



Productivity of wheat (*Triticum aestivum*) and weed competition influenced by different planting techniques and weed competition treatments

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ABSTRACT

An experiment was conducted during winter (*rabi*) 2022–23 and 2023–24 at Lovely Professional University, Phagwara, Punjab to study the productivity of wheat (*Triticum aestivum* L.) and weed competition influenced by different planting techniques and weed competition treatments. The wheat variety used for the experiment was PBW824. The experiment was conducted using a split plot design (SPD) with three replications. The major plots were assigned four different planting patterns, viz. two-rows/bed, three-rows/bed, cross sowing, and flat sowing while in the minor plots, there were four weed competition treatments, viz. competition by *Phalaris minor* alone; competition by broadleaf weeds (BLW) alone; joint competition (weedy check); and a weed-free treatment (without competition). These treatments were applied to study their effects on crop growth under varying planting patterns and weed competition conditions. Findings revealed that three-rows/bed and cross sowing produced significantly higher grain yield (5039 and 4727 kg/ha) and (5161 and 4662 kg/ha) than two-rows/bed and flat sowing technique. Grain yield also higher in three-rows/bed, bidirectional sowing and two-rows/bed was (11.94 and 10.34%, 14.02 and 9.09% and 4.60 and 4.80%), respectively than flat sowing. In comparison to joint competition there were (24.46 and 29.16%, 9.24 and 14.30% and 17.24 and 23.62%) higher grain yield in weed free treatment, competition by BLW only and competition by *Phalaris minor* alone. The 35–42 days critical period for crop-weed competition was observed and noticed various weed flora found in wheat field was *Phalaris minor*, *Malva neglecta*, *Melilotus indica*, *Medicago sativa*, *Sonchus arvensis*, *Argemone mexicana*, *Lepidium sativum*, *Veronica* spp., *Vicia sativa*, *Anagallis arvensis*, *Chenopodium album*, *Fumaria parviflora*, *Rumex spinosus*.

Keywords: Competition, Count, Planting techniques, Weed, Wheat

Wheat (*Triticum aestivum* L.) is one of the world's most frequently cereal crop globally, providing a food for large community of worldwide (Olabanji *et al.* 2007). Uttar Pradesh has highest production of wheat in India (359 lakhs metric tonnes) and productivity has more in Punjab per unit area. In Punjab the area of wheat was 35.2 lakh ha, production 176.3 lakh tonnes and average yield 20.4 q/ha (Annual Report 2021–22).

Choosing of proper planting techniques is very important to increase the crop productivity. The planting technique is more crucial for gaining a higher return and more crop output. Planting patterns in agriculture refer to the arrangement or layout of crops within a field or agricultural area (Zhao *et al.* 2023). Different planting patterns can impact crop growth, yield, and resource utilization. Some common planting patterns includes, Broadcasting, bed method, bidirectional sowing and line sowing. There are pros

and cons of both sides of flat and bed technique (Hahimi 2021). The growth and yield metrics, ridge and furrow method better than flat sowing. Row spacing is critical for sustaining the plant populations. Flat sowing inferior than bed technique because bed method gives strengthen to plants, save water, higher N use efficiency and lessen the crop-weed competition, less water logging, less erosion (Singh *et al.* 2021).

Weeds are unacceptable and lowers the efficiency of inputs and productivity of crops. Weed infestation during early phases of crop growth is one of key causes responsible for low productivity of crop. Weeds may reduce 20–30% yield reduction and it may go up to sometime 62% depending upon their intensity, weed flora and types (Singh and Sharma 2019). Weed compete with cultivated plants for nutrients, water, and sunlight, causing harm to the desired crops. The critical periods of weed competition in wheat ranges between 15–45 days after sowing (Trefe *et al.* 2016). The weeds caused 68.8% and 45.8% reduction in grain yields in wheat due to crop-weed competition with the infestation of both grassy and broad leaf weeds respectively (Yadav *et al.* 2018).

