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METRIC TRAITS STUDIES IN WHEAT VARIETIES AS AFFECTED BY SOWING TECHNIQUES

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Abstract

Quantitative parameters for the wheat crop as influenced by different sowing techniques were studied in the present research work. Hence, routine and cross sowings were adopted to check their efficacy for yield attributes in wheat cultivars viz. Inqilab-91, Daman-98 and Dera-98. The research trials were conducted for two years at the experimental area of Faculty of Agriculture, Gomal University, Dera Ismail Khan. The split plot design was used for conducting the trials. The results showed that wheat cultivar Dera 98 produced maximum grain yield in both years of experimentation when cross drill technique (30x30cm^2) was adopted. This technique interacted significantly with varieties for plant height, spikes m^{-2}, grains spike^{-1}, 1000 grain weight, biological yield, straw yield and grain yield. All varieties under experimentation showed a significant effect as noted for spikes m^{-2}, spike length, spikelets spike^{-1}, grains spike^{-1} and 1000-grain weight during both years.

Key words: Sowing techniques cross drill, Wheat varieties, Agronomic characters.

Introduction

According to an estimate, the global population will be doubled from its current level of 6 billion to 12 billion by the mid of 21st century (Hall, 1995). Therefore, it is imperative that if agriculture is to meet this demand for food, the development of better soil atmosphere with proper method of sowing that exhibit higher yield is essential. Cereal production has considerably expanded and improved with the introduction of better sowing techniques, combine harvesters, driers and chemical aids such as herbicides, fungicides, insecticides and growth regulators (Lockhart & Wiseman, 1988). After many centuries of yield stagnation, steady yield increases have taken place in the past half-century. These increases are the result of a combination of scientific inputs in the hands of knowledgeable and capable crop producers. A semi-dwarf winter wheat yielded 12.9 ton ha^{-1} in Washington but was not produced regularly (Anonymous, 1996). Wheat occupies a central position in Pakistan's agricultural policies because of being a foremost cereal and a staple crop of the country. It enjoys a share of 2.2% and 10.3% to GDP and value addition in agriculture, respectively. The area under wheat crop increased from 8,660 thousand ha of last year to 9,039 thousand ha this year, while its total production was recorded to be 25.3 million tons (Anon., 2014). The most common and preliminary characters which are responsible for boosting the economic status of bread wheat include grain yield and its protein contents which serve as the indices for its better quality (Oury & Godin, 2007). Wheat yield in Pakistan in general is too low compared to that in other countries. Sowing techniques and selection of proper genotypes are the two major yield-limiting factors. These factors are the major determinants which not only help the plants in capturing and converting the solar energy for better harvest of the crop but also balance the production by maneuvering intra-plant competition and establishing proper crop stand. Jadho & Nalamwar (1993) reported that cross sowing at 22.5 cm gave significantly higher yield attributes than those by other sowing methods. Parihar & Singh (1995) concluded that as compared with normal sowing, an enhancement of 4.3% was achieved with cross-sowing technique. While Arif *et al.,* (1997) indicated significant influence of seed rate and sowing methods on grain yield of wheat. They also showed that broadcast method of sowing produced significantly lower grain yield as compared to line or bi-directional sowing. Similarly, Khan *et al.,* (2000) reported that number of fertile tillers, biomass yield, seed yield and harvest index were strongly influenced by sowing technique. Krinsten *et al.,* (2008) indicated efficient weed suppression and commendable increase in wheat yield adopted to cross sowing technique. The present study was attempted with three wheat cultivars in order to investigate performance based on yield components and seed yield under conventional sowing vs cross drill sowing technique.

Materials and Methods

The effect of sowing techniques on three wheat varieties viz. Inqilab-91, Daman-98 and Dera-98 was studied at the agronomic research area, Faculty of Agriculture, Gomal University, D.I.Khan during the winter season of 2009-2010 and 2010-2011.

