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Effect of population density of *Phalaris minor* on production potential of wheat (*Triticum aestivum*)

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ABSTRACT

A field experiment was conducted at Ludhiana, Punjab, for two years (2006-07 and 2007-08) to study the effect of varying population levels *viz.,* 0, 10, 15, 25, 50, 75, 100, 125, 150, 200, 250 and a solid stand of *Phalaris minor* on the production potential of wheat (*Triticum aestivum* L. emend Fiori and Paol) crop and also to find out the critical threshold level of *Phalaris minor.* In the experiment *Phalaris minor* population was deliberately maintained in wheat crop after 30 days of sowing. As the population density of *Phalaris minor* increased, the dry matter production, number of tillers as well as effective tillers and ultimately yield of wheat decreased exponentially. Even the presence of 15 plants/m^2 *Phalaris minor* resulted in significant decrease (14%) in wheat yield. Reduction in wheat yield was mainly attributed to reduction in the number of effective tillers, lesser grains/spike and lower 1,000-grain weight.

Key words : *Phalasis minor, Population density, Wheat* .

Wheat is the most important and widely cultivated cereal crop in the world. In Punjab it is cultivated over an area of 3.52 million ha with a total production of 15.7 million tones and an average yield of 4.5 t/ha (Anonymous, 2010). Major detriments to higher productivity of wheat are stiff competition from weeds, multiple nutrient deficiencies, insect-pests and incidence of diseases. Infestation by different species of weeds in wheat is one of the major problems faced by the farmers and severe weed competition has resulted from the change in morphological characteristics of wheat varieties and shift in sowing paradigm over a period of four decades. Moreover, high initial soil moisture and low temperature at sowing leads to severe infestation by grassy and non-grassy weeds. Global yield reduction in wheat due to weeds is 13.1% (Oerke *et al.,* 1994) or even more. Anjuman and Bajwa (2010) reported that selected wheat varieties incurred 60-65% biomass loss due to weed infestation. The effect was evident on tillering capacity which decreased by 41.6%. Among different weed species, the infestation by little seed canary grass (*Phalaris minor*) in wheat is rampant and it alone divests the crop of 42.2 kg N, 6.5 kg P and 71.6 kg K/ha (Walia and Gill, 1985a).

Weeds also interfere with harvest and lower the quality of grains. Yield loss and harvest problems caused by weed species in wheat will vary depending on the weed species, weed population, time of weed emergence, growing conditions and status of wheat crop. A healthy stand of wheat that has a head start on weeds is competitive and will suppress weed growth. However, increased uptake of mineral nutrients in weeds often results in a significant competitive advantage over crop species. The present study was, therefore, undertaken to investigate the effect of levels of population of little seed canary grass (*Phalaris minor* Retz.) on growth and yield of wheat crop.

MATERIALS AND METHODS

Field experiment was conducted at the Student's Research Farm of the Department of Agronomy, Punjab Agricultural University, Ludhiana during *rabi* seasons of 2006-07 and 2007-08. The soil of the experimental field was sandy loam in texture, with normal soil reaction (pH 7.63 and 7.41) and electrical conductivity (0.14 and 0.18 dS/m). Soil was low in organic C (0.35 and 0.33%) and available N (238.7 and 219.5 kg/ha) and medium in available P (19.2 and 18.9 kg/ha) and K (207.2 and 203.5 kg/ha) in 2006-07 and 2007-08, respectively. The experiment consisting of 12 population levels of *Phalaris minor* i.e. 0, 10, 15, 25, 50, 75, 100, 125, 150, 200, 250 plants/m^2 and a solid *Phalaris minor* stand (T_{max}) was conducted in Randomised Block Design (RBD). The different population levels of little seed canary grass were deliberately

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maintained under field conditions by charging the field with *P. minor* seed first at the time of sowing of wheat crop and after a month of sowing the required plant density was maintained on per meter square basis and rest of the weed species were removed manually. The Wheat variety PBW 343 was sown in mid November with kera method (behind a desi plough) using a seed rate of 100 kg/ha. The biometric observations like plant height, dry matter production, leaf area index, chlorophyll index, number of tillers for both crop as well as weed were recorded periodically and yield contributes of wheat were recorded at harvest. Plant height (cm) of wheat crop and weed plants was recorded at harvest by selecting ten plants at random from each plot from plant base (soil surface) to the base of the last fully opened leaf. The samples for dry matter production were taken from 25 cm row length, oven dried at 65^o C till a constant weight achieved and weighed for dry matter which was converted into g/m^2 and then into q/ha for presentation. Leaf area was recorded with the help of calibrated Plant Canopy Analyzer (LICOR-make, Model LAI 2000).

