INFLUENCE OF ROW SPACING ON GRAIN YIELD OF WINTER WHEAT GENOTYPES

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خلاصہ

شہید زیڈاے بھٹوزرعی کالج ڈوکری میں معاشی پیداواراوراس کے اجزاءپر قطاروں کے مناسب اثر کے تخمینے کے لئےایک مطالعہ کیاگیا۔موسم سرمامیں گندم کی چار جینوٹائپس، یعنی۔ٹی جے-83، سرسبز،ٹی ڈی-1اور کرن-95شامل تھے۔صف وقفہ کاری؛ 15سینٹی میٹر، 22سینٹی میٹر، 30سینٹی میٹراور 40سینٹی میٹر کاانتظام کیاگیا۔مطالعہ کی گئی علامتیں ابتدائی سرخی میں لے جانے والے دن، پختگی دن کی، لمبائی(سینٹی میٹر)، ٹیلرپلانٹ-1کی تعداد،اہم پیڈنکل لمبائی(سینٹی میٹر)، بیجوں کی بڑھتی ہوئی واردات-1، 1000بیج وزن(جی)، تنکے وزن والے پلانٹ کے دن تھے-1(جی)، بیجوں کی پیداوار پلانٹ-1(g) اور فصل کاانڈیکس(٪)۔نتائج سے انکشاف ہواہے کہ صف کی جگہوں اوران کے باہمی تعامل کے مابین جینوٹائپس کے لئےاہم اختلافات دیکھنے میں آئے ہیں۔بیج کی پیداوار سمیت زیادہ ترخصائل کے 30سینٹی میٹر قطار کی جگہ زیادہ موثر تھی۔بیجوں کی زیادہ سے زیادہ پیداوار پلانٹ-1، مین پیڈنکل لمبائی، بیجوں کی بڑھتی ہوئی وارداتاور 1000بیج وزن,سرسبز نے30سینٹی میٹر قطار کی جگہ کے تحت دکھایا۔جینوٹائپس کی خراب کارکردگی 15سینٹی میٹر کی جگہ کے تحت نوٹ کی گئی تھی۔اسی طرح 30سینٹی میٹر کی قطار میں باقی کاشتوں پر سرسبز کے ذریعہ زیادہ ٹلرپلانٹ-1مرتب کیاگیاہے۔جینوٹائپس اور 30سینٹی میٹر کی جگہ کے مابین تعامل نےاچھا مجموعہ امتزاج ثابت کیااور سرسبز نے جینوٹائپس کے پیچھے رہ جانے پر فوقیت ظاہر کی۔

Abstract

A study was conducted at Shaheed Z. A. Bhutto Agricultural College Dokri, for estimation of proper row space effects on economic yield and its components. Four genotypes of winter wheat, viz; T.J-83, Sarsabz, TD-I and Kiran-95 were included in this study. The row spacing i-e; 15 cm, 22 cm, 30 cm and 40 cm were managed. The studied traits were taken on days to initial heading, days taken to maturity, stature length (cm), number of tillers plant^{-1}, main peduncle length in (cm), seeds spike^{-1}, 1000 seed weight (g), straw weight plant^{-1} (g), seed yield plant^{-1} (g) and harvest index (%). The results revealed that significant differences were observed for genotypes between the row spaces and their interaction in studied parameters. The 30 cm row space was more effective for most of the traits including seed yield. The maximum seed yield plant^{-1}, main peduncle length, seeds spike^{-1} and 1000 seed weight shown by Sarsabz under 30 cm row space. The poor performance of studied genotypes was noted at 15 cm row space. Similarly row space of 30 cm set more tillers plant^{-1} by Sarsabz over rest of the cultivars. The interaction between genotypes at 30 cm space proved a good combination and Sarsabz showed superiority over rest of the genotypes.