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MATERIALS AND METHODS

A experiment was conducted during winter (*rabi*) 2022–23 and 2023–24 at Lovely Professional University, Phagwara, Punjab. The wheat variety used for the experiment was PBW-824. The soil of the experimental farm was sandy loam pH 6.9, 6.3. Four planting methods (M_1 , Two-rows/bed; M_2 , Three-rows/bed; M_3 , Cross method; M_4 , Row/flat method were stayed in major compartments) and 4 weed control methods (T_1 , Competition by *Phalaris minor* alone; T_2 , Competition by broad leaf weed (BLW) alone; T_3 , Joint competition (weedy check); T_4 , No competition) were settled in sub compartments with use of split plot design (SPD) replicated four times. The discs and cultivators were used for preparation of field two times and November 5, 2022 during 1st season and November 3, 2023 during 2nd season *kera* technique was used for sowing. In both years, the size of principal plot 64 m² and 5 m × 3.2 m measured for sub compartments. The bed dimensions were 67.5 cm and 37.5 cm (top of bed), 30 cm (furrow) with 2 rows/bed and three-rows/bed grown on top of bed. The spray of 2,4-D ethyl ester @250 ml, Pinoxaden (axial) @400 ml and metribuzin + clodinofof (ACM-9) @240 g were sprayed on crop to avoid the infestation of *Phalaris minor*, broad leaf weeds (BLW) and both. According to protocols, the herbicide spray was completed (POE) after 35 days of seeding. At time of sowing the 1st N dose was applied and 35 days of sowing (DAS) the 2nd half dose was supplied. Due to precipitation the 1st irrigation was contested at crown root initiation (CRI) stage 21 DAS, the 2nd at starting of tillers, the 3rd at boot phase and 4th at milking phase.

To stop aphid and jassid damage, Malathion was spritzed on the plot @1.0 L/ha. The crop was sickled at 142 DAS during 1st season and 146 DAS during second, after accounting for the symbols of maturity. From the center of each plot, 2 m² of net plot were removed. Crop was banded after cutting and let to dry fully in the sunlight. Then crop was staked, the seeds were distinguished, and a balancing machine was used to inspect the plot. OPSTAT performed analysis. A quadrat of 0.3 m × 0.3 m (1 ft²) was thrown twice in every sub plot randomly and count of *Phalaris minor* and BLW was observed at 60, 90, 120 DAS and at harvest and later on converted into m² for presentation. Statistical analysis was done after square root transformation after adding one to all original values.

RESULTS AND DISCUSSION

Population of Phalaris minor/m²: In planting techniques, significantly increased population of *Phalaris minor* was observed less in bed with three-rows due to smothering effect and less weed competition on bed than furrow at 60, 90, 120 DAS and at harvest during both years than cross sowing, bed with two-rows and line/flat sowing (Table 1). Bed with two-rows noticed significantly more number of weeds than other methods which may be due to more space for growth of weeds in the former technique but in three-rows and bidirectional sowing was smothering effect of weeds and the weeds was present in furrows, so

competition was less on bed.

Among weed competition treatments, significantly less population of *Phalaris minor* was examined at 60, 90, 120 DAS and at harvest in no competition treatment (weed free) and competition by broad leaf weeds only; because here only present broad leaf weeds which was significantly better than other weed competition treatments. The count of *Phalaris minor* was significantly highest recorded in competition was *Phalaris minor* only than competition by both weeds. The interaction was significant at all growth stages during both years except at 90 DAS in 2022–23.

Generally, *Phalaris minor* count/m² was significantly less in bed sowing and cross sowing methods as compared to flat sowing when recorded at all periodic intervals during both years which may be due to the reason that in bed sowing methods weed seeds were buried deep at the time of bed preparation. The population of *Phalaris minor* was also less in cross sowing treatment as crop sown with this method smothered this weed effectively due to proper spacing of the crop. Number of weeds/m² were significantly less in weed free treatment and competition by broad leaf weeds only because there was no population of *Phalaris minor* in these treatments. The *Phalaris minor* population in joint competition treatment and in *Phalaris minor* competition treatment was significantly higher as compared to other competition treatments which may be due to the reason that *Phalaris minor* was allowed to grow freely under these treatments.

