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IMPACT OF DIFFERENT SOWING METHODS ON GROWTH AND YIELD ATTRIBUTES OF DIRECT-SEEDED RICE *(ORYZA SATIVA* L.) IN ALLUVIAL SOILS OF PUNJAB, INDIA

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Abstract

Rice is a major food crop for the people of the world and especially in Asian countries. It is a staple food for majority of the population residing in Asian continent. Rice is a short-day summer season crop grown under diverse climatic and edaphic conditions. It grows well in humid tropical regions with high temperature and high rainfall. From many years continuous use of rice- wheat cropping system specially in the non-conventional north Indian states especially Punjab and Haryana has led to depleted ground water levels. So, this research was conducted during *kharif* season of 2016 to find the effect of different methods of sowing on yield and yield attributes in direct seeded rice. Three sowing methods employed were 1. Dry broadcasting 2. Sprouted wet broad casting and 3. Line sowing. The rice varieties used were Pusa1121 and Basmati 1509. The results showed that higher paddy yield was obtained in line sowing method with both varieties as compare to other sowing methods.

Key words*:* Rice, Sowing methods, sandy loam, Yield.

Introduction

Rice is an important cereal crop after wheat in India. It is a self-pollinated crop and belongs to Graminae family. It occupies 28.51 lakh hectares with total production of 169.1 lakh tones of paddy during 2013-14. The average yield of paddy was 23.7 quintals per acre, *i.e.* 59.3 quintals per hectare (Anonymous, 2015). There are minimum 114 countries growing rice and more than 50 countries have an annual production of 0.1 million tonnes (Mt) or more (FAO, 2010). The largest producer of rice is china followed by India in second position. West Bengal, Uttar Pradesh, Telangana, Punjab, Bihar, Chhattisgarh, Tamil Nadu, Haryana are the major Rice growing states of India and West Bengal is at first position in the production followed by Punjab on the 4th Position. In 2015, 30.78 lakh tonnes of basmati rice was produced in Punjab state which was cultivated on 7.63 lakh hectares of land. 19-20 lakh tons of basmati rice production is being expected from Punjab by the end of 2016.

Basmati Rice depicts those varieties of rice that have characteristic aroma and pleasant flavor after cooking. It has long slender grains having a length: breath ratio of around 3.5, sweet and aromatic taste, small curvature and an extra elongation with very less breadth-wise swelling on cooking (Hussain *et al.,* 2009). The Basmati known as 'Pearl of India' and has high commercial value in the national and international market. It is grown in north and north-western part of Indian subcontinent since ages. Indus river banks produce high quality of basmati rice since centuries due to fertile soils.

There are three methods of sowing rice 1. Line sowing 2. Puddled wet sowing, and 3. Transplanting. In dry seeding, we broadcast or dribble the seed into dry soil. In wet seeding, we sow pre-germinated seeds into well puddled soil (Rana *et al.,* 2013). Whereas in transplanting we replant rice seedling that we had grown in nurseries. The dry and wet sowing methods are included in DSR. Due to rising labour expenses, more and more demand for water, need for crop, farmers are shifting from conventional methods to DSR rice as it have several plus points over conventional methods (Shen *et al.,* 2013). Direct seeding can reduce labor expenses by above 60% (Das *et al.,* 2009). The labour does not care of the spacing between plants and results are plant population

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remains lower to meet the needs of water supply to the crops at this stage when the availability of water is very less we must now switch to methods which use less water and matures quickly. Taking this in to consideration farmers and agricultural universities in India are shifting to direct seeded technology rather than to transplanting methods. Further this technology ensures sowing at a stipulated time period. An important factor that determines the uniform crop stand and better germination is the sowing methods. The sowing and spacing later in stages of growth determines the weed population in the field. Therefore, a proper method of sowing is very important for flowering, growth, germination, proper tillering to get a good yield at last (Yadav *et al*., 2005). Thus, we must know the morphological features and growth rate factors of a variety before planting. The morphology and growth rate of a cultivar is another important aspect, which can significantly affect the development of both the crop and weed.

