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Effect of different sowing dates on growth and yield of candidate wheat varieties

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Abstract
The results showed that varieties as well as sowing dates had significant effect on most of the growth and yield contributing characters except tillers. Wheat variety Imdad-2005 proved to be more promising variety as compared to W.R.I-11 and SKD-2 varieties; with a plant height of 100.31 cm and 94.57 cm and 92.02 cm, tillers plant^{-1}, 6.11, 5.24 and 4.64, spike length, 10.37 cm, 9.92 and 9.44 cm, grain weight plant^{-1} 27.50 g, 25.32 g and 23.72 g, maximum biological yield 10355.49, 10162.14 and 9423.41 kg ha^{-1} were recorded from SKD-2 followed by Imdad-2005 and W.R.I-11 wheat varieties, grain yield 6134.60, 5962.03 and 5892.36 kg ha^{-1} and seed index value 5.26 g, 5.20 g and 4.64 g respectively. As regards sowing dates 15thNovember followed by 1st November sowing produced significantly better results for the growth and yield contributing characters of wheat varieties. It was concluded that variety Imdad-2005 was superior in all the growth and yield contributing characters, followed by W.R.I-11 and SKD-2; while among sowing dates, 15th November was remained appropriately best sowing time for producing highest grain yield in all varieties respectively.

Keywords: effect of different sowing dates, growth, yield, wheat varieties, tandojam

1. Introduction
Wheat (*Triticum aestivum* L.) is one of the world most widely cultivated cereal crop. It finds a major place in both time meals of common population in major wheat growing states. The cultivation of wheat has also been symbolic of green revolution, self-sufficiency in food and sustained production. As a result of technological innovations, the country which produced only. Wheat maintains superiority in area, production and versatility in adopting a wide range of agro climates. Increasing population leads to an increase demand of wheat with no possibility in further increase in area due to growing urbanization. Among production factors, sowing time and wheat varieties are the most crucial factors deciding its productivity. Sowing of wheat in Sindh generally starts from November and ends in late December depending on the weather; topography and harvesting of the preceding crop. Under late sown conditions, wheat face low temperature in the earlier part and high temperature in the later part of the growing season and require favorable moisture for better growth and development. In Sindh, late planting of wheat expressed to high temperature at reproductive stage causes reduced grain yield. Therefore, efforts ought to be made to minimize the effect of temperature variation caused due to changed sowing date by choosing appropriate wheat varieties which can synchronize its temperature requirement. Pakistan is the 9th largest wheat producer country; accounting for 3.04% of the world's wheat production from an area of 3.57% of the world Food and Agriculture Organization (FAO), wheat is the leading food grain of Pakistan and being staple diet of the people. It occupies a central position in formulation of agriculture policies. It contributes 14.4% to the value added in agriculture and 3.1% to GDP. 85% of wheat production takes place under irrigation system (tube well, canals) and 15% of wheat production takes place under rain feed area in Pakistan [1]. Wheat in Pakistan grown under different agro-ecological zones. In Sindh low crop yield is related to poor management. This includes later planting of wheat due to later maturity and harvest of previous crop like cotton, rice and sugarcane, low soil fertility due to continuous exhaustive cropping system and lack of legumes in the rotation and weed infestation. With the country anticipating record production of 25.4 million tons of wheat this year, the UN's Food and Agriculture Organization (FAO) has express satisfactions over rising cereal production in Pakistan in 2014 [2]. This increase is due to expansion in area under cultivation, favorable weather conditions during Rabi season in the main wheat producing provinces of Punjab and Sindh and ample supply of fertilizers and water. According to the State Bank of Pakistan's annual report for 2012-2013, the country produced 24.21 million tons of wheat from and area of 8.66 million hectares in the previous fiscal year of 2013, grew 23.47 million tons of wheat from 8.65 million hectares in 2012 and cultivated 25.21 [3]. Total 76% of wheat produced in Punjab, while Sindh produce 16%, KP-5% and Baluchistan produce 3% of total wheat produced across the country [2]. The average what production per acre in Sindh is close to 26 Munds, while in Punjab it is around 23 Munds per acre. In Sindh only 14-million-acre land is under wheat cultivation and only 1.8 million acres having two crops per year. In Pakistan, wheat is averagely used for about 60 percent of daily diet of common man with average per capita consumption of 125 kg [4]. Wheat yields in Pakistan are very low as compared to other advanced wheat growing countries