Key Words: Row space, winter wheat genotypes, *Triticum aestivum* L, Days to maturity, Seed yield

Introduction

Wheat (*Triticum aestivum* L.) is a major food grain of the globe, and considered one of the three main cereals feeding the globe (Salim *et al.,* 2020). According to (FAO 2014) reported that the world annually wheat feeding by human may be one-fifth of the population. In Pakistan wheat was grown on 8734 thousand hectares, with production of 25492 million tones. Wheat accounts 9.1% of the value added in agriculture and 1.7% of GDP of Pakistan (Agriculture statistics of Pakistan-2017-18), population of Pakistan is rapidly growing with 2.4% per annum, so all possible measures would be taken to face increasing population in future. Grain crops are affected by genetic and surrounding environments viz; late sowing, low seed rate, weed density, irrigation, low fertilizer doze and dense plant population are the main causes of higher wheat production. Optimum row space of wheat crop is of primary importance especially for inter-culturing practices and ease in crop protection measures. In this present study four selected winter wheat cultivars were chosen such as; T.J-83, Sarsabz, TD-1 and Kiran-95 they estimated for grain yield and their related components as well for effective row space. Under the current scenarios of climate change an increase in the cultivation area without adverse social and environmental impacts is virtually impossible yet an increase in yield is only possible option Farooque *et al*. (2014). Wheat cultivars behave differently under varying row spacing due to their divergent stature and tillering potential (Hussain *et al.*, 2012 and 2013). Keeping in view of different behavior of wheat genotypes under varying environments, this study was set up with hypothesize that wheat cultivars would same in divergent environments. The aim of this work was to investigate the impact of row spacing on economic yield and its components of different winter wheat genotypes.

Materials and Methods

This study was under taken at the field of Shaheed Z. A. Bhutto Agricultural College Dokri SZABAC-Dokri (27.433773°N, 68.119635 °W). During wheat growing season 2017-18. randomized complete block design (RCBD) was used. Wheat cultivars were; TJ-83, Sarsabz, TD-I and Kiran-95. Four row spaces viz; 15cm, 22cm, 30cm and 40cm were managed for sowing where row spacing was major plot and wheat cultivars were sub plots. Wheat sowing was done on adequate water conditions. Usual cultural practices were applied. Data was recorded on days taken to initial flowering, days taken to maturity, stature length, fertile tillers plant^{-1}, main peduncle length, seeds spike^{-1}, 1000 seed weight, straw weight, seed yield plant^{-1} and harvest index. Crop was manually harvested at maturity and plants were threshed separately. Harvest index was calculated as ratio of seed yield over straw. The data were subjected to statistical analysis for mean squares as suggested by Steel and Torrie (1980). Means of obtained data were compared by Duncan's multiple range test (D'MRt) according to method suggested by Duncan (1955).

Results and Discussion

Mean squares (Table 1) showed significant differences among genotypes for days to initial heading (2.39**), days to maturity (2.87**), plant height (3.15**), Tillers plant^{-1} (4.44**), spike length (4.14**), seed yield plant^{-1} (0.67**), straw yield plant^{-1} (4.3**), and its contributing component. Interaction between wheat cultivars and row spaces showed highly significant variances for days taken to maturity, seeds spike^{-1}, 1000 seed weight and straw yield among wheat cultivars. Hasan *et al*. (2018) observed highly significant differences between wheat cultivars and row spaces. Furthermore, Amjad and Anderson (2006) noted significant effects of narrow row space. Wheat cultivars showed significant differences for seed yield plant^{-1}

Table 1. Mean squares of genotype, row spaces and replications

Source Variation	**D.F**	**Ds IHD**	**Ds MT**	**Plant HT**	**Tillers P^{-1}**	**Spk. L**	**Seeds spk^{-1}**	**Seed Y p^{-1}**	**Straw Y p^{-1}**	**H I**	**1000 Seed Wt**
Rep	2	0.74	1.31	0.19	0.81	0.23	0.29	1.44	1.40	0.97	1.00
Genotype	3	2.39**	2.87**	33.15*	4.44**	4.14**	338.4*	0.67**	4.3**	2.5*	5.1**
Row spacing	3	67**	48**	88.5**	10.12	11.8**	48*	33**	87**	28.5**	30.3**
G x spacing	9	33.34**	20.22**	90.86**	20.33**	9.56**	51.90**	10.35**	44.56**	33.20**	10.33**
Error	6	0.73	0.44	19.71	1.39	0.83	15.14	0.09	0.93	1.24	0.96

