, 1976; Efferson, 1985) [8]. Aroma is due to certain chemicals present in the endosperm and was recognized as 2-acetyl-1-pyrroline (Buttery *et al*., 1988) [2].
In India, West Bengal is a home of many unique varieties of non-basmati aromatic rice. All these traditional rice varieties are tall with weak stem, prone to lodging, photosensitive and having moderate to very strong aroma. They are susceptible towards diseases and pests and their cultivation is controlled to certain areas. However, each variety is extremely price in the locality where they are fully grown. In North Bengal and other part of North Eastern states, aromatic rice played a important part in a worldwide rice exchange system (Dwivedi, 1997) [5]. The issue of lower productivity of local aromatic rice is mainly due to improper time of sowing and lack of selection of appropriate variety suitable in a specific area which is the main mandates for maximizing quality rice production. Besides, very early or very late transplanted rice crop leads to decrease in yield owing to floret sterility and lesser number of productive tillers correspondingly (Nazir, 1994) [13]. Early period, the rice crop varieties were highly prone to photoperiod sensitivity which permit more in lag vegetative phases only,

leading to enhance in the height of the crop along with heavy biomass that are very vulnerable to lodge, mostly at the stage of grain filling. On the other hand, the reproductive stages of the delay transplanted rice crop agonizes owing to short temperature and from time-to-time panicle cannot appear accurately and some percentages persist in the sheath of the leaf and subsequently enhances sterility of the spikelet and give short production of the grain (Canet, 1986) [3]. The information for transplanting non-basmati aromatic varieties in optimum time is still lacking in this part of West Bengal. To exploit residual effect of different transplanting date in succeeding crop after harvest of rice and to enrich the soil in dry season, growing of subsequent pulse crop like lentil seems to be appropriate. Hence, an attempt was made to invent out best time of transplanting for obtaining satisfactory yield of non-basmati aromatic rice variety and following succeeding crop in this zone through this dissertation work.

Materials and Methods

This trial was led during 2017 and 2018 to study the effects of different transplanting date along with suitable cultivar in sandy loam soil of West Bengal at experimental farm of Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar. The soil of the investigational site stood acidic (pH 5.43), high in Organic carbon (0.73%), Nitrogen (183.47 kg ha^{-1}) and Potassium (102.3 kg ha^{-1}) content while Phosphorus (34.3 kg ha^{-1}) content was medium. The research was design in split plot with 3 different transplanting time of *viz*. D_1: 10th July, D_2: 25th July and D_3: 10th August in major plots and 4 varieties (Tulaipanji, Khasa, Gobindobhog and Kalonunia) in sub plots in the spacing of 20 x 15 cm and harvested on 17th November, 2nd December and 15th December in 2014 whereas in 2015, it was harvested on 16th November, 3rd December and 15th December. Just prior to transplanting, 20 kg N ha^{-1} is applied in the urea form; 20 kg P_2O_5 in the single super phosphate form and 20 kg K_2O ha^{-1} in the muriate of potash form were applied as basal at the period of last land preparation in all the plots irrespective of variety. Remaining 20 kg N ha^{-1} was applied at active tillering stage as top dressing. For both the respective years 2014 and 2015, pooled mean was calculated for every parameter recorded. The different growth parameters of rice were recorded at 30 days interval till upto 120 DAS. SPAD value was recorded at each interval by using SPAD meter from the leaves of selected five sample plants Yield attributing characters (number of effective tillers m^{-1}, numbers of panicle m^{-2}, panicle length (cm), numbers of filled grain $panicle^{-1}$, test weight) and Yield (straw and grain yield). The effect of the experiment was recorded according to the different date of transplanting, varieties and interaction between the different date of transplanting and varieties for every parameter.

In the succeeding lentil crop no fertilizer was applied and lentil variety "Moitree" was raised on residual fertility due to different in transplanting date following data such as growth parameters (plant height, number of nodules per plant), yield attributes (number of pods per plant, Test weight) and yield (grain and stover) was collected and calculated. Statistical analysis of all the collected data from the experiment was calculated on investigation of alteration system as recommended by Gomez and Gomez (1984) [10] at 5% level of probability.

