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Effect of Planting Patterns and Weed Competition on Growth, Yield and Quality of Wheat (*Triticum aestivum* L.)

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ABSTRACT

Background: A study was done during the *Rabi* 2022-23 on the farm of Lovely Professional University, Phagwara (Punjab) on "Effect of planting patterns, weed competition on growth, yield and quality of wheat (*Triticum aestivum* L.)." PBW-824 variety was used for the experiment which is suitable under irrigated conditions of Punjab.

Methods: The experiment was conducted in split plot design (SPD) with 4 planting techniques *viz*. two rows per bed, three rows/ bed, bidirectional sowing, flat/line sowing in main/major plots and four weed competition treatments *viz*. competition by *Phalaris minor* only, competition by broad leaf weeds only, competition by both (weedy check) and no competition (weed free) in minor/sub plots.

Result: The findings concluded that among main plots, crucially more grain yield (51.93 q/ha) and (51.29 q/ha) was obtained in cross sowing and three rows/bed, than two rows/bed and flat/line sowing pattern. Also increased seed/kernel yield in cross sowing, three rows/bed and two rows/bed was (14.43%, 13.02% and 5.39%) respectively than flat sowing. The growth and yield attributes were also seriously more in cross sowing, three rows per bed than flat sowing. Among weed competition treatments grain yield was significantly higher in no competition by both *Phalaris minor* and broad leaf weeds than other weed competition treatments. There were 41.85%, 25.55% and 14.75% increased grain yield in no competition treatment, competition by broad leaf weeds only and competition by *Phalaris minor* only as compared to control (unweeded) treatment. Among sub plots, all yield attributes were significantly higher in weed free treatment as contrast to all other weed competition treatments.

Key words: Growth, Planting pattern, Weeds, Wheat.

INTRODUCTION

Wheat is of the world's important staple food. Its yield is being severely impacted by major biotic and abiotic factors such as infestation of weeds, insects, rodents, cold, salinity, flood, heat, and drought *etc*. Among various factors responsible for reducing wheat productivity, the infestation with weeds are one of the important factor to reduce the crop productivity. Weeds may reduce 20-30% wheat yield and it may go up to sometimes 62% depending upon their intensity, weed flora and types (Singh *et al.,* 2019). Weeds are common and compete with crops for agencies like water, nutrients, space, and light (Fahad *et al.,* 2015). According to FAO (Food and agriculture organization of United States, 2002) report that 30% losses by grassy weeds and 24% losses by broad leaf weeds in wheat are common. The time for critical crop weed competition periods in wheat varies from 30-50 days after sowing (Choudhary *et al.,* 2008).

The yield of wheat can be incremented by using proper planting techniques which includes bed method, cross sowing, flat sowing etc. Every method has its own pros and cons. Raised-bed method related to problems of water management, mean less effects of water logging in heavy soil or use high production irrigation system (Sayre *et al.,* 2004). Walia *et al*. (2003) recorded that the weight of 1000 grains, length of spike and grain yield was higher under the two rows per bed than conventional sowing but length of ear head of wheat was long under the three rows/bed. They observed that the less dry matter of weeds with narrow row spacing as compared to two or three row on bed planting.

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MATERIALS AND METHODS

The field experiment on wheat variety PBW 824 was grown at farm of Lovely Professional University, Phagwara, Punjab during *Rabi* 2022-2023. The trial was conducted on sandy loam soil with pH 6.9 and nitrogen (available) content was 312.3 kg/ha. The trial was set out in SPD with four planting techniques in main plots and four weed competiton treatments in sub plots with 4 replications. The 4 planting patterns *i.e*. M1- 2 rows per bed, M2- three rows/bed, M3- Cross sowing, M4-Flat sowing were stayed in main/major plots and 4 weed control treatments *i.e*. T1- competition by

Phalaris minor only, T2- competition by broad leaf weeds only, T3- no competition, T4- competition by both *Phalaris minor* and broad leaf weeds (weedy check) were retained in sub plots. The field was prepared with discing and cultivators (twice) and sowing was done with kera method on 4 November 2022. The sub plot size was 5×3.2 m and main plot size was 64 m. The size of bed was 67.5 cm with top of bed 37.5 cm and furrow 30 cm, two rows/bed and three rows/bed were sown on bed top. The spray of 2,4-D @ 250 ml, Axial @ 400 ml and ACM-9 @ 240 g were made to keep the crop free from broad leaf weeds, *Phalaris minor* and both respectively. The spray of herbicides was done after 35 days after sowing according to treatments. The first dose of N was applied at sowing time and 2nd half dose was appealed after 35 DAS. The 1st irrigation was appealed after 21 days after sowing (DAS) at CRI stage, 2nd at initiation of tillering, 3rd at boot stage, 4th at dough stage as opinion to rainfall situation.