Table-2: Effect of varying row spacing on days to initial heading and days to maturity of wheat

Varieties	**Row spacing (cm)**									
	15	22	30	40	Mean	15	22	30	40	Mean
	Days to flowering					Days to maturity				
TJ-83	110	110	113	111	111 a	139	137	140	143	139.75 a
Sarsabz	109	110	112	111	110.5 a	137	136	135	139	136.75 b
TD-1	100	103	106	110	104.75 b	130	131	128	132	130.25 b c
Kiran-95	110	110	112	113	111.25 a	137	138	139	142	139.00 a
Mean	107.25	108.25	110.8	111.3		135.75	135.5	135.5	139	

LSD p=0.05 for row spacing =1.02 LSD p=0.05 for row spacing =2.0. Mean

Days to initial heading: According to results in Table 2, great number of days for initiation of heading (111 days) was noted in plots with 40cm row space, while early flowering was noted (107 days) in plots having 15cm row space. Mean performance of the genotypes for days to initiation of heading indicated that Sarsabz (112 days), flowered as earlier followed b TJ-83 (113days) in row space 30cm. In row space 40cm Sarsabz and Kiran-95 (112) showed earlier flowered followed by Kiran-95 (113 days). Kiran-95 (112days) in row space 30cm, TJ-83 and Sarsabz (111days) in row space 40cm, TJ-83 (110days) in row space 15cm and 22cm, Sarsabz (110days) in row space 22cm, TD-I (110days) in row space 40cm, Kiran-95 (110days) in row space 15cm and 22cm. Results in Table-2 indicated that Sarsabz was found earliest flowering (109days). Results indicated that wheat cultivars showed two groups for initiation of heading.

Period of maturity: Data in Table-2, indicated that earliest period for maturity was observed in wheat cultivar TD-I (128days) in row space 30cm, followed by TD-I (130days, 131days and 132days) in row space 15cm, 22cm and 40cm respectively. Sarsabz (135days and 136days) in row space 30cm and 22cm respectively. Indeed, TJ-83 (137days) in 22cm row spacing, Sarsabz (137days) in 15cm and Kiran-95 (137days) in 15cm row space. In the similar way, Kiran-95 (138days) in 22cm row space. TJ-83 (39days) in 15cm row space, Sarsabz (139days) in 40cm row space, Kiran-95 (139days) in 30cm row space. TJ-83 received 140days in row space of 30cm. Kiran-95 matured in 142 days in row space of 40cm apart. In row space 40cm TJ-83 matured in 143days. Depending on mean performance for maturity period, wheat cultivars showed 3 groups. Table-2 revealed that row spaces 22cm and 30cm responded similarly (135.5days) for maturing period followed by row space 15cm (135.75days) and 40 (139days) respectively.

Table-3: Effect of various row spacing on plant height and tillers/plant of wheat

Varieties	Row spacing (cm)									
	15	22	30	40	Mean	15	22	30	40	Mean
	Plant height (cm)					Tillers/plant				
TJ-83	80.27	85.25	90.07	92.2	86.95 a	12.3	16.22	23.31	19.1	17.73 a
Sarsabz	73.35	74.62	78.0	78.52	76.12 c	13.2	16.8	25.3	20.43	18.93 a
TD-1	59.8	60.1	62.2	63	61.28 b c	9.8	10.2	12.2	10.3	10.63 b c
Kiran-95	75.3	76.2	80.8	83.8	79.03 b	11.3	16.2	18.8	17.3	15.9 b
Mean	72.18	74.04	77.77	79.38		11.65	14.86	19.9	16.78	

LSD p=0.05 for row spacing =2.0. Mean values with different letters are significantly different at p=0.05