Results and Discussion

Effects of date of transplanting and varieties on the growth parameter of rice

Data on rice growth parameters were noted at four stages i.e. 30, 60, 90 and 120 Transplanting Date. Most of the parameters was found to be significant accept at 30 DAT of LAI and CGR at 30-60 DAT and 90-120 DAT. Based on pooled analysis, plant height of rice crops transplanted on 10th July noted the maximum height of the plant at 90 Transplanting Date (124.9 cm) related it to late transplanting on 25th July (123.7 cm) and 10th August (118.8 cm). Early planted crops D_1 (10th July) produce the highest dry matter in 1 m^{-2} areas, CGR, LAI and spad value throughout the cropping period compared to delay transplanting D_2 (25th July) and D_3 (10th August) at entire phases of crop progress. Similar results aimed at early planting on 10th July were reported by Bali and Uppal (1995) [1]. Regarding varieties, Gobindabhog variety recorded tallest plant height i.e. V_3 (72.6 cm, 108.9 cm, 125.4 cm and 124.7 cm at 30, 60, 90 and 120 DAT) and shortest in the variety Tulaipanji i.e. V_1 (67.8 cm, 104.6 cm, 119.9 cm and 117.0 cm at 30, 60, 90 and 120 date of tranplanting). Maximum DMA (dry matter accumulation) at 30 DAT (162.70 g m^{-2}) and 60 DAT (352.08 g m^{-2}), Gobindobog variety recorded maximum whereas at 90 DAT (479.03 g m^{-2}) and 120 DAT (585.08 g m^{-2}), the variety Khasa found highest. Results reveals that in the data recorded at different stages, CGR were not found a single significant effect. LAI of Gobindobog variety at 30 DAT (1.148) reported highest and Khasa variety recorded maximum at 60 DAT (3.131), 90 DAT (3.114) and 120 DAT (2.041) while minimum was observed in Kalonunia variety at all stages. In case of Spad value recorded, Khasa variety reported highest in all the stages. The data relating to mutual effect of dates of transplanting and varieties given in the (Table 1 a and b) obviously directed that growth parameter was not prejudiced significantly.

Table 1 (a): Result of different transplanting date and variety on rice growth parameters

Date of transplanting	Plant Height (DAT)				DMA (g m-2) (DAT)				CGR (g m-2 day-1) (DAT)		
	30	60	90	120	30	60	90	120	30-60	60-90	90-120
	Pooled	Pooled	Pooled	Pooled	Pooled	Pooled	Pooled	Pooled	Pooled	Pooled	Pooled
D_1-10th July	73.1	108.7	124.9	123.1	160.65	351.51	477.64	585.27	6.36	4.2	3.59
D_2-25th July	70.1	106.6	123.7	121.1	156.31	347.53	471.74	576.71	6.37	4.14	3.5
D_3-10th August	67.4	104.2	118.8	118.5	152.09	342.63	464.22	565.92	6.35	4.05	3.39
S.Em±	1.04	0.54	2.2	2.03	0.664	0.49	0.993	1.44	0.032	0.041	0.051
CD (P=0.05)	4.1	2.12	N.S.	7.98	2.609	1.925	3.901	5.654	N.S.	0.161	N.S.
Variety											
V_1- Tulaipanji	67.8	104.6	119.9	117	149.13	339.67	461.37	561.79	6.35	4.06	3.35
V_2-Khasa	69.8	106.8	122.5	122.3	159.9	351.79	479.03	585.08	6.3	4.27	3.53
V_3-Gobindabhog	72.6	108.9	125.4	124.7	162.7	352.08	476.68	583.78	6.41	4.12	3.57
V_4-Kalonunia	70.7	105.6	121.7	119.3	153.68	345.34	467.72	573.23	6.39	4.08	3.52

S.Em±	1.3	1.16	1.945	1.49	1.307	2.705	2.297	2.123	0.085	0.046	0.125
CD(P=0.05)	3.87	3.45	N.S.	4.42	3.884	8.038	6.826	6.307	N.S.	N.S.	N.S.
IE(AB)											
S.Em±	2.26	2.01	3.37	2.57	2.264	4.686	3.979	3.677	0.147	0.08	0.216
CD(P=0.05)	N.S.										

