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Performance of wheat genotypes under different row spacing in New Alluvial Zone of West Bengal

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West Bengal is not a traditional wheat growing state in India. However, at present wheat has become a staple food crop next to rice and its consumption is gradually increasing because of changing in food habit and economic prosperity. In spite of a wide range of adoptability, little attention has been paid towards wheat production and maximization of yield potential of this crop in West Bengal and its share to national production is less than 1%. Productivity of 2.8 t ha^{-1} is also far below the national average of 3.14 t ha^{-1} (Anon., 2013). Since wheat is a major cereal crop and population is gradually increasing with time, increasing its production and acreage should be given top priority in order to achieve food and nutritional security in the state. However, success of any crop production depends on the use of appropriate and selectivity of location-specific genotype/variety of high yield potential, and additionally improved cultural practices is an imperative part, may not be ignored.

Among the agronomic practices spacing plays a significant role in maximizing the crop yield as well as productivity. Inter row spacing is very important for proper distribution of plants over cultivated area and for better utilization of available soil and natural resources (Mali and Choudhury, 2012). Planting distance effects crop yields as it not only determines the optimum crop stand but also ensures the feasibility and effortlessness of using inter tillage devices for sufficient weed control and conservation of soil moisture. In addition, proper row spacing is important for maximizing light interception, penetration, light distribution in crop canopy and average light utilization efficiency of the leaves in the canopy and thus affects yield of a crop (Hussain *et al.*, 2003).

Keeping this in view, the present investigation was undertaken during the winter season of 2012-13 to evaluate the effect of different row spacing on growth, yield components and yield of wheat genotypes under new alluvial zone of West Bengal.

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The field experiment was conducted at the University Research Farm of Bidhan Chandra Krishi Viswavidyalaya, Kalyani, Nadia, West Bengal during winter season of 2011-12 in upland situation. The farm is situated at approximately 22°56′ N latitude and 88°32′ E longitude with an elevation of 9.75 m above mean sea level (MSL). The soil of the experimental field was loamy in texture and almost neutral in reaction having pH 7.1 with the presence of organic carbon 0.41% and available nitrogen 228.0, available phosphorus 24.0 and available potassium 230.0 kg ha^{-1}, respectively. The experiment was carried out in a strip plot design with three wheat genotypes (K 0307, HD 2733 and DBW 39) and four row arrangements (15.0, 17.5, 20.0 and 22.5 cm), replicated thrice. Wheat genotypes were assigned to three horizontal strips and spacings were assigned to four vertical strips. The size of plots was 10.8, 12.6, 14.4 and 16.2 m^2 for line spacing of 15.0, 17.5, 20.0 and 22.5 cm, respectively. The length of each plot was 8 m (nine rows of wheat). The sowing of crop was done on 25th November, 2012 using recommended seed rate of 100 kg ha^{-1} and 150 kg N, 60 kg P_2O_5 and 40 kg K_2O ha^{-1}, respectively. All the genotypes of wheat were harvested on 29th March, 2012. The data pertaining to growth, yield attributes and yield were analyzed statistically as per the methods suggested by Gomez and Gomez (1984).

Growth attributes

Genotypes

A perusal of data on leaf area index (LAI) presented in table - 1, reveals that the LAI was significantly affected by both wheat genotypes and row spacing. LAI varied from 2.38 to 3.04 at 55 and 2.76 to 3.75 at 70 days after sowing (DAS). Among the genotypes the mean maximum values were observed in K 0307 (3.04 and 3.75 at 55 and 70 DAS, respectively) followed by HD 2733 and DBW 39.

Variability among the genotypes on tiller number was statistically non-significant, but the genotype HD 2733 recorded relatively higher number of tillers m^{-2}

(435.1) closely followed by K 0307 (419.6) and the least was recorded in DBW 39 (385.7). The results indicated that inherent tillering potential per unit area of HD 2733 was relatively higher than that of K 0307 and DBW 39.

Wheat genotypes had significant effect on days to 50% heading (Table 1). Among the genotypes, K 0307 took minimum period (63.6) for 50% heading, which was followed by DBW 39 (71.3), whereas the maximum duration (74.5) was observed in case of HD 2733. Varietal character of genotypes might be the reason for difference in crop duration for attaining 50% heading (Tewari and Singh, 1995). The variation of genotypes was statistically significant with regard to the days required for attaining physiological maturity. Among all the genotypes, K 0307 took minimum period (110.0) for attaining physiological maturity followed by DBW 39(112.7), whereas the maximum duration (114.7) was observed in wheat genotype HD 2733. Genetic character of genotypes might be the reason for difference in duration for attaining their physiological maturity.