The three sowing techniques were;
M_1 30 cm single row drill
M_2 30 cm cross drill
M_3 45 cm cross drill

The research trial was repeated in four replications of a split-plot design having 2 × 5 m^2 size of each sub-plot. The varieties were allotted to main plots and the sowing techniques to sub-plots. Sowing was done with 200 kg ha^{-1} seed rate. General recommendations for the crop were followed for performing all other agronomic practices excluding the treatments.

Methods and procedures adopted for data recording of the selected parameters are as follows:

Plant height (cm) at maturity: Random selection of ten plants was performed in three places from a square meter area in each experimental unit. These tillers were measured in centimeters and their mean values obtained.

Number of spikelets per spike: Three places were chosen in all the experimental plots for opting ten spikes at random and then their spikelets were enumerated and average data were recorded.

Biological yield (ton ha^{-1}): In each plot, the crop plants were harvested, fastened in to bundles sparately and then weighed in kilograms with the help of a spring balance and after that the data were changed in to ton ha^{-1}.

Grain yield (ton ha^{-1}): The bundles obtained for recording biological yield were dried under the sun and then with the help of a mechanical thresher, seeds were separated, weighed in kilograms and then the data were changed into ton ha^{-1}.

Straw yield (ton ha^{-1}): For the purpose of obtaining straw yield, the seed yield obtained was subtracted from the biomass yield achieved in each plot. The results so obtained were then transformed in to ton ha^{-1}.

Harvest index (%): The percentage of harvest index was worked out as:

$$\text{Harvest index (\%)} = \frac{\text{Grain yield}}{\text{Biomass yield}} \times 100$$

Analysis of variance technique (Steel & Torrie, 1984) was utilized for the analysis of obtained data while in order to check the comparison between treatments mean values, Duncan Multiple Range Test was performed (Duncan, 1955).

Results and Discussion

Plant height (cm): It can be seen from the data presented in Table 1 that the sowing techniques had significant effect on plant height during both years. The highest plant height of 104.54 cm was obtained in that plot where cross sowing technique (30 × 30 cm^2) was adopted. However, this was statistically similar with the plant height (102.37 cm) obtained with cross sowing (45 x 45 cm^2). It was due to plant competition on the motive of survival of the fittest. Varieties had significant differences during 2009-2010. But in the next year, non-significant differences were exhibited by the varieties. Minimum plant height of 94.8 cm was noted in treatment (Inqilab-91, 30 cm single row drill). Regarding the sowing techniques, cross sowing technique produced comparatively taller plants in both years. The sowing techniques and varietal interaction had a significant effect on plant height in 2009-2010 but in the year 2010-2011, it produced non-significant differences.

Among the varieties, Daman-98 produced tallest plants during both years due to its better genetic potential as described by Khan *et al.,* (2001) who reported that Daman-98 produced taller plants than many other varieties. While Khan *et al.,* (1992) and Muhammad *et al.,* (1999) also reported that plant height significantly varied among different genotypes of wheat. Mehmet & Telat (2006) indicated that grain yield had a significant and positive correlation with plant height. These results are also in agreement with the finding of Khakwani *et al.,* (2012). Ali *et al.,* (2010) revealed that taller wheat plants were produced when sown in wider rows than that by the narrow ones.

Spikelets spike^{-1}: The mean value data presented in Table 2 showed that number of spikelets spike^{-1} was significantly affected by varieties and their interaction with sowing techniques due to variation in genotypes in both years. But in year 2009-2010, the sowing techniques produced non-significant results (Table 2). It is evident from Table 5 that the mean values were affected by the sowing techniques and genotypes ranging from 17 to 21.65 in year 2009-2010 and 16.4 to 21.4 in year 2010-2011. Maximum number of spikelets spike^{-1} (21.65) was produced by 45x45 cm^2 cross sowing technique interacted with Daman-98 in year 2009-2010 but in the next year Daman- 98 produced the maximum number of spikelets spike^{-1} with 30cm single row drill. Among the varieties, Daman-98 dominated over the other two varieties in this regard in both years. The present findings are similar to those of Khan *et al.,* (1992), Adnan & Bhutta (1994), Tahir *et al.,* (1995) and Jan *et al.,* (2000) who observed significant differences for spikelets (spike^{-1}) among the wheat cultivars used in their individual studies.