Population of BLW (no./m²): In planting techniques, the count of BLW was indicated at 60, 90, 120 DAS and at harvest during both seasons (Table 2). The less population of broad leaf weeds recorded in bed with three-rows due to less weed count because a few weeds was present only in furrows not on top of bed and the competition was less in bed. In bidirectional sowing weed population was also recorded less, due to smothering effect of crop. The population of broad leaf weeds was observed higher in flat sowing due to more availability of space.

In weed competition treatments, significantly highest number of wide leaf weeds was observed in competition by BLW only than competition by *Phalaris minor* and BLW both (weedy check) and lowest recorded in competition by *Phalaris minor* only and no competition treatment (weed free) because here was no weed population and observed only broad leaf weeds and both grassy and broad weeds at 60, 90, 120 DAS and at harvest. The CD of interaction was non-significant at 60, 90 and 120 DAS during 2022–23 but was significant all other growth stages. Same findings were recorded by Pandey *et al.* 2007 and Noor *et al.* 2023.

Count of broad leaf weeds/m² was highest in flat sowing method when recorded at all periodic intervals during both years than bed sowing methods as weed seeds were buried deep in bed planting treatments. In cross sowing techniques, all weeds were smothered by crop due to uniform distribution of crop plants in this technique. Number of broad leaf weeds/m² were significantly less in weed free treatment and competition by *Phalaris minor* only because they were

Table 1 Effect of planting patterns and weed competition treatments on count of *Phalaris minor*

Treatment	Population of <i>Phalaris minor</i> /m ²											
	60 DAS			90 DAS			120 DAS			At harvest		
	2022–23	2023–24	Pool	2022–23	2023–24	Pool	2022–23	2023–24	Pool	2022–23	2023–24	Pool
Planting technique												
M ₁	4.8(27)	5.9(54)	5.1(38)	3.5(15)	5.6(48)	4.7(31)	3.2(12)	5.5(45)	4.5(29)	3.1(11)	5.4(43)	4.4(27)
M ₂	4.0(22)	5.2(40)	4.8(33)	3.3(12)	4.8(33)	4.2(24)	3.0(10)	4.6(30)	4.0(20)	2.9(9)	4.5(28)	3.8(18)
M ₃	4.1(22)	5.8(51)	5.0(36)	3.3(12)	5.7(49)	4.6(30)	3.2(11)	5.4(45)	4.4(27)	2.9(9)	5.3(42)	4.3(26)
M ₄	5.2(39)	6.3(61)	5.7(49)	3.8(18)	6.1(57)	5.1(38)	3.3(13)	5.9(54)	4.8(33)	3.1(11)	5.8(52)	4.7(31)
LSD (<i>P</i> =0.05)	0.41	0.13	0.14	0.4	0.11	0.19	NS	0.09	0.13	NS	0.09	0.12
Weed competition treatment												
T ₁	7.7(59)	10.5(110)	9.2(83)	5.7(32)	10.0(100)	8.2(66)	5.4(28)	9.7(93)	7.8(60)	5.0(23)	9.5(89)	7.6(56)
T ₂	1	1	1	1	1	1	1	1	1	1	1	1
T ₃	7.1(51)	9.9(97)	8.7(74)	5.3(27)	9.4(89)	7.7(58)	4.5(19)	9.1(82)	7.2(50)	4.3(17)	8.8(78)	7.0(47)
T ₄	1	1	1	1	1	1	1	1	1	1	1	1
LSD (<i>P</i> =0.05)	0.29	0.14	0.14	0.41	0.15	0.2	0.31	0.18	0.09	0.37	0.18	0.11
Interaction	0.61	0.28	0.29	NS	0.3	0.41	0.64	0.36	0.2	0.76	0.37	0.23

Figures without parentheses are transformed values ($\sqrt{x+1}$). Figures with parentheses are original values.