***DMA: Dry Matter Accumulation; CGR: Crop Growth Rate; IE: Interaction effect; N.S.: Non-significant

Table 1 (b): Results of different transplanting date and variety on rice growth parameters

Date of transplanting	LAI (DAT)				SPAD Value (DAT)			
	30	60	90	120	30	60	90	120
	Pooled	Pooled	Pooled	Pooled	Pooled	Pooled	Pooled	Pooled
D_1-10th July	1.141	3.092	3.05	1.998	37.8	41.6	33.1	29.9
D_2-25th July	1.138	3.087	3.04	1.994	34.8	37.7	31.13	28.61
D_3-10th August	1.137	3.08	3.035	1.989	33.15	35.55	28.67	27.61
S.Em±	0.002	0.003	0.003	0.005	0.300	0.335	0.333	0.334
CD (P=0.05)	N.S.	0.011	0.011	0.019	1.179	1.309	1.303	1.307
Variety								
V_1- Tulaipanji	1.135	3.044	2.981	1.952	30.7	35.7	26.4	23.7
V_2-Khasa	1.14	3.131	3.114	2.041	33.7	37.5	30	26.1
V_3-Gobindabhog	1.148	3.128	3.111	2.037	32.7	37.1	28.7	25.8
V_4-Kalonunia	1.131	3.041	2.961	1.945	31.8	36.2	27.3	24
S.Em±	0.002	0.003	0.004	0.005	0.457	0.287	0.476	0.502
CD(P=0.05)	0.007	0.009	0.011	0.015	1.357	0.852	1.414	1.492
IE (AB)								
S.Em±	0.004	0.005	0.006	0.009	0.791	0.497	0.824	0.870
CD(P=0.05)	N.S.							

***LAI: Leaf Area Index; IE: Interaction Effect; N.S.: Non-significant

Effects of transplanting date and varieties on the attributed character of Yield and yield of rice

The 10th July transplanted Crop i.e. D_1 indicate highest in the number of effective tillers m^{-2} (323), panicles m^{-2} (275), filled grain $panicle^{-1}$ (151.99) along with panicle length (25.50 cm), test weight (21.3), grain yield (2.44 t/ha), straw yield (5.41 t/ha) and lastly the harvest index (31.05%) of aromatic rice followed by 25th July (D_2) and was significantly affected accept the panicle length. It is apparent from the statistics (Table 2) that there was extreme lessening in the production with late date of transplanting i.e. 10th August. These outcomes were in promise with the outcome of Dhiman *et al*., 1995, Kumar *et al*., 1998, Nayak *et al*., 2003 [4, 11, 12].

From the results it was revealed that there is a significant variation in the yield parameters owing to the different varieties throughout the two years. Among the four varieties, Khasa noted highest in the number of effective tillers m^{-2} (306), panicles m^{-2} (240), filled grain $panicle^{-1}$ (138.68) along with the panicle length (25.00 cm), test weight (21.87), grain yield (2.38 t/ha) and harvest index (31.51%) which was closely followed by Gobindobog by obtaining highest in yield of straw (5.18 t ha^{-1}) and minimum were reported in Tulaipanji variety *viz*. the number of effective tillers m^{-2} (221), number of panicles m^{-2} (178), number of filled grain $panicle^{-1}$ (117.61), panicle length (24.20 cm), test weight (20.61), grain yield (1.91 t/ha), straw yield (4.66 t/ha) and harvest index (29.18%), respectively. It can be observed from table 2 that yield parameters was not pretentious significantly when judged over the collaboration of varieties and transplanting dates except the number of panicles m^{-2}. Investigation of variance revealed that transplanting date and varieties on the yield attributes and yield except number of panicles m^{-2} was found to have non-significant interaction.