Materials and Methods

The research was conducted at agricultural research farm of Lovely Professional University, Phagwara, Punjab during the months of June – October 2016 in the *kharif* season ,geographically situated at 31º15.491'N, 75º42.476' E with an altitude of 252m above mean sea level, which falls under central plain zone of agro climatic zone of Punjab. The experimental soil is sandy loam with Sand (75%), Silt (10.3), Clay (14.7)%. Soil pH (7.5-8). Available phosphorous 16.84-18.84 (kg/ha), available potassium (540-625), Iron 7.5 (kg/ha). The experiment was laid in Randomised complete block design with a total area-250m² with total of six treatments and three replications with total of eighteen plots with dimensions of 2×3m and 0.5m bunds and two 1m water channels.

Two varieties of rice were used in the research trial. Pusa 1121 and Basmati 1509. Usage of farm yard manure was done at the time of primary tillage. 550 kg of FYM was used and incorporated by mixing well in slight moist conditions. DAP, $ZnSo_4$ and MOP was applied in the seedbeds as basal dose as per recommendations. Urea was the source of nitrogen and was applied in two split doses; the 1st was applied 21 days after sowing and 2nd was applied at 45 days of sowing. Pendimethalin 30% EC @ 3.5 L/ha was used as pre-emergence to avoid any weeds from emerging. Bispyribac sodium 10% SC@ 200 ml/ha as post emergence weedicide was also used in addition to two hand weeding done at 25 and 45 days after sowing.

Results

The plant height was maximum in line sowing. The plant height of Pusa 1121+line sowing $\mathbf{T_1}$ at 38.80cm as well as basmati 1509 + line sowing ($\mathbf{T_4}$) at 38.08was highest from date of sowing till harvest. The lowest height was seen in dry broadcasting methods, in both the varieties. *i.e.* $\mathbf{T_6}$ (Pusa 1121 + dry broadcasting) at 36.06cm and followed by T_5 (basmati + dry broadcasting), at 37.06cm. $\mathbf{T_4}$ shows only 1.84% decrease from $\mathbf{T_1}$. However, the $\mathbf{T_6}$ shows 7.06% decrease from $\mathbf{T_1}$. The results obtained so were due to better germination in the line sowing methods due to better placement of seeds at a depth of 5cm depth and proper spacing which resulted in reduced competition for moisture conditions. The wet puddled broadcasting showed less results comparatively because the sowing was shallow are randomly scattered which lead to reduced germination. The results are with confirmation of the findings of Yadav *et al*., (2005) in which the un-puddled direct seeded rice gave poor results.

Plant height at 45 DAS

The height of plant was higher in $\mathbf{T_1}$ at 63.79cm followed by $\mathbf{T_4}$ at 62.71cm. the $\mathbf{T_1}$ and $\mathbf{T_4}$ are significant. The percentage decrease of $\mathbf{T_4}$ from $\mathbf{T_1}$ was only 1.69%. However, the $\mathbf{T_6}$ shows reduction of 13.41%. Pusa 1121 shows better results with line sowing in comparison to Basmati 1509. Pusa 1121 shows more height at 45 days. The plants were affected both with the variety and sowing method. In this the line sowing continued to have more values and also at 45, 60, 75 DAS which may be due to the better line spacing and more availability of solar radiations to every plant. Further the root surface area was maximum and better uptake of nutrients was there.

Plant height at 45 DAS

SL.No.	Treatments	30 DAS	45 DAS	60 DAS	75 DAS
1	Pusa 1121+line sowing	$38.80^{a}\pm0.40$	$63.79^{a}\pm0.25$	$96.58^{a}\pm0.35$	$113.43^{ab}\pm1.96$
2	Pusa 1121 +broadcasting	$36.93^{d}\pm0.17$	$58.65^{b}\pm0.23$	$89.20^{c}\pm1.21$	$109.47^{abc}\pm0.99$
3	Pusa 1121 + wet sowing	$37.66^{c}\pm0.46$	$59.31^{b}\pm1.95$	$92.53^{b}\pm0.24$	$109.80^{abc}\pm0.50$
4	Basmati 1509+ line sowing	$38.086^{b}\pm0.35$	$62.71^{a}\pm0.14$	$96.37^{a}\pm0.32$	$114.13^{a}\pm0.53$
5	Basmati 1509+ wet sowing	$36.06^{d}\pm0.26$	$55.57^{c}\pm0.75$	$86.23^{d}\pm.21$	$103.2^{c}\pm0.11$
6	Basmati 1509 + broadcasting	$36.06^{d}\pm0.66$	$55.24^{c}\pm0.29$	$85.80^{d}\pm0.50$	$106.96^{c}\pm04.3$