Row spacing

Narrow (15.0 cm) row spacing recorded the higher values of LAI as compared to other row spacing. The highest values (3.0 and 3.36) were recorded in 15.0 cm spacing at 55 and 70 DAS, respectively whereas the least values (2.48 and 2.76) were recorded from 22.5 cm spacing. The results are in consistent with the findings of Angiras and Sharma (1996), who noted that the closer spacing of 15.0 cm increased LAI significantly over 20.0 cm spacing, because of its influence in reducing the weed biomass and weed growth rate and increasing CGR of the crop. Chatha and Nazir (1985) had also reported similar results.

As regards row spacing, number of tillers m^{-2} was significantly higher (484.0) in 15.0 cm row spacing as compared to other row spacing. These results confirm the findings of Ahmad *et al.* (1999) who reported that narrow row spacing produced significantly more tiller m^{-2} (Table 1). However, days to 50 % heading was not affected significantly by alternation of row arrangement. The result is in conformity with the observation of Bakht *et al.* (2007). On the other hand days to physiological maturity was not affected significantly due to alternation of row configuration.

Yield attributes and yield

Genotypes

The difference among the wheat genotypes had been found be statistically not-significant, which indicated that inherent tillering potential of the genotypes were almost similar (Table 2). However, Genotype K 0307 recorded the highest mean ear head m^{-2} (301.4) as compared to HD 2733(297.2) and DBW 39(283.6).

The data presented in the table 2 show that the genotypes did not differ significantly among themselves; however, K 0307 recorded higher value of grains ear $head^{-1}$ (41.3) than other two genotypes, DBW 39 and HD 2733 which followed trend in deceasing order. HD 2733 recorded higher 1000 grain weight (43.8 g) followed by DBW 39 (41.9 g) and K 0307 (40.8 g). However, the difference amongst the

Table 1: Effect of row spacing on the growth attributes of wheat genotypes

Treatment	LAI		No. of tillers	Days to 50%	Days to physiological
	55 DAS	70 DAS	m^{-2}	heading	maturity
Genotypes					
K 0307	3.04	3.75	419.6	63.6	110.0
HD 2733	2.85	3.20	435.1	74.5	114.7
DBW 39	2.38	3.11	385.7	71.3	112.7
SEm (±)	**0.04**	**0.07**	**25.04**	**0.27**	**0.75**
LSD (0.05)	**0.16**	**0.27**	**NS**	**1.05**	**2.95**
Spacing (cm)					
15.0	3.00	3.36	484.0	69.8	112.4
17.5	2.86	3.20	413.6	69.9	112.4
20.0	2.68	2.90	415.7	69.7	112.2
22.5	2.48	2.76	340.6	69.9	112.7
SEm (±)	**0.02**	**0.05**	**25.58**	**0.26**	**0.21**
LSD (0.05)	**0.07**	**0.16**	**88.51**	**NS**	**NS**

genotypes was not-significant. Higher 1000 grain weight in HD 2733 was attributed to their comparatively well-developed bold grains compared to others.

There was no significant difference in grain yield among the genotypes. However, from the mean values it was noted that K 0307 recorded higher mean grain yield (3.86 t ha^{-1}) followed by HD 2733(3.72 t ha^{-1}). Higher values in ear head m^{-2} and number of grain $earhead^{-1}$ might have resulted in higher grain yield in K 0307. The lowest yield was recorded from DBW 39 (3.62 t ha^{-1}).

The effect of genotypes on straw yield was statistically not significant, although the genotype K 0307 produced highest straw yield of 5.8 t ha^{-1} as compared to other two genotypes and DBW 39 produced the lowest straw yield (5.4 t ha^{-1}). Among the genotypes, HD 2733 recorded the highest value of (41.1%) of harvest index, while DBW 39 recorded the least (40.5%). The results are in conformity with the findings of Bakht *et al*. (2007) who noted that the effect of row spacing and interactions with varieties were not statistically significant in case of harvest index.

From the study, it may be concluded that all the three wheat genotypes tested in this experiment, namely K 0307, HD 2733 and DBW 39 gave high yields when grown in narrow row spacing instead of conventionally followed 22.5 cm spacing under new alluvial zone of West Bengal. In this study, 15.0 cm row spacing produced higher growth and yield attributes along with higher yield indicating better resource utilization in narrow rows than wider rows (Table 2).