Table 2: Result of different transplanting date and variety on rice yield attributes and yield-

Date of transplanting	No. of tillers m^{-2}	No. of Panicles m^{-2}	Panicle length (cm)	No. of filled grains $panicle^{-1}$	1000 Grain weight (g)	Grain Yield (t/ha)	Straw yield (t/ ha)	Harvest Index (%)
	Pooled	Pooled	Pooled	Pooled	Pooled	Pooled	Pooled	Pooled
D_1-10th July	323	275	25.50	151.99	21.3	2.44	5.41	31.05
D_2-25th July	267	216	25.20	125.83	21.2	2.21	5.01	30.62
D_3-10th August	193	132	24.70	104.27	21.2	1.85	4.51	29.62
S.Em±	14.71	10.61	0.40	3.56	0.03	0.013	0.025	0.196
CD (P=0.05)	57.74	41.67	N.S.	13.99	0.09	0.053	0.097	0.771
Variety								
V_1- Tulaipanji	221	178	24.20	117.61	20.61	1.91	4.66	29.18
V_2-Khasa	306	240	25.00	138.68	21.87	2.38	5.17	31.51
V_3-Gobindabhog	278	219	24.50	131.79	21.72	2.31	5.18	30.84
V_4-Kalonunia	246	195	26.80	121.36	20.81	2.07	4.89	29.82
S.Em±	12.86	9.47	0.50	2.49	0.13	0.027	0.046	0.34
CD(P=0.05)	38.20	31.13	1.40	7.39	0.39	0.08	0.137	1.01
IE (AB)								
S.Em±	22.27	16.40	0.80	4.31	0.23	0.047	0.08	0.59
CD(P=0.05)	N.S.	48.73	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.

*** IE: Interaction Effect; N.S.: Non-significant

Table 3: Results of different transplanting date and variety on lentil growth parameter, yield attributes and yield-

Date of transplanting	Plant Height (cm)	Number of nodules/plant	Number of pods/plant	1000 grain weight (Test weight) (g)	Grain yield (t/ha)	Stover yield (t/ha)
	Pooled	Pooled	Pooled	Pooled	Pooled	Pooled
D_1-10th July	35.67	19.891	47.78	17.66	1.133	9.759
D_2-25th July	35.37	19.077	46.22	17.55	1.123	9.618
D_3-10th August	35.3	18.625	42.31	17.23	1.114	9.568
S.Em±	0.219	0.312	1.401	0.031	0.007	0.031
CD (P=0.05)	N.S	1.224	5.502	0.11	0.029	0.122
Variety						
V_1- Tulaipanji	35.47	18.279	44.82	17.38	1.119	9.629
V_2-Khasa	35.48	20.191	45.99	17.75	1.131	9.686
V_3-Gobindabhog	35.3	18.166	43.33	17.31	1.111	9.614
V_4-Kalonunia	35.51	20.156	47.55	17.5	1.135	9.664
S.Em±	0.365	0.29	0.925	0.311	0.005	0.027
CD(P=0.05)	N.S	0.861	2.748	0.181	0.016	0.08
IE (AB)						
S.Em±	0.632	0.502	1.602	0.539	0.009	0.047
CD(P=0.05)	N.S					

*** IE: Interaction Effect; N.S.: Non-significant

Effects of date of transplanting and varieties on the growth parameter, yield attributes and yields of lentil

Results (Table 3) discovered that maximum of the parameters in growth and yield attributing characters in lentil was significantly difference among dates of transplanting except the plant height. Timely transplanted plot (10th July) observed highest Plant height (35.67 cm), number of nodules/plant (19.891), number of pots/plant (47.78) and 1000 grain weight (17.66 g) while lower in delay transplanted plot (10th August) i.e. Plant height (35.30 cm), number of nodules/plant (18.625), number of pots/plant (42.31) and 1000 grain weight (17.23 g). Grain yield of lentil was found to be increased by 0.89 and 1.71% over the plots transplanted in 10th July compared to rice crops transplanted on 25th July and 10th August. The increase in grain yield of lentil could be attributed to timely sowing of lentil after early harvesting of rice. This finding is in conformity with that of Gupta and Bhowmick, 2005 and Tripathi, 1986. In this experiment, the plot Khasa and Kalonunia variety accomplished well compared to Gobindobog and Tulaipanji plot. In the performance of the experiment, Kalonunia variety plot Plant height (35.51), number of pods/plant (47.55) and Grain yield (1.135 t/ha) was examined to be uppermost whereas in Khasa variety plot Number of nodules/plant (20.191), Test weight (17.75 g) and Stover yield (9.686 t/ha) observed maximum. There was no significant interaction between transplanting dates and different varieties towards growth parameter, yield attributes and yields of lentil**.**

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