of the world. Among various factors responsible for low yield of wheat crop in the country. Sowing time and varietals selection are of primary importance [5, 6]. Reported that cultivated wheat varieties can be adopted to fairly broad range of climatic conditions and consequently has a wide regional distribution by significantly better examining different sowing dates. Wheat varieties according to their adoptability potential in various environments need to be improved [7].

Late planting of wheat is one of the major reasons of yield reduction. Reported that early sowing enhance germination per unit area, plant height, grains-1 and 1000 grain weight over late sowing. Delay sowing suppressed the yield. Wheat, so that a wheat variety with high bread quality and other promising characteristics can be grown successfully under different environments. Wheat sown in November was compare [5, 8]. Reported that's owing of wheat on 25th November resulted in expressing significantly more total tillers (420 m^2), higher crop growth rate (19.30 g m-2/day) at maturity and higher spike m^{-2} (400 spikes m^{-2}), 26.43 percent higher spike length (10.40 cm), 15.15 percent higher number of grain per spike (39 grains/spike), 45.20 percent higher grain yield (51.00 kg ha^{-1}). Wheat sown on 25th November achieves higher net return of 37400 with benefit: cost ratio of 1.34 which is 88.70 percent higher than 20th December sown wheat. Among wheat varieties K 0307 proved superiority in total tillers (492 m^{-2}) and grain yield (45.40 kg ha^{-1}), the use of certified seed of registered cultivar will aid the producer in limiting potential problems.

Keeping in view the facts stated above a study was carried out to assess the effect of sowing dates on the growth and grain yield of wheat varieties under agro- ecological conditions of Tandojam.

2. Materials and methods

The study to assess the impact of sowing dates effect on the growth and yield of wheat varieties was conducted at the experimental field of Agronomy Section, Agriculture Research Institute, Tandojam during 2013-14. The experiment was laid out in a three-replicated randomized complete block design (RCBD-Factorial), having net plot size of 3.15 x 5m (15.75m^2). The experimental land was left fallow after giving cross wise deep ploughing in the off season. After soaking dose, when the land came in condition, the seedbed was prepared by using cultivator (cross-wise plowing) and rotavator. Thereafter, clods were broken completely by clod crusher followed by thorough leveling. Pure seed of three wheat varieties was obtained with the courtesy of Wheat botanist, Agriculture Research Institute, Tandojam and the sowing was done on different dates and completed on first December 2013. The treatment details are given as follows:

2.1 Factor - A (Sowing dates) = 3
S_1 = 1st November, S_2 = 15th November, S_3 = 1st December

2.2 Factor - B (Varieties) = 3
V_1 = Imdad-2005, V_2 = W R I-11, V_3 = SKD-2

The sowing was done with the help of single row hand drill. Nitrogen was applied in the form of urea at the rate of 134 kg N ha^{-1} and 67 kg P_2O_5 ha^{-1} in the form of DAP. All P and 1/3rd of nitrogen fertilizer were applied at the time of sowing, while the remaining nitrogen was divided into two equal doses and applied at third and fourth irrigation. All the agronomic practices were carried out uniformly in all the plots. Irrigations were applied from sowing up to the crop maturity as per the schedule. The observations were recorded on the following parameters.

2.3 Observations recorded

1. Plant height (cm)
2. Tillers $plant^{-1}$
3. Spike length (cm)
4. Grain weight $plant^{-1}$(g)
5. Biological yield (kg ha^{-1})
6. Grain yield (kg ha^{-1})
7. Seed index (100 grain weight, g)

2.4 Procedure for recording observations

2.4.1 Plant height (cm)

Plant height was recorded at maturity of the crop in randomly selected plants using measuring tape from bottom to tip of the spike in centimeters.