Number of tillers/hill at 30, 45, 60, 75 DAS

SL.No.	Treatments	30 DAS	45 DAS	60 DAS	75 DAS
1	Pusa 1121+line sowing	$6.26^{ab} \pm 0.17$	$13.12^{a} \pm 0.09$	$17.19^{a} \pm 0.35$	$18.94^{a} \pm 0.41$
2	Pusa 1121 +broadcasting	$6.13^{abc} \pm 0.17$	$11.66^{ab} \pm 0.24$	$15.00^{c} \pm 0.70$	$180^{b} \pm 0.50$
3	Pusa 1121 + wet sowing	$5.6^{cd} \pm 0.30$	$11.26^{b} \pm 0.15$	$15.73^{bc} \pm 0.37$	$16.01^{a} \pm 0.20$
4	Basmati 1509+ line sowing	$6.53^{a} \pm 0.17$	$12.86^{ab} \pm 0.17$	$16.59^{ab} \pm 0.19$	$16.93^{a} \pm 0.17$
5	Basmati 1509+ wet sowing	$5.73^{bcd} \pm 0.06$	$9.30^{c} \pm 0.17$	$11.23^{cd} \pm 0.12$	14.4b± 0.50
6	Basmati 1509 + broadcasting	$5.26^{d} \pm 0.17$	$8.93^{c} \pm 0.17$	$11.40^{d} \pm 0.30$	$13.20^{c} \pm 0.22$

Number of tillers/hill at 30, 45, 60, 75 DAS

The tillers/hill is significant in T_4 at 6.53/hill in Basmati 1509+ line sowing. The T_4 shows a decrease of 4.13% from T_1. However a significant decrease of 15.97% from T_1. The plant height was more in T_1 and T_4. The reason may be the line spacing provides more area to the plant for better uptake of nutrients. Further the proper spacing enhances the solar radiation absorption by the spatial plant for more development of the tillers. Similar results were found at 45, 60, 75 DAS. The results are also given by Hussain *et al.,* (2009) in which the number of productive tillers are more in line-sowing method of DSR.

Number of leaves /hill at 30 DAS

The number of leaves /hill is significant at T_1 and T_2 with 9.23 and 8.65 leaves /hill respectively. The %age decrease of T_4 from T_1 is 10.07%. The T_5 has least number of leaves 7.53 with % decrease of 18.4 % from T_1. At 45 DAS the T_4 was 32.80 with % increase of 2.4 from T_1. The T_6 shows lowest number with 32.06 % decrease. The T_4 shows significant results at 47.73 with 15.35% increase from T_1. The T_6 is lowest with value of 31.36 with 22.37% decrease from T_1. The more leaves per hill was seen in Line sowing methods because of better sunlight and nutrient availability status. The better spacing increased the surface area of the plant, which increased leaf number due to sustainable conditions. The results found are in confirmation of the findings of Yadav *et al*., (2005) in which the un-puddled direct seeded rice gave poor results in comparisons to the line sowings.

Grain yield

The grain yield was significant at T_1 and T_4 at 4771.7 and 4668.7 respectively the T_4 has 2.15% decrease from T_1. The lowest was seen in T_6 at 3825.3 which were 19.83% less than T_1. The grain yield was significantly affected by the sowing methods effect on the varietal response. Both the varieties *viz*. Pusa 1121 and Basmati 1509 showed positive effect of line sowing with 20 cm row to row spacing and 5 cm depth placement. While as the yield was minimal in dry broadcasting because the overcrowding of the seeds and shallow placement of the seeds which in later stages leads to less root development and poor nutrient uptake. The results are in confirmation with the findings of Singh and Gandhi (2014) in which