Grain yield (ton ha^{-1}): The sowing techniques showed highly significant effects whereas varieties showed non-significant effect on grain yield. While the varietal interaction with the sowing techniques also had a significant effect on grain yield. The highest mean grain yield of 7.46 ton ha^{-1} and 6.93 ton ha^{-1} was noted in cross sowing (30 x 30 cm^2) technique in year 2009-2010 and 2010-2011 respectively (Table 3). In 2010-2011, grain yield and yield contributing parameters including spikes, grains spike^{-1}, spike weight, spike length etc. were lower as compared to those of previous year trial. This was mainly due to abiotic stresses (soil, environment) during the second year of experimentation. It has been reported that temperatures above normal alter plant functions and productivity (Mahboob *et al*., 2005). Short heat stress (≥35°C) in post-anthesis period can significantly reduce grain yield in wheat (Wardlaw & Wrigley, 1994). In the present study, disastrous temperature to wheat crop (≥40°C) occurred in the month of April. Previous studies have revealed that moderately high temperature (34-40°C) severely affected the yield and yield components in wheat (Stone & Nicolas (1994); Reynolds *et al.,* (2001). Similarly Araus *et al*., (2001) reported that yield of a genotype is influenced by all known and unknown factors. When growth resources from source to sink are limited by heat stress, the size of organs such as leaves, spikes and height are reduced (Fischer, 1984). The lowest grain yield was found in the line sowing technique in both years. There were little differences in grain yield as affected by the line sowing and the cross sowing (45 x 45 cm^2) technique. It is evident from Table 3 that highest grain yield (8 ton ha^{-1}) was in Dera-98, which was sown in cross sowing technique (30 x 30 cm^2) of sowing in year 2009-2010. It might have been due to uniform emergence of seedling and maximum number of spikes compared to those in the other varieties. These results also agree with those of Ahmed *et al*., (1995) and Khan *et al.,* (2000) in which an increase in population increased the grain yield in the wheat crop. Jensen (1978) reported that if a genotype contributed 50% to this increase, then cropping practices could be presumed to have contributed to the remaining 50%. The lesson to be learnt from this observation is that yield increases as a result of many factors. Crop production is most successful when all available factors are utilized advantageously. Among varieties, only a visible difference found in both years was that, Daman-98 produced highest grain yield (5.72 ton ha^{-1}) in 2009-2010 but Dera-98 produced maximum grain yield (5.39 ton ha^{-1}) during the year 2010-2011. Evidently, the superiority of the wheat varieties Daman-98 and Dera-98 regarding grain yield might have been due to their better phenotypic and genotypic makeup. Our results are in agreement with those of Khan *et al.,* (2001) in which Daman-98 performed better than all the other varieties in agro-ecological conditions of Dera Ismail Khan. Nazir *et al.,* (1987), Parihar & Singh (1995) and Arif *et al.,* (1997) reported that the cross sowing technique increased grain yield as compared to that by normal sowing technique. The grain yield (ton ha^{-1}) is a function of the integrated effect of the yield components, which were influenced differently by the growing conditions. Grain yield depends upon many factors like spike m^{-2}, number of grains $spike^{-1}$ and grain weight. Daman-98 produced heavier and more grains and Dera-98 produced maximum spikes which ultimately increased their grain yields. Numerous attempts to increase one or more of these factors have led to disappointment, because often when one factor is increased, the other declines. All yield factors depend on available food energy to produce yield. Such components draw on a fixed pool of food energy, and if yield is to be increased, photosynthesis must be increased. This is a positive approach to crop production (Stoskopf, 1981; Kazi *et al.,* 2012).