2.4.2 Tillers $plant^{-1}$

Total tillers for randomly selected plants were counted at the time of maturity and averaged.

2.4.3 Spike length (cm)

The length of all the spikes in randomly selected plants was measured in centimeters with measuring tape and average was worked out.

2.4.4 Grain weight $plant^{-1}$(g)

Weight of grains from randomly selected plants was obtained after threshing and the average weight of grains $plant^{-1}$ was recorded in grams.

2.4.5 Biological yield (kg ha^{-1})

The all foliage and grains received from each plot were weighed on the basis of biological yield $plot^{-1}$, which converted into biological yield ha^{-1} in kilograms.

2.4.6 Grain yield (kg ha^{-1})

The grain received from each plot was weighed on the basis of grain yield $plot^{-1}$, which converted into grain yield ha^{-1} in kilogram

2.4.7 Seed index (100 grain weight, g)

The seed index was calculated by taking 100 grains from every treatment and weighed separately in grams.

2.4.8 Statistical analysis: The data thus collected were subjected to ANOVA technique using MSTAT-C statistical package. The LSD test was applied to compare mean superiority, where necessary (Russel and Eisensmith,1983).

3. Results

The experiment was conducted to evaluate the effect of different sowing dates on the growth and yield of wheat varieties at Agronomy Section, ARI, Tandojam, varieties

tested were: Imdad-2005, W.R.I-11 and SKD-2 and sowing dates were: 1st November, 15th November and 1stDecember. The observations recorded were: plant height (cm), tillers plant^{-1}, spike length (cm), grain weight plant^{-1} (g), biological yield (kg ha^{-1}), seed index (100 grain weight, g) and grain yield (kg ha^{-1}). The results thus are tabulated and analyzed and given as (Tables 1 to 7). The results on each parameter is presented as follows:

3.1 Plant height (cm)

The data shown in (Table-1) revealed that wheat variety Imdad-2005 produced significantly maximum plant height (100.31 cm), followed by variety W.R.I-11 (94.57 cm) plant height; while the minimum plant height (92.02 cm) was recorded from variety SKD-2 respectively. It is further revealed that the crop sown on 15th November produced maximum plant height (101.06 cm), followed by 1st December sowing date (97.46 cm) plant height. However, the minimum plant height (88.37 cm) was recorded under late sowing of 1st November respectively. The table further revealed that treatment interaction showed that variety Imdad-2005 when sown on 15th November produced significantly maximum plant height (110.17 cm), followed by the variety W.R.I-11 when sown on 1st December (98.66 cm) plant height, respectively. However, the minimum plant height (81.72 cm) was recorded in treatment combination of variety SKD-2x 1st November sowing.

3.2 Tillers plant^{-1}

The results presented in (Table-2) revealed that wheat variety Imdad-2005 produced comparatively greater number of tillers (6.11) plant^{-1}, followed by variety SKD-2 (5.24) tillers plant^{-1}. While minimum number of tillers (4.64) plant^{-1} was recorded in case of variety W.R.I-11. As regard the sowing dates 15th November sowing produced more number of (5.60) tillers plant^{-1}, followed by 1st November sowing dates (5.29) tillers plant^{-1}. However, 1st December sowing date produced less (5.11).

3.2.1 Tillers per plant respectively

Treatment interaction showed that variety Imdad-2005 when sown on 15th November produced significantly maximum (6.27) tillers plant^{-1}, followed by same variety when planted on 1st November (6.27) tillers plant^{-1}. However, the minimum (4.26) tillers plant^{-1} was recorded in treatment combination of variety W.R.I-11 x 1st December sowing respectively.

3.3 Spike length (cm)

The results presented in (Table-3) reported that spike length was comparatively greater (10.37 cm) in variety Imdad-2005 followed by variety W.R.I-11 (9.92 cm) and (9.44 cm) spike length from variety SDK-2 respectively. The data further indicated that 15th November sown crop produced relatively greater spike length (10.25 cm) followed by 1st November and 1st December sowings, (9.98 and 9.50 cm) spike length respectively. The results further revealed that interaction of variety Imdad-2005 x All sowing dates produced comparatively highest spike length (10.80 cm and 10.18 cm) and (10.15 cm) as compared to other varieties and sowing dates respectively.