DAS, Days after sowing.

Treatment details are given under Materials and Methods.

treated with selective herbicides in these treatments. The weed population in joint competition and competition by *Phalaris minor* treatments was significantly more due to no control of these target weeds in these treatments.

Dry matter accumulation of crop (kg/ha): The dry matter of crop was significantly increased in 3 rows/bed

than bidirectional sowing, two- rows/bed and line sowing methods when was recorded at 60, 90, 120 DAS and at harvest during both years (Table 3). Also dry matter was significantly at par with three-rows/bed and cross sowing techniques at 60, 90, 120 DAS and at harvest in 2022–23 and 2023–24 and it was significantly higher than two-rows/

Table 2 Effect of planting patterns and weed competition treatments on population of broad leaf weeds

Treatment	Population of broad leaf weeds/m ²											
	60 DAS			90 DAS			120 DAS			At harvest		
	2022–23	2023–24	Pool	2022–23	2023–24	Pool	2022–23	2023–24	Pool	2022–23	2023–24	Pool
Planting technique												
M ₁	2.9(9)	4.9(35)	4.1(22)	2.8(8)	4.8(33)	4.0(21)	2.7(7)	4.6(30)	3.8(19)	2.6(7)	4.5(29)	3.7(18)
M ₂	2.8(8)	4.0(22)	3.5(15)	2.7(7)	4.0(21)	3.5(14)	2.3(4)	3.9(20)	3.4(14)	2.1(3)	3.7(18)	3.0(12)
M ₃	2.8(8)	4.5(28)	3.8(18)	2.7(7)	4.5(28)	3.7(18)	2.3(4)	4.3(26)	3.5(15)	2.3(3)	4.2(24)	3.6(14)
M ₄	3.1(10)	5.0(37)	4.1(23)	2.8(8)	5.1(37)	4.1(23)	2.8(8)	4.9(35)	3.9(20)	2.7(7)	4.8(34)	3.8(18)
LSD (<i>P</i> =0.05)	NS	0.14	0.1	NS	0.2	0.17	0.4	0.18	0.22	0.21	0.2	0.13
Weed competition treatment												
T ₁	1	1	1	1	1	1	1	1	1	1	1	1
T ₂	4.9(22)	8.5(71)	6.9(47)	4.3(17)	8.4(69)	6.7(43)	3.9(14)	8.4(65)	6.4(39)	3.6(11)	7.9(61)	6.1(36)
T ₃	4.0(15)	7.2(51)	5.8(33)	4.1(15)	7.2(52)	5.9(33)	3.5(11)	6.9(47)	5.5(29)	3.3(10)	6.7(44)	5.3(27)
T ₄	1	1	1	1	1	1	1	1	1	1	1	1
LSD (<i>P</i> =0.05)	0.28	0.23	0.18	0.35	0.22	0.21	0.38	0.24	0.2	0.33	0.24	0.21
Interaction	NS	0.48	0.36	NS	0.45	0.44	NS	0.48	0.42	0.66	0.5	0.43

Figures without parentheses are transformed values ($\sqrt{x+1}$). Figures with parentheses are original values.

DAS, Days after sowing.

Treatment details are given under Materials and Methods.

bed and flat sowing. The dry matter in three-rows/bed and bidirectional sowing was more due to better growth, smothering effect, less weed count than other methods.

In weed competition treatments the dry matter aggregation noticed at 60, 90, 120 DAS and at harvest was crucially more in weed free treatment due to no growth of weeds than other weed competition treatments during both the years. Also less dry matter was recorded in control i.e. joint competition treatment resulting in less growth of crop due to huge weed growth and advancement but lesser plant stand. These findings with conclusions of Kamboj *et al.* 2017 and Du *et al.* 2021.