Plant height (cm): Table-3 showed the largest plants (92.2 cm) attained by TJ-83 in row space 40cm apart, and 90.07 in row space 30cm. The shortest statured plants (59.8 cm) was showed by TD-I in row space 15cm, (60.1 cm) in row space 22cm, (62.2) in row space 30cm and (63) in 40 cm row space. After TD-I and Sarsabz showed second dwarf plants (73.35 cm) and (74.62 cm) in row space of 15cm and 22cm respectively. Followed by Sarsabz, wheat cultivar Kiran-95 attained plant height (75.3 cm) at 15 cm and (76.2 cm) at 22 cm row spacing respectively. Sarsabz showed plant height (78 cm) and (78.52 cm) in row space 30cm and 40cm apart. Stature height of TJ-83 was 80.27cm in row space 15cm. Kiran-95 showed 80.8 cm in row space 30 cm. Kiran-95 recorded plant height as 83.8 cm in row space 40cm. TJ-83 (85.25 cm) showed in row space 22 cm. According to Table-3, there were 3 groups of wheat cultivars in relation to plant height. Results coincide with Ghafari *et al*. (2017), who observed the maximum height of Herat 99 wheat variety at 30 cm row spacing as compared to PBW 154 and Darulaman 07 varieties.

Number of tillers plant^{1}: Data in Table-3 revealed that in row spacing 15cm maximum number of tillers plant^{1} was recorded in wheat cultivar Sarsabz (13.2), followed by TJ-83 (12.3), Kiran-95 (11.3) and TD-I (9.8). In row space 22cm, wheat cultivar Sarsabz was more tiller producer (16.8), followed by genotypes such as TJ-83 (16.22), Kiran-95 (16.2) and TD-I (10.2). Results of Table-3, indicated that in row spacing 30cm apart, wheat cultivar Sarsabz (25.3) was found maximum tiller producing genotype, followed by TJ-83 (23.31), Kiran-95 (18.8) and TD-I (12.2) respectively. In row space 40cm, wheat cultivar Sarsabz produced maximum (20.43) number of tillers plant^{1} followed by TJ-83 (19.1), Kiran-95 (17.3) and TD-I (10.3) respectively. Wheat cultivars showed three groups in relation to number of tillers plant^{1}. These findings are in line with Amjad and Anderson (2006) reported increased row spacing showed increased tillers. Furthermore, the narrow row spacing potentially reduced the number of wheat tillers (Al-Fakhry and Ali, 1989). Sarsabz proved to be best which showed maximum (18.93). Hussain *et al.* (2012) observed that the higher row spacing produced productive wheat tillers.

Table 4. Effect of different row spacing on main spike length (cm)/plant and grains/spike of wheat

Varieties	Row spacing (cm)									
	15	22	30	40	Mean	15	22	30	40	Mean
	Main spike length (cm)					Grains spike[1]				
TJ-83	12.3	13.22	13.31	14.1	13.23 b	56.3	63.22	65.31	63.1	61.98 b
Sarsabz	13.2	16.8	20.3	17.43	16.93 a	62.2	68.8	70.73	70.03	67.94 a
TD-1	9.84	10.29	12.26	14.3	11.67 b c	51.3	54.2	56.2	53.3	53.75 c
Kiran-95	13.5	16.23	15.8	13.3	14.71 b	55.3	56.2	58.8	57.3	56.9 bc
Mean	12.21	14.14	15.42	14.78		56.28	60.61	62.76	60.93	

LSD p=0.05 for row spacing =2.0. Mean values with different letters are significantly different at p=0.05

Main spike length (cm): Results in Table-4, revealed that large main spike length (13.5cm) was shown by Kiran-95 in row space 15cm, followed by Sarsabz (13.2cm), TJ-83 (12.3cm) and TD-I (9.84cm) respectively.

Wheat cultivar Sarsabz showed maximum (16.8cm) spike length in row spacing 22cm, seconded by Kiran-95 (16.23cm) followed by TJ-83 (13.22cm) and TD-I (10.29cm) respectively. Maximum spike length was noted in Sarsabz (20.3cm) in 30cm row spacing, followed by Kiran-95 (15.8cm), TJ-83 (13.31cm) and TD-I (12.26) respectively. According to results in Table-4, main spike length was large in Sarsabz (17.43cm) in row space 40cm, whereas, seconded by TD-I (14.3cm), followed by TJ-83 (14.1cm) and Kiran-95 (13.3cm) respectively in same row space. Interaction between varieties and row space showed three groups. Ghafari *et al*. (2017) found the highest spike length and spikelets/spike were observed with 30 cm row spacing.