To avoid the damage of jassid and aphids, the plot was sprayed with Malathion @ 1.0 lit./ha. After that crop was culled with sickle after 142 DAS after considering the signs of puberty and switch the colour of plant. Net plot harvested was two sq.m. from central portion of each plot. The plants was bind after harvesting and keep in sun for complete drying. Then crop was beated with stakes and seeds were winnowed and plot wise chew over on balance machine. The analysis was completed by OPSTAT.

RESULTS AND DISCUSSION

Weed count, dry matter accumulation by weeds and WCE

Increased in count of weeds of both *Phalaris minor* and broad leaf was significantly higher (Table 1) in bed with two rows due to wider row spacing and direct sunlight exposure to ground level. Similarly, weed count was significantly less in bidirectional sowing than bed with three rows, and two rows. The accumulation of dry matter of *Phalaris minor* and broadleaf weeds was significantly less in cross sowing planting method than other treatments of bed planting and flat planting when observations were recorded at harvest. Bed with two rows noticed significantly higher dry matter of weeds than other methods which may be due to more presence of space for growth of weeds in the former technique.

Among weed competition treatments, significantly less weed population and weed dry matter of *Phalaris minor* and broad leaf weeds was recorded at harvest in no competition treatment (weed free) which was seriously better than other weed competition treatments. Weed control efficiency (WCE) (percentage) was more in cross sowing (56.4%) than other planting techniques *viz*. three rows/bed (51.82 %), flat sowing (42.23%) and two rows/bed (31.8%). Among weed control treatments it was 100% in no competition treatment which was followed by 67.8% in competition by broad leaf weeds only and 14.6% in competition by *Phalaris minor* only. C.D for interaction between planting patterns and weed competition treatments were found to be non- significant. Ali *et al.* (2002) and Mahajan *et al.* (2001) examined similar results.

Plant height (cm) and crop dry matter accumulation (q/ha) at harvest

Plant height (cm) is important growth factor. The height of plants was crucially increased (Table 2) in two rows per bed than three rows/bed, bidirectional sowing and line/flat sowing methods when was recorded at harvest. Also plant height was at par with three rows/bed and bidirectional sowing techniques and it was significantly higher than flat sowing. The plant height in three rows/bed was more due to better growth, less spacing than three rows/bed. Significantly more accumulation of dry matter of crop was observed at harvest in bidirectional sowing which was at par with three rows/bed and both these treatments produced significantly higher dry matter aggregation of crop than two rows per bed and flat sowing methods.

In weed competition treatments the plant height noticed at harvest was significantly more in no competition by both *Phalaris minor* (grassy) and broad leaf weeds due to no growth of weeds than other weed competition treatments.

Table 1: Effect of different planting patterns and weed competition treatments on weed ount/sq.m., dry matter accumulation by weeds (q/ha) and WCE (%) of weeds in wheat at harvest.

Treatments	Population of weeds/sq.m.	Dry matter accumulation by weeds (q/ha)	WCE %
Main plot (Planting patterns)			
Two rows/bed	4.19(18.93)	2.89(7.46)	31.80
Three rows/bed	3.91(16.31)	2.56(5.27)	51.82
Cross sowing	3.61(13.37)	2.45(4.76)	56.48
Flat sowing	3.80(15.56)	2.71(6.32)	42.23
C.D. at 5%	0.25	0.16	-
Sub plot (Competition)			
Competition by P. minor only	5.01(23.87)	3.31(9.34)	14.62
Competition by broad leaf only	3.74(12.43)	2.33(3.52)	67.82
No competition	1(0)	1(0)	100
Competition by both	5.35(27.87)	3.56(10.94)	-
C.D. at 5%	0.44	0.26	-
C.D. for interaction	NS	NS	-

Square root transformation.

Table 2: Effect of different planting patterns and weed competition treatments on plant height (cm) and dry matter accumulation (q/ha) by wheat at harvest.

Treatments	Plant height (cm)	Crop dry matter (q/ha)
Main plot (Planting patterns)		
Two rows/bed	102.13	61.08
Three rows/bed	100.11	64.54
Cross sowing	99.49	65.18
Flat sowing	97.72	58.63
C.D. at 5%	1.48	1.48
Sub plot (Competition)		
Competition by P. minor only	98.94	60.01
Competition by broad leaf only	100.95	64.40
No competition	104.09	71.04
Competition by both	95.47	53.99
C.D. at 5%	1.53	1.50
C.D. for interaction	NS	NS

Table 3: Effect of different planting patterns and weed competition treatments on effective tillers/sq.m., spike length (cm), number of grains/ear, test weight (g) of wheat.