Number of leaves /hill at 30 DAS

SL.No.	Treatments	30 DAS	45 DAS	60 DAS	75 DAS
1	Pusa 1121+line sowing	$9.23^{a} \pm 0.68$	$32.00^{fab} \pm 1.20$	$40.4^{b} \pm 3.14$	$54.33^{g} \pm .26$
2	Pusa 1121 +broadcasting	$8.65^{a} \pm 0.02$	$29.06^{bc} \pm 0.24$	$42.0^{b} \pm 0.19$	$47.86^{f} \pm 0.76$
3	Pusa 1121 + wet sowing	$6.66^{b} \pm 0.58$	$30.86^{ab} \pm 0.24$	$47.00^{a} \pm 0.50$	$54.40^{e} \pm 0.34$
4	Basmati 1509+ line sowing	$8.30^{b} \pm 0.20$	$32.80^{a} \pm 1.41$	$47.73^{a} \pm 0.46$	$55.66^{e} \pm 0.24$
5	Basmati 1509+ wet sowing	$7.53^{b} \pm 0.43$	$26.06^{c} \pm 1.79$	$31.60^{c} \pm .23$	$35.46^{d} \pm 0.67$
6	Basmati 1509 + broadcasting	$8.13^{b} \pm 0.73$	$21.73^{d} \pm .24$	$31.36^{e} \pm 1.65$	$33.93^{b} \pm 1.33$

Grain yield

SL. No.	Treatments	Grain yield kg/ha	Straw yield kg/ha
1	Pusa 1121+ line sowing	$4771.7^{a} \pm 30.33$	$5664.1^{a} \pm 40.27$
2	Pusa 1121 + broadcasting	$4450.3^{b} \pm 47.16$	$5293^{b} \pm 34.44$
3	Pusa 1121 + wet sowing	$4470.71^{b} \pm 37.39$	$5302^{b} \pm 49.00$
4	Basmati 1509+ line sowing	$4668.7^{a} \pm 23.24$	$5612.7^{a} \pm 92.12$
5	Basmati 1509+ wet sowing	$3988.3^{c} \pm 69.54$	$4639.3^{c} \pm 122.84$
6	Basmati 1509 + broadcasting	$3825.3^{c} \pm 89.51$	$4635^{c} \pm 103.719$

the Pusa 1121 and Basmati 1509 both are well suited for DSR. Pusa 1121 gave more profuse tillers and good yield but Basmati 1509 was recommended to farmers due to early maturity.

Straw yield

The T_4 shows significant results at 5612.7 with the 0.92% increase from T_1. The T6 has lowest results at 4635 at 18.17% decrease from T_1. The straw yield was maximum in plants which showed better growth that was found in line sowing methods and almost similar in both the cultivars. The straw yields showed the direct proportion with the grain yields obtained. The more grains were obtained from T_1 and T_4 and so was the straw yield. The reasons were well developed plants with more tillers and leaves. Which in turn lead to more straw from the plants. The plants developed well in line sowing due to better growing conditions as compared to broadcasting method of sowing. The researchers Singh and Gandhi (2014) also found that straw yields were more in these varieties because of lodging resistance and taller plants which leads to more accumulation of dry matter.

Test weight

The significant results are seen in T_1 and T_4, with values equal to 24.30gm and 24.12gm. T_4 showing 2.58% decrease from T_1. However, T_6 shows a 13.38% decrease from T_1. The test weight was found to be more in plants which were healthy and had better plant growth parameters. The test weight was maximum in T_1 which followed line sowing method. Both varieties responded well to this sowing method, which increased yield and in turn the test weight. The results finding Das *et al., (*2009) showed that puddled sowing and line sowings have more potential in comparison to broadcasting.

SL. No.	Treatments	1000 Kernel wieght (g)	% decrease over recommended
1	T_1-Pusa 1121 +line sowing	$24.80^{a} \pm 0.47$	
2	T_2-Pusa 1121 +broadcasting	$22.38^{b} \pm 0.64$	9.70%
3	T_3-Pusa 1121 + wet sowing	$22.04^{b} \pm 0.33$	11.12%
4	T_4-Basmati 1509 + line sowing	$24.16^{a} \pm 0.42$	2.58%
5	T_5-Basmati 1509 + wet sowing	$21.41^{b} \pm 0.17$	13.66%
6	T_6-Basmati 1509 + broadcasting	$21.48^{b} \pm 0.19$	13.38%

Filled grains

The filled grains show T_1 as significant with value of 87.09. T_4 shows a little 0.61% decrease from T_1. However, T_5 shows a 13.12% decrease from T_1. The more the number of filled grains the more is the suitability of the variety in that sowing methods. The broadcasting methods had least filled grains which may be due to poor availability of the nutrients and solar radiation to the plants, which lead to poor grain filling in later stages of line. It was not in case of line sowing, in which better radiations and nutrient uptake and spacing was available as shown from positive result of T_1 and T_4.