Table 2: Effect of row spacing on the yield, yield attributes and harvest index of wheat genotypes

Treatment	Ear head m^{-2}	Grains $earhead^{-1}$	1000-grain weight (g)	Grain yield (tha^{-1})	Straw yield (tha^{-1})	Harvest index (%)
Genotypes						
K 0307	301.4	41.3	40.8	3.86	5.8	40.6
HD 2733	297.2	39.6	43.8	3.72	5.4	41.1
DBW 39	283.6	41.1	41.9	3.62	5.4	40.5
SEm (±)	**4.33**	**1.18**	**0.83**	**0.14**	**0.17**	**1.23**
LSD (0.05)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
Spacing (cm)						
15.0	321.4	42.9	43.6	3.96	6.7	37.6
17.5	296.1	40.9	42.0	3.83	5.3	42.2
20.0	282.0	39.9	41.8	3.67	5.1	41.9
22.5	276.7	39.0	41.4	3.46	4.9	41.4
SEm (±)	**3.80**	**0.77**	**0.88**	**0.08**	**0.26**	**1.47**
LSD (0.05)	**13.16**	**NS**	**NS**	**0.28**	**0.90**	**NS**

Row spacing

The different spacing treatments were found to have significant influence on number of ear head m^{-2} (Table 1). The maximum mean ear head m^{-2} was recorded in 15.0 cm row spacing (321.4) followed by 17.5 cm (296.1). On the contrary the least mean ear head m^{-2} (276.7) was recorded in 22.5 cm row spacing (control treatment). The results are not in agreement with the findings of Mali and Choudhary (2013) who observed more number of effective tillers in 20 cm row spacing as compared to 22.5 cm row spacing.

However, number of grains per earhead under various row spacing varied significantly. Similar observations were reported by Cheema *et al.* (1986), and Singh *et al.* (1988) who reported that closer spacing produced superior yield attributes viz., tillers m^{-2}, ear length, plant height, and grains per earhead. Higher number of grains $earhead^{-1}$ was noted from the crop spaced at 15.0 cm apart and thereafter the number progressively decreased with the increase of the distance between the rows.

No significant difference among the treatments (row spacing) had been found, but a higher test weight was evident in case of 15 cm row spacing (43.6 g). It was also observed that there was progressive decrease in 1000 grain weight as the distance between rows was increased from 15.0 cm to 22.5 cm. These findings are in accordance with Thakar *et al.* (1974). Wider distance between plants within rows in narrow spacing might have ensured the plant little competition for light, water, and nutrients from other plant and thus influenced the crop in narrow spacing to record higher values of 1000 grain weight.

Various row spacing treatments showed significant differences among themselves. The grain yield varied from 3.46 to 3.96 t ha^{-1} from wider to narrow spacing, respectively. Row spacing of 15.0 cm resulted in significantly higher grain yield (3.96 t ha^{-1}) as compared to yields obtained from 20.0 and 22.5 cm but remained at par with that of 17.5 cm spacing. Row spacing of 15.0 cm recorded about 14% higher yield than the yield obtained from the usually followed 22.5 cm row spacing. Mali and Choudhary (2013) reported lower yield in 22.5 cm spacing as compared to 20.0 cm spacing. The grain yield depends upon many factors such as effective tillers m^{-2}, grains $earhead^{-1}$ and 1000 grain weight, etc. The greater values of these yield attributes at the narrow row spacing were possibly due to uniform spatial distribution and less plant to plant competition compared with wider row spacing. Ercoli and Masoni (1995) reported that aboveground biomass progressively decreased with increasing row spacing. Number of spikes m^{-2} was the yield component most affected by row spacing.

However, straw yield varied significantly as a result of different row spacing. Closer spacing produced more straw yield as compared to wider spacing. This result is in conformity with the findings of Bakht *et al.* (2007) and Das (1993). In this trial the highest straw yield (6.7 t ha^{-1}) was obtained from 15 cm row spacing followed by 17.5 cm row spacing (5.3 t ha^{-1}). More number of tillers m^{-2} and higher LAI might be responsible for influencing higher straw yield in 15.0 cm spacing. The lowest straw yield (4.9 t ha^{-1}) was recorded in 22.5 cm spacing. Harvest index was not significantly influenced by row spacing. However it was noted higher (42.2%) in 17.5 cm spacing and the least was noted in 15.0 cm spacing (Table 2).

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