Number of grains spike[1]: Table-4, revealed that in row space 15cm, more grains spike[1], was noted in Sarsabz (62.2), followed by TJ-83 (56.3), Kiran-95 (55.3) and TD-I (51.3) respectively. In row space 22cm, maximum grains spike[1] (68.8) were noted in Sarsabz, followed by TJ-83 (63.22), Kiran-95 (56.2) and TD-I (54.2) respectively. Large number of grains spike[1] was recorded in Sarsabz (73.69) in row space 30cm. TJ-83 (65.31) was found second, followed by Kiran-5 (58.8) and TD-I (56.2) respectively. In row space 40cm, wheat cultivars showed different response for grains spike[1]. Large number of grains were found in Sarsabz (70.03) followed by TJ-83 (63.1), Kiran-95 (57.3) and TD-I (53.3) respectively. In the former study, Deswarte and Gouache (2011) stated that significant reductions in yield with higher row spacing, with noticeable variances in the level of reduction liable on the cultivar.

Table- 5: Effect of different row spacing on 1000 grain weight and grains/spike of wheat

Varieties	Row spacing (cm)									
	15	22	30	40	Mean	15	22	30	40	Mean
	1000 seed weight (g)					Straw yield plant[1](g)				
TJ-83	36.3	38.22	39.31	38.1	37.98 b	96.3	98.22	100.31	98.1	98.23 a
Sarsabz	38.2	40.8	43.73	40.03	40.69 a	88.2	90.8	94.73	90.03	90.94 a
TD-1	37.3	40.12	44.2	35.3	39.23 b c	87.3	90.12	77.2	75.3	82.48 b c
Kiran-95	35.3	36.24	38.81	37.35	36.93 b	85.3	86.24	88.81	87.35	86.93 b
Mean	36.78	38.85	41.51	37.7		89.28	91.35	90.26	87.7	

1000 grain weight (g):

Table-5, indicated that maximum mean performance (38.2g) for 1000 grain weight in row space 15 cm was noted in Sarsabz, followed by TD-I (37.3g), TJ-83 (36.3g) and Kiran-95 (35.3g) respectively. Row space 22cm indicated that Sarsabz surpassed (40.8g) all wheat cultivars for 1000 grain weight, followed by TD-I (40.12g), TJ-83 (38.22g) and Kiran-95 (36.24g) respectively. Highest 1000 grain weight (44.2g) was recorded by TD-I in 30cm row space, followed by Sarsabz (43.73g), TJ-83 (39.31g) and Kiran-95 (38.81g) respectively. Table-5, revealed that maximum 1000 grain weight was noted in wheat cultivar Sarsabz (40.03g), followed by TJ-83 (38.1g), Kiran-95 (37.35) and TD-I (35.3g) in row space 40cm. Table-5 showed that there were 3 groups of means. Hussain *et al.* (2012) revealed that an enhance in number of grains/spike and 1000-grain weight, from broader row spacing (30 cm), could not compensate the severe decline in dynamic tillers subsequent in severe reduction in grain yield.

Straw yield/plant (g): Results of Table-5, revealed that maximum mean straw yield plant[1] (96.3g) was noted in TJ-83 in plot with 15cm row apart, followed by Sarsabz (88.2g), TD-I (87.3g) and Kiran-95 (85.3g) respectively. In row space 22cm, TJ-83 (98.22g) produced high straw yield plant[1], followed by Sarsabz (90.8g), TD-I (90.12g) and Kiran-95 (86.24g) respectively. According to results in Table-5, large straw yield/plant was showed by TJ-83 (100.31g) in row space 30cm, followed by Sarsabz (94.73g), Kiran-95 (88.81g) and TD-I (77.2g) accordingly. In row spacing 40cm, highest straw weight (98.1g) was found in TJ-83, followed by Sarsabz (90.03g), Kiran-95 (87.35g) and TD-I showed lowest straw (75.3g). Ghafari *et al*. (2017) reported the maximum straw yield and grain yield with 20 cm row spacing as compared to 30 cm row spacing.