3.4 Grain weight plant^{-1} (g)

It is obvious from the results (Table-4) that wheat variety Imdad-2005 produced comparatively greater grain weight plant^{-1} (27.50 g) followed by wheat variety W.R.I-11 (25.32 g) grain weight plant^{-1}, while the minimum grain weight plant^{-1} (23.72 g) was recorded in case of variety SKD-2 respectively. So far, the sowing dates are concerned; wheat sown on 15th November produced more (28.32 g) grain weight plant-1 followed by 1st December (25.10 g) and 1st November sowing dates produced less (23.14 g) grain weight plant^{-1} respectively. The treatment interaction revealed that maximum (30.79 g) grain weight plant^{-1} (30.79 g) was obtained under Imdad-2005 when sown on 15th November and minimum grain yield per plant (21.32 g) was recorded in treatment combination of variety SKD-2 x 1st November sowing date respectively.

3.5 Biological yield (kg ha^{-1})

The results pertaining to biological yield (kg ha) is presented in (Table-5). Wheat variety SKD-2 produced significantly maximum biological yield (10355.49 kg ha^{-1}) followed by variety Imdad-2005 with biological yield (10162.14 kg ha^{-1}), while minimum biological yield (9423.41 kgha^{-1}) was recorded under variety W.R.I-11 respectively. In case of sowing dates, it was observed that crop sown on 15th November produced significantly maximum biological yield (11146.44 kg ha^{-1}) followed by (9400.60 and 9394.00 kg ha^{-1}) biological yield when crop sown on 1st December and 15th November respectively. The treatment interaction revealed that maximum biological yield (11640 and 11217.33 kg ha^{-1}) was recorded from varieties SKD-2 and Imdad-2005 x 1st November sowing, minimum biological yield was recorded under other treatment interactions respectively.

3.6 Grain yield (kg ha^{-1})

Grain yield per hectare in wheat was the chief objective of this study. The results pertaining to grain yield per hectare is presented in (Table-6). Wheat variety Imdad-2005 produced significantly maximum grain yield (6134.60 kg ha^{-1}) followed by variety W.R.I-11 with grain yield (5962.03 kg ha^{-1}) while minimum grain yield (5892.36 kg ha^{-1}) was recorded in variety SKD-2 respectively. In case of sowing dates, it was observed that crop sown on 15th November produced significantly maximum grain yield (6213.80 kg ha^{-1}) followed by (6032.00 kg ha^{-1}) grain yield when crop sown on 1st December and the lowest grain yield (5743.20 kg ha^{-1}) was obtained from 15th December sowing respectively. The treatment interaction revealed that variety Imdad-2005 when sown on 15th November produced maximum grain yield (6292.60 kg ha). The minimum (5470.50 kg ha^{-1}) grain yield was obtained under variety SKD-2, when crop was sown on 1st December respectively.

3.7 Seed index (100 grain weight g)

The results regarding seed index of wheat varieties as influenced by sowing dates are reported in (Table-7). The results regarding the seed index of wheat varieties. Variety Imdad-2005 produced comparatively greater seed index (5.26 g) followed by variety W.R.I-II (5.20 g) and minimum seed index was recorded under variety SDK-2 (4.64 g) respectively. In case of sowing dates, it was observed that 15th

November sowing produced maximum seed index (5.36 g) followed by (4.91 g) seed index when crop was sown on 1st November. However, the 1st December sowing produced minimum seed index (4.82 g) respectively. Treatment interactions revealed that seed index was relatively higher (5.63 g) in variety Imdad-2005 x 15th November sowing, followed (5.43 g) seed index under treatment interactions of variety W.R.I-11 x 1st November and variety SKD-2 x 1st December sowing, respectively. However, SDK-2 x 1st November sowing produced minimum seed index value (4.23 g) respectively.