Table 1. Plant height (cm) affected by sowing techniques in wheat cultivars during 2009-2010 and 2010-2011.

Sowing techniques	2009-2010				2010-2011			
	Inqilab 91	Daman 98	Dera 98	Means*	Inqilab 91	Daman 98	Dera 98	Means*
30 cm single row	94.8 d	105.78 ab	98.65 bcd	99.74 b	94.97 ^{NS}	98.85	93.30	95.52 ab
30 × 30 cm^2 cross sowing	103.2 abc	108.03 a	102.4 abcd	104.54 a	97.28	99.8	96.28	97.58 a
45 × 45 cm^2 cross sowing	97.2 cd	110.23 a	99.68 bcd	102.37 ab	91.80	96.8	88.30	92.18 b
Means*	98.4 b	108.01 a	100.24 b	-	94.68	98.48	92.63	-

CV = 4.84% LSD $_{0.05}$ =3.83 (Varieties) LSD $_{0.05}$ = 4.239 (Sowing technique) LSD $_{0.05}$ (Interaction) =NS
CV = 5.27% (Varieties) = NS LSD $_{0.05}$ = 4.299 (Sowing technique) = 7.342 (Interaction)
*Means followed by the same letter(s) in the respective category are non-significant at 5% level of probability

Table 2. Spikelets $spike^{-1}$ as affected by sowing techniques in wheat cultivars during 2009-2010 and 2010-2011.

Sowing techniques	2009-2010				2010-2011			
	Inqilab 91	Daman 98	Dera 98	Means^{NS}	Inqilab 91	Daman 98	Dera 98	Means*
30 cm single row	17.88 bc	20.23 ab	17.38 c	18.49	20.78 ab	21.4 a	17.58 cd	19.92 a
30 × 30 cm^2 cross sowing	18.53 bc	21.31 a	17.58 c	19.14	18.98 bc	19.4 ab	16.4 d	18.26 b
45 × 45 cm^2 cross sowing	18.35 bc	21.65 a	17.00 c	19.00	18.4 cd	19.1 b	16.6 d	18.03 b
Means*	18.25 b	21.06 a	17.32 ab	-	19.38 ab	19.97 a	16.86 b	-

CV = 19.58% LSD $_{0.05}$ =1.776 (Varieties) Sowing technique = NS LSD $_{0.05}$ =2.198 (Interaction)
CV = 7.03% LSD $_{0.05}$ =1.121 (Varieties) LSD $_{0.05}$ = 1.129(Sowing technique) LSD $_{0.05}$ =2.128 (Interaction)
*Means followed by the same letter(s) in the respective category are non-significant at 5% level of probability

Table 3. Grain yield as affected by sowing techniques in wheat cultivars during 2009-2010 and 2010-2011.

Sowing techniques	2009-2010				2010-2011			
	Inqilab 91	Daman 98	Dera 98	Means^{NS}	Inqilab 91	Daman 98	Dera 98	Means*
30 cm single row	4.19 c	3.79 d	4.05 c	4.01 c	4.54 b	4.44 b	3.95 b	4.31 b
30 × 30 cm^2 cross sowing	6.68 bc	7.69 ab	8.00 a	7.46 a	6.37 a	7.05 a	7.33 a	6.93 a
45 × 45 cm^2 cross sowing	5.5 ab	5.69 bc	4.73 cd	5.31 b	4.9 b	4.13 b	4.9 b	4.64 b
Means^{NS}	5.45	5.72	5.59	-	5.26	5.21	5.39	-

CV =14.58% Varieties =NS LSD $_{0.05}$ =0.6004 (Sowing technique) LSD $_{0.05}$ =2.332 (Interaction)
CV = 20.22% Varieties =N.S LSD $_{0.05}$ =0.9162 (Sowing technique) LSD $_{0.05}$ =1.04 (Interaction)
*Means followed by the same letter(s) in the respective category are non-significant at 5% level of probability

Table 4. Biological yield (ton ha^{-1}) affected by sowing techniques in wheat cultivars during 2009-2010 and 2010-2011.