More dry matter aggregation in three-rows/bed and cross sowing due to superior crop stand on beds because of availability of better physical conditions. Also growth of cross sown crop was better due to uniform crop stand. In no competition treatment crop dry matter was more due to better crop growth in absence of weeds. Also crop dry matter in association with *Phalaris minor* was less as compared to crop grown in association of broad leaf weeds indicating there by that *Phalaris minor* is more competitive than broad leaf weeds.

Grain yield, straw yield, biological yield (kg/ha) and harvest index (%): Planting techniques and weed control treatments significantly affected the grain yield, straw yield, biological yield and harvesting index (Supplementary Table 1) of wheat crop during both years of the study. The grain yield (kg/ha) in three-rows/bed and bidirectional technique were at par aside each other and both these treatments significantly increased seed yield than two-rows/bed and flat method. The highest grain yield was noticed in three-rows/bed (5,039 kg/ha) and bidirectional sowing (5,161 kg/ha) in 2022–23 and (4,727 and 4662 kg/ha) in 2023–24 which was followed by two-rows/bed (4651 and 4452 kg/ha)

and flat sowing (4,437 and 4,238 kg/ha) during both the years. The straw and biological yield was observed seriously at par in three-rows/bed and bidirectional method which is more than 2 rows/bed and flat techniques. The planting method of three-rows/bed, cross sowing and two-rows/bed recorded (11.94 and 10.34 %, 14.02 and 9.09 % and 4.60 and 4.80 %) more grain yield than flat sowing during both years. The harvesting index was significantly better in three-rows/bed in 2022–23 but significantly more in cross sowing in 2022–23 than other treatments. All the yield parameters were significantly less recorded in flat sowing due to observed more count of weeds and competition was more for growth parameters.

Among weed competition treatments, yield parameters were crucially more in no competition method than all another competition method. Highest grain yield was recorded in weed free treatment (5,527 and 5,431 kg/ha) followed by in competition by BLW alone (5,016 and 4,654 kg/ha), competition by *Phalaris minor* alone (4,574 and 4,148 kg/ha) and lowest noticed (4,175 and 3,847 kg/ha) in competition by both type of weeds during both years. Competition by *Phalaris minor* resulted in significant reduction in grain yield than competition by broad leaf weeds treatment. Higher grain yield in weed free treatment due to better advances and superior crop stand because there was no competition between crop and weed. Also straw yield, biological yield and harvesting index was significant higher in no competition treatment than other treatments.

Grain yield in three-rows/bed and cross sown crop was significantly higher than flat sown crop as well as two-rows/bed planting pattern which may be due to less weed count. Aside competition methods grain yield was seriously higher in no competition method which may be due to the reason that all inputs like fertilizers, space, water and light were

Table 3 Effect of planting techniques and weed competition treatments on dry matter aggregation (kg/ha) of wheat

Treatment	Dry matter accumulation of crop (kg/ha)											
	60 DAS			90 DAS			120 DAS			At harvest		
	2022–23	2023–24	Pool	2022–23	2023–24	Pool	2022–23	2023–24	pool	2022–23	2023–24	Pool
Planting technique												
M ₁	975	804	890	3423	3148	3285	5483	5317	5401	5978	5704	5841
M ₂	1132	964	1048	3730	3375	3552	5751	5558	5654	6289	6003	6146
M ₃	1070	928	999	3627	3325	3476	5677	5462	5569	6363	5836	6099
M ₄	918	765	842	3354	3147	3251	5391	5207	5299	5763	5585	5673
LSD (<i>P</i> =0.05)	0.53	0.95	0.68	1.27	1.08	1.14	2.34	2.27	2.18	1.51	2.25	0.90
Weed competition treatment												
T ₁	986	830	908	3472	3143	3308	5516	5335	5425	5901	5673	5787
T ₂	1057	897	977	3555	3277	3416	5807	5613	5710	6341	5945	6143
T ₃	864	695	780	3261	2998	3130	4791	4597	4694	5299	5180	5240
T ₄	1189	1040	1114	3837	3576	3712	6188	5999	6094	6853	6328	6590
LSD (<i>P</i> =0.05)	0.46	0.67	0.53	0.63	0.87	0.66	1.78	1.86	1.82	1.43	1.72	1.12
Interaction	0.94	1.41	1.11	1.34	NS	1.39	NS	NS	NS	2.95	NS	2.28