4. Discussion

4.1 Plant height (cm)

It was reported from the study that variety Imdad-2005 produced taller plants as compared to rest of varieties which was mainly associated with the genetic makeup of parental material of the variety. It was further observed that differences in varieties for plant height were significant; while sowing from 1st November did not show any significant influence on plant height. However, plant height started decreasing rapidly when sowing delayed up to 1st December. The results are in accordance of the findings of [9, 10, 8].

4.2 Tillers plant^{-1}

Wheat variety Imdad-2005 is superior in tillering capacity as compared to rest of the varieties. Moreover, tillering in wheat varieties was optimally satisfying when sown on up to 15th November and tillers per plant the differences for tillers per plant is significant. The findings of [11] is closely relatively comparable to the present results who obtained varied tillering capacity in different wheat varieties and little change in tillers due to sowing times. While results of [10] are in accordance [5]. reported from the study that significant influence on tillers per plant was recorded due to different sowing dates.

4.3 Spike length (cm)

Varieties Imdad-2005 and W.R.I-11 were relatively superior in spike length as compared to SKD-2, while all these varieties performed well in case of spike length under 15th November and 1st November sowing. However, variety SKD-2 was more sensitive to delayed sowing and it deteriorated spike length when sown on 1st December. The differences, however, among varieties were significant, while significant for sowing dates. The results of [10] are well in agreement with the results of present study; they obtained better spike length in early sown varieties as compared to late ones. Moreover, they were of the experience that varieties mostly are genetically different in producing spike length.

4.4 Grain weight plant^{-1} (g)

It is perceived that variety Imdad-2005 was significantly better in grain weight plant^{-1} compared to W.R.I-11 and SKD-2 varieties; while sowing of 15th November was significantly appropriate sowing time for producing maximum grain weight plant^{-1}. Moreover, the grain weight plant^{-1} decreased with delay in sowing. Results supported by [12] who reported more grain weight plant^{-1} was recorded in early sown wheat.

4.5 Biological yield (kg ha^{-1})

As regards wheat varieties, SKD-2 variety produced significantly maximum biological followed by variety Imdad-2005, while minimum grain yield was recorded in variety W.R.I-11. In case of sowing dates, it was observed that crop sown on 15th November produced significantly maximum biological yield followed by when crop sown on 1st December, However, early sowing 1st November produced minimum biological yield [9, 13, 14]. all have reported significant effect of sowing dates on biological yield of wheat and reported that delay in sowing reduced the grain yield per unit area.

4.6 Grain yield (kg ha-1)

In case varieties, Imdad-2005 remained significantly ($P<0.05$) superior in grain yield as compared to W.R.I-11 and SKD-2, while among sowing dates, 15th November sowing date proved to be most appropriate sowing time for getting higher grain yield per unit area compared to other sowing dates. These results are in agreement with those of [15] who reported that grain yield varied in different wheat varieties, while [10], [11, 9, 13, 14]. They have reported significant effect of sowing dates on grain yield of wheat further reported that delay in sowing reduced the grain yield per unit area [8]. Is confirmed the same results.

4.7 Seed index (100 grain weight, g)

Among varieties, Imdad-2005 variety showed significantly better results in seed index as compared to W.R.I-11 and SKD-2 varieties. In case of sowing dates, it was observed that it is better that sowing of wheat may be done up to the end of November and delay beyond this would lead to reduced seed index. These results are confirmed and supported by the findings of [10, 14, 9] who all were of the opinion that different wheat varieties had varied seed index values and early sown wheat produced higher seed index as compared to late sowing.