Sowing techniques	2009-2010				2010-2011			
	Inqilab 91	Daman 98	Dera 98	Means^{NS}	Inqilab 91	Daman 98	Dera 98	Means*
30 cm single row	11.26 bc	9.90 c	9.94 c	10.37 b	11.65 b	13.73 ab	12.05 ab	12.48 b
30 × 30 cm^2 cross sowing	13.59 abc	13.79 abc	14.59 ab	13.99 a	17.4 a	16.33 a	16.00 a	16.58 a
45 × 45 cm^2 cross sowing	15.68 a	15.64 a	10.68 bc	14.0 a	12.8 ab	12.93 ab	12.2 ab	12.6 b
Means^{NS}	13.51	13.11	11.74	-	13.95	14.33	13.42	-

CV=19.24%. Varieties= N.S LSD $_{0.05}$ =2.13 (Sowing technique) LSD $_{0.05}$ =3.689 (Interaction)
CV=14.62, Varieties=NS LSD $_{0.05}$ =1.742 (Sowing technique) LSD $_{0.05}$ =3.755 (Interaction)
Means followed by the same letter(s) in the respective category are non-significant at 5% level of probability

Table 5. Straw yield (ton ha^{-1}) affected by sowing techniques in wheat cultivars during 2009-2010 & 2010-2011.

Sowing techniques	2009-2010				2010-2011			
	Inqilab 91	Daman 98	Dera 98	Means*	Inqilab 91	Daman 98	Dera 98	Means*
30 cm single row	7.08 bc	6.11 c	5.89 c	6.36 b	7.11^{NS}	9.29	8.1	8.17
30 × 30 cm^2 cross sowing	6.91 bc	6.1c	6.59 bc	6.53 ab	10.98	9.23	8.68	9.42
45 × 45 cm^2 cross sowing	10.18 a	9.95 ab	5.95 c	8.69 a	7.93	8.8	7.33	8.02
Means*	8.05 a	7.39 ab	6.14 b	-	8.67	9.11	8.04	-

CV = 28.66% LSD $_{0.05}$ =1.099 (Varieties) LSD $_{0.05}$ =1.963 (Sowing technique) LSD $_{0.05}$ = 3.399 (Interaction)
CV = 25.33% Varieties = NS (Sowing technique) = NS Interaction =NS
*Means followed by the same letter(s) in the respective category are non-significant at 5% level of probability

Table 6. Harvest index (%) as affected by sowing techniques in wheat cultivars during 2009-2010 and 2010-2011.

Sowing techniques	2009-2010				2010-2011			
	Inqilab 91	Daman 98	Dera 98	Means^{NS}	Inqilab 91	Daman 98	Dera 98	Means*
30 cm single row	37.2 bc	38.3 bc	40.7 bc	38.7 b	39.00^{NS}	32.5	33	34.83 b
30 × 30 cm^2 cross sowing	49.0 ab	55.7 a	54.8 a	53.2 a	38.65	44.31	46.75	43.24 a
45 × 45 cm^2 cross sowing	35.1 c	36.4 bc	44.3 b	38.6 b	38.5	32.03	37.86	36.13 ab
Means^{NS}	40.4	43.5	46.6	-	38.71	36.28	39.20	-

CV = 19.58% LSD $_{0.05}$ =7.157 (Varieties) LSD $_{0.05}$ =12.25 (Sowing technique) LSD $_{0.05}$ =11.26 (Interaction)
CV =22.18% Varieties =NS SD $_{0.05}$ =7.25 (Sowing technique) Interaction = NS
Means followed by the same letter(s) in the respective category are non-significant at 5% level of probability