Treatment details are given under Materials and Methods.

used by the crop only in no competition treatment. Crop infested with broad leaf weeds yielded more as compared to competition by *Phalaris minor* as it is more competitive weed than broad leaf weeds. However, the treatment of competition by both weeds recorded significantly less yield as compared to competition by *Phalaris minor* or broad leaf weeds alone due to severe crop-weed competition in this treatment. Higher grain yield in weed free and competition by broad leaf weeds only than all other competition treatments may be due to less weed intensity.

Cross sowing and three-rows/bed recorded more yield of grains, biological yield, yield of straw and HI than other planting techniques due to higher favourable crop geometry. Among weed competition treatments the less count of weeds, dry matter of crop and yield parameters were crucially better in without weeds treatment (weed free due to absence of 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.

REFERENCES

- Annual Report. 2021–22. *Directorate of Economics and Statistics and International Wheat Production Statistics*. Ministry of Agriculture and Farmer's Welfare, New Delhi.
- Du X, Le W, Zhou Y, Kong L, Wei Z, Xu Y, Xu W and Xi M. 2021. A novel planting patterns increases the grain yield of wheat after rice cultivation by improving radiation resource utilization. *Agricultural and Forest Meteorology* **310**: 108625. <https://doi.org/10.1016/j.agrformet.2021.108625>
- Hahimi S M, Afsana N and Sarhadi W A. 2021. Study of raised bed planting method on yield and yield componenet of wheat in Kabul. *International Journal of Science and Research* **10**(1): 303–08.
- Kamboj N K, Sangwan N, Hooda V S and Gupta G. 2017. Effect of planting methods and weed management practices on yield and nutrient uptake by wheat (*Triticum aestivum* L.). *Indian Journal of Economics* **44**(6): 889–92.
- Noor H, Sun M, Sun P, Gao Z, Ding P, Yan Z, Zhang L, Li L and Ren A. 2023. Effects of nitrogen on photosynthetic productivity and yield quality of wheat. *Agronomy* **13**(6): 1448. <https://doi.org/10.3390/agronomy13061448>
- Olanbanji O G, Mohammed I, Nkema I, Omeje M U and Ndahi W. 2007. Principles of production and utilization of wheat, in cereal crops of Nigeria. *Principles of Production and Utilization* **22**(337): 230–49.
- Pandey I V, Pandey R K and Deivedi D K. 2007. Efficacy of herbicide and fertilizer management on weed dynamics in wheat (*Triticum aestivum*). *Indian Journal of Agronomy* **52**(3): 235–38.
- Singh K and Sharma R. 2019. Effect of different methods of sowing and row orientation on growth, yield and quality of wheat (*Triticum aestivum*). *Agricultural Research Communication Centre* **39**(1): 51–54.
- Singh A, Kaur K, Chabra V, Kaur M and Bhakri A. 2021. Comparison of growth attributes in raised and flatbed methods of sowing on wheat. *The Pharma Innovation* **10**(8): 822–25.
- Terefe H, Denberu E and Woldesenbet A. 2016. Effects of different weeding time of Ryegrass on growth and yield components of wheat (*Triticum* spp.) in Jimma area, south-west Ethiopia. *International Journal of Research Granthaalayah* **4**(10): 111–17.
- Yadav D B, Singh N, Duhan A, Yadav A and Punia S S. 2018. Penoxsulam + cyhalofop-Butyl (premix) evaluation for control of complex weed flora in transplanted rice and its residual effects in rice-wheat cropping system. *Indian Journal of Weed Science* **50**(4): 333–39.
- Zhao Y X, Zhou X B, Mao X M and Yong Y Y. 2023. Effects of irrigation and planting patterns on photosynthetic capacity and grain quality of winter wheat. *International Agrophysics* **33**(3): 313–21.