5. Tables

Table 1: Plant height (cm) of wheat varieties as affected by sowing dates

Sowing dates	Varieties			Mean
	Imdad-2005	W R I-11	SKD-2	
1st November	94.69	88.72	81.72	88.37 C
15th November	110.17	96.33	96.67	101.06 A
1st December	96.06	98.66	97.68	97.46 B
Mean	100.31 A	94.57 B	92.02 B	

CV % = 5.54%

	S	V	S x V
S.E	= 4.3327	4.3327	6.5325
LSD @ 5%	= 2.4549	2,4549	4.2521
LSD @ 1%	= 5.2042	5.2042	9.0140

Table 2: Tillers plant^{-1} of wheat varieties as affected by sowing dates

Sowing dates	Varieties			Mean
	Imdad-2005	W R I-11	SKD-2	
1st November	6.27	4.53	5.07	5.29 A
15th November	6.27	5.13	5.40	5.60 A
1st December	5.80	4.26	5.26	5.11 A
Mean	6.11 A	4.64 AB	5.24 B	

CV % = 7.04%

	S	V	S x V
SE	= 0.4054	0.4054	0.7021
LSD @ 5%	= -	0.8593	-
LSD @ 1%	= -	1.840	-

Table 3: Spike length (cm) of wheat varieties as affected sowing dates

Sowing dates	Varieties			Mean
	Imdad-2005	W R I-11	SDK-2	
1st November	10.15	10.40	9.40	9.98 B
15th November	10.80	10.10	9.85	10.25 A
1st December	10.18	9.26	9.07	9.50 B
Mean	10.37A	9.92 B	9.44 B	

CV % = 8.14%

	S	V	S x V
SE	= 0.6232	0.6232	1.0794
LSD @ 5%	= 1.3212	1.3212	
LSD @ 1%	= -	-	-

Table 4: Grain weight plant^{-1}(g) of wheat varieties as affected by sowing dates

Sowing dates	Varieties			Mean
	Imdad-2005	W R I=11	SDK-2	
1st November	24.57	23.52	21.32	23.14 AB
15th November	30.79	27.87	26.29	28.32 A
1st December	27.15	24.59	23.56	25.10 B
Mean	27.50 A	25.32 B	23.72 AB	

C V % = 10.94%

	S	V	S x V
SE	= 1.6672	1.6672	2.8877
LSD @ 5%	= 1.3177	1.3177	1.3177
LSD @ 1%	= 2.7935	2.7935	2.7935

Table 5: Biological yield (kg ha^{-1}) of wheat varieties as affected by sowing dates

Sowing dates	Varieties			Mean
	Imdad-2005	W R I=11	SDK-2	
1st November	11217.33	10582.00	11640.00	11146.44 A
15th November	9734.67	8888.67	9558.67	9394.00 B
1st December	9534.44	8799.56	9867.80	9400.6 B
Mean	10162.14 A	9423.41 B	10355.49 A	

CV % = 14.25%

	S	V	S x V
SE	= 732.95	732.95	269.5
LSD @ 5%	= 1553.8	1553.8	2691.2
LSD @ 1%	=		

Table 6: Grain yield (kg ha^{-1}) of wheat varieties as affected by sowing dates

Sowing dates	Varieties			Mean
	Imdad-2005	W RI=11	SDK-2	
1st November	6041.20	6031.50	6023.30.	6032.00 B
15th November	6292.60	6165.50	6183.30	6213.80 A
1st December	6070.00	5689.10	5470.50	5743.20 C
Mean	6134.60 A	5962.03 B	589236 AB	

CV % = 7.83%

	S	V	V x S
SE	= 364.72	364.72	631.71
LSD @ 5%	= 235.57	235.57	408.02
LSD @ 1%	= 499.38	499.38	864.95

Table 7: Seed index (100 grain weight, g) of wheat varieties as affected by different sowing dates

Sowing dates	Varieties			Mean
	Imdad-2005	W R I=11	SDK-2	
1st November	5.08	5.43	4.23	4.91 B
15th November	5.63	5.43	5.03	5.36 A
1st December	507	4.75	4.66	4.82 B
Mean	5.26 A	5.20 A	4.64 B	

CV % = 11.42%

	S	V	S x V
SE	= 0.2349	0.2349	0.4068
LSD @ 5%	= 0.4980	0.4980	0.8625
LSD @ 1%	= 0.5453	0.5753	0.9964

6. Conclusion

The results of the present study confirmed that variety Imdad-2005 was superior in all the growth and yield contributing factors as compared other wheat varieties. While 15th November sowing date remained appropriately best for producing higher grain yield in all varieties under local conditions of Tandojam.

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