Treatments	Effective tillers/m^2	Spike length (cm)	No. of grains/ear	Test weight (g)
Main plot (Planting patterns)				
Two rows/bed	454.1	11.95	42.62	35.93
Three rows/bed	487.8	13.31	47.01	37.13
Cross sowing	500.9	13.52	51.91	38.52
Flat sowing	451.1	10.15	44.23	36.43
C.D. at 5%	23.4	0.42	1.37	0.72
Sub plot (Competition)				
Competition by P. minor only	469.8	10.80	40.23	36.21
Competition by broad leaf only	477.7	14.20	49.87	37.32
No competition	498.7	15.08	66.03	39.48
Competition by both	447.8	8.85	29.63	35.01
C.D. at 5%	11.8	0.52	1.32	0.59
C.D. for interaction	NS	NS	NS	NS

Also less crop dry matter accumulation was recorded in control *i.e.* competition by both *Phalaris minor* and broad leaf weeds resulting in less growth of crop. The dry matter aggregation of crop was significantly more in no competition than competition treatment than all other weed competition treatments. These results are in near findings with the conclusions of Bhullar *et al.* (2012) and Singh *et al.* (2019).

Effective tillers (m^2), length of spikes (cm), no. of grains ear^{-1} and 1000 weight (g)

In planting methods the effective tillers were at par in cross sowing and three rows/bed which were significantly (Table 3) more than two rows/bed and flat sowing methods. The spike length in cross sowing and three rows/bed was at par and significantly higher than two rows per bed and flat sowing techniques, also number of grains per ear and test weight were significantly higher in bidirectional sowing than three rows/bed, two rows per bed and flat sowing. These parameters were also significantly more better in weed free treatment than other weed competition treatments *i.e.* competition by *Phalaris minor* only, broad leaf weeds only and both of these. These results also close confirmty with Sharma *et al.* (2022).

Leaf area index, Chlorophyll index and Protein content (%)

Planting patterns and weed control treatments influenced significantly the leaf area index, chlorophyll and protein content of wheat (Table 4). In planting pattern treatments the leaf area index significantly higher recorded in two rows/bed *i.e.* 4.29 at 90 DAS than three rows/bed (3.46), cross sowing (3.16) and in flat sowing (3.11) due to better crop stand, less weed infestation and less competition between crop plants. Also chlorophyll index at 90 DAS significantly higher recorded in 48.67 than other planting pattern treatments. The protein content significantly highest recorded in two rows/bed (7.68%) than bidirectional sowing, three rows/bed and flat sowing (7.31%, 7.06%, 6.18%). Zhao *et al.* (2023) reported similar findings.

Among weed competition treatments, leaf area index and chlorophyll index at 90 DAS significantly highest observed in no competition treatment due to no weed population and the crop growth and development was better.

Table 4: Effect of different planting patterns and weed competition treatments on leaf area index, chlorophyll index and protein content (%).

Treatments	Leaf area index at 90 DAS	Chlorophyll index at 90 DAS	Protein content (%)
Main plot (Planting patterns)			
Two rows/bed	4.29	48.67	7.68
Three rows/bed	3.46	47.05	7.06
Cross sowing	3.16	47.14	7.31
Flat sowing	3.11	45.80	6.18
C.D. at 5%	0.44	NS	0.50
Sub plot (Competition)			
Competition by P. minor only	3.47	46.19	7.68
Competition by broad leaf only	3.54	48.16	6.68
No competition	3.78	48.21	5.12
Competition by both	3.23	46.08	8.68
C.D. at 5%	0.19	1.80	0.43
C.D. of interaction	NS	NS	NS

Table 5: Effect of different planting patterns and weed competition treatments on grain yield (q/ha), biological yield (q/ha), straw yield (q/ha) and harvest index (%) of wheat.

Treatments	Grain yield (q/ha)	Biological yield (q/ha)	Straw yield (q/ha)	HI %
Main plot (Planting patterns)				
Two rows/bed	47.83	108.92	61.08	43.83
Three rows/bed	51.29	115.83	64.54	44.16
Cross sowing	51.93	117.12	65.18	44.29
Flat sowing	45.38	104.01	58.63	43.53
C.D. at 5%	1.48	2.96	1.48	0.18
Sub plot (Competition)				
Competition by P. minor only	46.75	106.76	60.01	43.77
Competition by broad leaf only	51.15	115.56	64.40	44.24
No competition	57.79	128.83	71.04	44.83
Competition by both	40.74	94.73	53.99	42.96
C.D. at 5%	1.50	3.01	1.50	0.17
C.D. of interaction	NS	NS	NS	NS

Afterward no competition treatment the highest leaf area was recorded in competition by broad leaf only than competition by *Phalaris minor* only. But in case of chlorophyll the highest chlorophyll was significantly recorded in competition by *Phalaris minor* only than competition by broad leaf only. The leaf area index and chlorophyll index was lowest concluded in competition by both *Phalaris minor* (grassy) and broad leaf weeds. The protein content also highest recorded in no competition treatment.