SL. No.	Treatments	Filled Grains /penicle	% decrease over recommended
1	T_1-Pusa 1121 +line sowing	$87.09^{a} \pm 0.32$	
2	T_2-Pusa 1121 +broadcasting	$84.49^{b} \pm 0.25$	2.98%
3	T_3-Pusa 1121 + wet sowing	$84.77^{b} \pm 0.28$	2.66%
4	T_4-Basmati 1509 + line sowing	$86.56^{ab} \pm 0.28$	0.61%
5	T_5-Basmati 1509 + wet sowing	$75.66^{c} \pm 1.45$	13.12%
6	T_6-Basmati 1509 + broadcasting	$76.42^{c} \pm 0.8$	12.25%

Panicle length

The T_1, T_2, T_4 shows significant results. The maximum found in T_1 with value of 22.76 and T_4 at 22.50. The least is seen in T_6 with 19.36cm. The best results were seen in treatments using line sowing methods. The broadcasting didn't show positive results because of less plant height which later lead to reduced length of panicle.

SL. No.	Treatments	Panicle length (cm)	% increase over recommended
1	T_1-Pusa 1121+ line sowing	$22.76^{a} \pm .14$	
2	T_2-Pusa 1121 +broadcasting	$21.60^{a} \pm 0.75$	5.09%
3	T_3-Pusa 1121 + wet sowing	$21.82^{a} \pm 0.60$	4.13%
4	T_4-Basmati 1509 + line sowing	$22.50^{a} \pm 0.27$	11.42%
5	T_5-Basmati 1509 + wet sowing	$19.85^{b} \pm 0.15$	12.78%
6	T_6-Basmati 1509 + broadcasting	$19.36^{b} \pm 0.34$	14.90%

Harvest Index

The table shows significant results for every treatment. However, the T_1 shows highest result at 45.88

Q/ha. The T_6 shows lowest at 45.20Q/ha. The T_4 shows a 0.78% decrease from T_1. The best results were found in line sowing in both Pusa 1121 as well as basmati 1509. The broadcasting showed relatively low results in both the varieties. The harvest was effected by the plant growth parameters such as the plant height, the number of leaves, panicle length and the filled grains. The line sowing showed better results in terms of plant growth parameters which in turns affected the yield of the crop. The T_1 and T_4 showed better plant growth parameters and later better yield due to better line spacing of 20 cm line to line and 5 cm plant to plant spacing. The depth of sowing around 4-5 cm deep effected the plant establishment at early stages. Further the varietal response showed better response with line sowing than any other method of sowing. The findings of Shen *et al., (*2013) also gave that line- sowing reduced the labour cost and increased the benefit.

SL. No.	Treatments	Harvest Index (%)	% increase over recommended
1	T_1-Pusa 1121+ line sowing	$45.88^{a}\pm$	0.18
2	T_2-Pusa 1121 +broadcasting	$45.51^{a}\pm0.20$	0.81%
3	T_3-Pusa 1121 + wet sowing	$45.74^{a}\pm0.43$	0.31%
4	T_4-Basmati 1509 + line sowing	$45.52^{a}\pm0.48$	0.78%
5	T_5-Basmati 1509 + wet sowing	$45.57^{a}\pm0.44$	0.67%
6	T_6-Basmati 1509 + broadcasting	$45.20^{a}\pm0.76$	1.48%

Conclusion

It has been observed from the experiments that treatment T_1 (Pusa 1121 +line sowing) showed the best values as compared to all the other treatments. The method of sowing shows the significant impact on the growth and yield parameters as depicted on the final yield. Treatment T_4 (Basmati 1509 + line sowing) also showed similar results which may be due the positive varietal difference with different sowing methods. Further, the molecular level research may be required to evaluate the variety and yield correlations.

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