Table 6. Effect of different row spacing on grain yield plant^{1} and harvest index of wheat

Varieties	Row spacing (cm)									
	15	22	30	40	Mean	15	22	30	40	Mean
	Grain yield plant^{1}(g)					Harvest index				
TJ-83	46.3	48.22	50.31	48.1	48.23 b	0.48	0.49	0.50	0.49	0.49 bc
Sarsabz	48.2	50.8	54.73	50.03	50.94 a	0.55	0.56	0.58	0.56	0.56 b
TD-1	47.3	50.12	47.2	47.3	47.98 bc	0.54	0.72	0.61	0.63	0.67a
Kiran-95	45.3	46.24	48.81	47.12	46.87 bc	0.53	0.54	0.55	0.55	0.54 b
Mean	46.78	48.85	50.26	48.14		0.57	0.58	0.56	0.56	

Grain yield plant^{1} (g): Table-6, showed that the highest economic yield (48.2g) of Sarsabz in row space 15cm, followed by TD-I (47.3g), TJ-83 (46.3g) and Kiran-95 (45.3g) respectively. Row space 22cm of Table-6 showed that highest grain yield (50.8g) was obtained from Sarsabz, followed by TD-I (50.12g), TJ-83 (48.22g) and Kiran-95 (46.24g) respectively. In row space 30cm, Sarsabz (54.73g) was more grain yield producing, followed by TJ-83 (50.31g), Kiran-95 (48.81g) and TD-I (47.2g) respectively. In row spacing 40cm, Sarsabz showed highest grain yield/plant (50.3g), followed by TJ-83 (48.1g), TD-I (47.3g) and Kiran-95 (47.12g) respectively. 3 groups of means were appeared. Hussain et al. (2003) noted significant effects of row spaces 30cm and 60cm. Wheat sown with narrow row spaces resulted high seed yield and 20 row space was found optimum row space (Hussain *et al.,* 2016).

Harvest index: Results showed that in row space 15cm, Sarsabz gave more harvest index (0.55), followed by TD-I (0.54), Kiran-95 (0.53) and Kiran-95 (0.53) respectively. TD-I was highest harvest index producer (0.72), followed by Sarsabz (0.56), Kiran-95 (0.54) and TJ-83 (0.49) respectively (Table-6) in row space 22cm. Wheat cultivar TD-1 (0.61) in row space 30cm, showed highest harvest index plant^{1}, followed by Sarsabz (0.58), Kiran-95 (0.55) and TJ-83 (0.50) respectively. In row space 30cm, highest harvest index was showed by wheat cultivar TD-I (0.61), followed by Sarsabz (0.58), Kiran-95 (0.55) and TJ-83 (0.50) respectively. According to Table-6, highest harvest index was recorded by TD-I (0.63) in row space 40cm, followed by Sarsabz (0.56), Kiran-95 (0.55) and Tj-83 (0.49) respectively. Means showed 3groups. These results agreed with Fonts et al. (1997), who revealed that the grain yield and harvest index decreased with increase in the row spacing. Fischer *et al.* (2019) found that the wheat production was sensitive to row spacing, the most responsive cultivars (erect dwarf wheat cultivars) lost yield at spacing 30-cm and superior, whereas the smallest susceptible (some taller vigorous semi-dwarf cultivars) tolerated spacing up to at least 50cm with no production loss.

Conclusion

According to this study, wheat cultivar Sarsabz and TD-I were best potential cultivars in all row spaces with respect to seed yield and its components. Similarly, among row spaces, 30cm row sowing was found superior row spacing in this study. It is suggested that Sarsabz and TD-I wheat cultivars can be successfully planted with 30cm row sowing for local farming community.

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