Biological yield (t ha^{-1}): Biological yield is inter-related with pant height and number of tillers per unit area (Ahmad *et al*., 1999) .While, Donald & Hamblin (1976) strongly advocated that biological yield should be a standard measurement along with grain yield to allow for the calculation of harvest index. The data regarding biological yield ton ha^{-1} given in Table 4 elucidated that it was significantly affected by sowing techniques during both years, but not significantly affected by varieties. Interaction of varieties and sowing techniques were also significant both the years. Cross sowing technique as shown in Table 4 indicated that biological yield ton ha^{-1} of this technique was more as compared to that of routine sowing technique during both years. This might have been due to uniform distribution of seeds, establishment of more seedling and maximum number of spikes recorded by cross sowing technique. The highest biological yield ton ha^{-1} (15.675 and 17.4) in variety Inqilab-91 interacted with the cross sowing technique (45 × 45 cm^{-2}) was recorded in year 2009-2010 and Inqilab-91 interacted with cross sowing technique (30 × 30 cm^{-2}) 2010-2011 respectively. Whereas least biological yield 9.90 ton ha^{-1} was recorded in the line sowing technique. More plants per unit area in cross sowing technique of 30 × 30 cm^2 are probable reason of this result. Nazir *et al*., (1987) found enhancement in biomass yield with cross sowing which is in concordance of the current findings. Among varieties, Inqilab-91 recorded maximum biological yield in both years. But all varieties were statistically at par during both years. Our findings coincide with those of Razzaq *et al*., (1986) who also observed non-significant differences in biological yield among various varieties. Ghaffar *et al*., (2013) revealed that biological yield along with yield attributes in wheat are influenced by planting pattern. Similarly, present results for biological yield are also corroborated by Naresh *et al*., (2014).

Straw yield (ton ha^{-1}): Varieties, sowing techniques and their interactions significantly affected the straw yield during 2009-2010 (Table 5), while the results differed non-significantly in 2010-2011. Interaction between the cultivars and the sowing techniques showed that Inqilab-91 sown with cross sowing (45 × 45) technique produced maximum straw yield 10.18 ton ha^{-1} in the year 2009-2010 and 10.98 ton ha^{-1} in 2010-2011, respectively. Variety Inqilab-91 produced significantly higher straw yield (8.05 ton ha^{-1}) in 2009-2010 but remained statistically at par with the other two varieties i.e. Daman-98 and Dera-98 in 2010-2011. All the three varieties produced higher but statistically equal straw yield when sown with cross sowing technique (45 × 45 cm^2) in 2009-2010. The cross sowing technique recorded maximum straw yield during both years. This might have been due to more number of tillers, which emerged and produced taller plants. Similar results were observed by Geleta *et al*., (2002) who recorded maximum straw yield in variety Inqilab-91. Our results are also in agreement with Nazir *et al*., (1987) who reported that cross sowing increased straw yield. Lockhart & Wiseman (1988) reported that a wheat cultivar tested under a specific regime may not produce more grain perhaps because unproductive or low yielding tillers were promoted, and a high leaf area and poor partitioning of food energy into grain and straw resulted in an increase in straw yield.

Harvest Index (%): The relationship between biological yield and grain yield of a crop is expressed in terms of harvest index, which ultimately determines the ability of a cultivar to convert the dry matter into economic yield. Sowing techniques and their interaction with the varieties differed significantly during 2009-2010 but non-significantly during 2010-2011 (Table 6). The varieties remained non-significantly different during both years. While in sowing techniques, cross sowing in 30 x 30 cm^2 remained statistically dominant over the other techniques in both years. Maximum harvest index in Daman-98 (55.7%) and Dera-98 (46.75%) was recorded when it was sown through cross sowing technique (30 x 30 cm^2) in year 2009-2010 and 2010-2011, respectively. Row spacing of 30 x 30 cm^2 cross sowing produced the highest grain yield as well as biological yield (ton ha^{-1}) which is ultimately reflected in highest harvest index (%). Similar indications were reported by Arif *et al*., (1997) in which higher harvest index was obtained in cross sowing over the other techniques.

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