Seed yield (q/ha), Biological (straw+grain) yield (q/ha), Straw yield (q/ha) and HI (%)

Planting techniques and weed control treatments affected significantly the grain yield of wheat crop. The grain yield (q/ha) in cross sowing and three rows/bed was found at par among themselves and both these treatments significantly increased seed yield than two rows/bed and flat sowing treatments (Table 5). The highest grain yield was noticed in cross sowing (51.93 q/ha) and three rows/bed (51.20 q/ha) which was followed by two rows/bed (47.83 q/ha) and flat sowing (45.38 q/ha). The planting pattern of cross sowing, three rows/bed and two rows/bed recorded 14.43%, 13.02% and 5.39 % more grain yield than flat sowing. The biological (grain+straw) yield, straw yield and harvest index was significantly better in cross sowing and three rows/bed than two rows/bed and flat sowing techniques. These results also same with Sudesh *et al.* (2017).

Among weed competition treatments, the all yield parameters were significantly higher in no competition treatment than all other weed competition treatments. Highest grain yield was recorded in weed free treatment (57.70 q/ha) followed by in competition by broad leaf weeds only (51.15 q/ha), competition by *Phalaris minor* only (46.75 q/ha) and lowest (40.74 q/ha) in competition by both type of weeds. Competition by *Phalaris minor* resulted in significant reduction in grain yield than competition by broad leaf weeds treatment. However competition by both type of weeds significantly reduced grain yield than all other competition treatments. The weed free treatment gave 41.85% more grain yield than weedy check whereas competition by broad leaf weeds only and *Phalaris minor* only increased grain yield by 25.55% and 14.75% respectively than joint competition treatment. Higher grain yield in weed free

Table 6: Effect of different planting patterns and weed competition treatments on nitrogen uptake by grains, straw and weeds (kg/ha).

Treatments	Nitrogen uptake by grains (kg/ha)	Nitrogen uptake by straw (kg/ha)	Nitrogen uptake by weeds (kg/ha)
Main plot (Planting patterns)			
Two rows/bed	58.83	38.26	36.82
Three rows/bed	57.95	35.39	30.77
Cross sowing	60.75	27.52	22.84
Flat sowing	44.92	19.05	34.03
C.D. at 5%	0.11	0.10	0.14
Sub plot (Competition)			
Competition by P. minor only	57.50	31.79	35.53
Competition by broad leaf only	54.73	28.13	45.52
No competition	75.12	47.38	0
Competition by both	37.07	15.88	37.48
C.D. at 5%	0.10	0.085	0.13
C.D. of interaction	NS	NS	NS

treatment due to better growth and development of crop because there was no competition between crop and weed. Kamboj *et al.* (2017) reported similar findings.

Nitrogen uptake by grains, straw and weeds (kg/ha)

Planting patterns and weed competition treatments influenced significantly the nitrogen absorption by grains, straw and weeds of wheat (Table 6). In planting techniques the nitrogen uptake by grains was significantly highest noticed in bidirectional sowing (60.75) than two rows/bed (58.83 kg/ha), three rows/bed (57.95 kg/ha) and flat sowing (44.92 kg/ha). In case of straw the highest nitrogen uptake was significantly observed in two rows/bed 38.26 kg/ha than three rows per bed, bidirectional sowing and flat/line sowing. In case of weeds the more nitrogen uptake in two rows per bed (36.82 kg/ha) than flat sowing (34.03 kg/ha), three rows/bed (30.77 kg/ha) and cross sowing (22.84 kg/ha).

In weed competition treatments the highest nitrogen uptake by grains, straw and weeds was significantly recorded in no competition treatment (75.12 kg/ha, 47.38 kg/ha, 0 kg/ha) than other competition treatments and lowest observed in competition by both type of weeds (37.07 kg/ha, 15.88 kg/ha, 37.48 kg/ha). The weed used more nitrogen than straw and broad leaf weeds consumed higher nitrogen than grassy weeds. These findings also similar with (Noor *et al.* 2023).

CONCLUSION

Among all the parameters, the growth parameters were higher in three rows/bed and two rows/bed but yield parameters was higher in cross sowing than other planting techniques because the growth was good on bed method due to loose soil and less infestation of weeds. Cross sowing and three rows/bed recorded more grain yield, biological yield, straw yield and HI than other planting techniques due to better favourable crop geometry. Among weed competition treatments the growth and yield attributes were significantly more better in weed free treatment (no competition by both *Phalaris minor* (grassy) and broad leaf weeds) due to good crop growth in the non-appearance of weeds than other weed competition treatments. *Phalaris minor* was found highly competitive as indicated by more reduction in grain yield than broad leaf weeds. The 32-42 days period was observed critical period of crop-weed competition.

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Conflict of interest

The authors declare that they have no conflict of interest.

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