The number of effective tillers was recorded at the time of harvest from 25 cm row length in each plot and then converted into per square meter basis. For recording dry matter accumulation by weeds, weed plants were removed from ground level by using quardrat of 50 × 50 cm. These samples were first sundried and then dried in oven at 60^{0}C and after the samples reached a constant weight, the dry matter accumulation was recorded and expressed as g/m^2. The weed samples were also used for recording leaf area which was measured with leaf area metre (Model GA-5) and the leaf area index was calculated. Yield attributes of wheat crop like spike length, number of grains/spike, grain weight, 1,000-grain weight, grain yield and straw yield were recorded at harvest.

RESULTS AND DISCUSSION

Weed growth

Plant height of *Phalaris minor* increased with increasing levels of its population from 10 to 250 plants/m^2 (Table 1). The tallest (105.30 cm) *P. minor* were in its solid stand, which was statistically at par with the treatments having 125, 150, 200 and 250 plants/m^2. The lowest height of *P. minor* plants varied from 85 to 90 cm in its population density of 10-75 plants/m^2. The increase in plant height at higher population densities was due to competition for light, nutrients and space.

The fastest increase in dry matter accumulation (DM) was obtained during 90-120 DAS, and it slowed down later. At harvest, it was observed that the dry matter accumulation by *Phalaris minor* increased with increase in weed population levels from 10 to 250 plants/m^2. A significant increase in DM of *P. minor* was recorded when the density increased from 10 to 75 plants/m^2, while the next significant increase in DM was recorded when density was increased from 75 to 150 plants/m^2 and a final increase when it was increased from 150 to 200 plants/m^2, the latter was at par with a density of 250 plants/m^2.

Leaf area index (LAI) was the highest with solid stand of *P. minor* which was at par with a plant density of 250 plants/m^2; both these treatments were significantly superior to a density of 100 plants/m^2, which in turn recorded significantly more LAI than plant densities of 10-25 plants/m^2. The largest number of tillers/plant were produced when the plant density was 10 plants/m^2, while the least number of tillers/plant were produced in the solid stand of *P. minor*. There were only minor differences between different densities in respect of number of tillers/plant.

Wheat growth

The mean data on plant height showed an increasing trend in plant height with increasing population pressure of *P. minor* up to 75 plants of *P. minor*/m^2 and then it decreased with further increase in weed population levels (Table 2). The tallest (89.7cm) wheat plants were recorded with 75 plants of *P. minor*/m^2 which was statistically at par with treatments having 50, 100 and 125 plants of *P. minor*/m^2, while the shortest (76.5cm) wheat plants were recorded with a *P. minor* density of 250 plants/m^2, which was statistically at par with a *P. minor* density of 200 plants/m^2.

Dry matter (DM) accumulation of wheat was affected significantly by presence of different levels of *P. minor* and DM accumulation decreased with an increase in weed density. At harvest, weed free wheat (sole wheat) accumulated largest amount of dry matter, which was significantly more than all other treatments. The lowest dry matter accumulation (7665g/m^2) at harvest was recorded in treatment having the highest *Phalaris minor* density (250 plants/m^2). The reduction in dry matter accumulation with 25, 50, 100, 150, 200 and 250 plants of *P. minor*/m^2 was to the tune of 10.9, 12.64, 19.40, 24.51, 27.34 and 31.28%, respectively compared to the sole crop. The difference in dry mater accumulation under various treatments is due to severe competition posed by *P. minor* to the wheat crop. Graf and Hill (1992) reported that even at a density of 100 rice plants/m^2, 10 plants of *E. crusgalli/* m^2 caused a yield loss of about 50%.

At 100 DAS, maximum (4.990) LAI was obtained with *P. minor* density of 250 plants/m^2, which was significantly higher than all other treatments except 125, 150 and 200 plants/m^2 being at par with one another. Similarly population densities starting from sole wheat upto 50 plants of *P.*

Table 1. Plant height, dry matter, leaf area index and number of tillers of *Phalaris minor* under its different population densities (Data pooled over two years)

P. minor Plants/m^2	Plant height at harvest (cm)	Dry matter at harvest (g/m^2)	Leaf Area Index 100 DAS	Number of tillers per plant 100 DAS
10	86.0	80.5	1.21	4.07
15	86.4	99.0	1.20	3.47
25	85.5	102.0	1.21	3.39
50	87.4	125.5	1.28	3.32
75	90.2	159.0	1.31	3.23
100	95.9	203.0	1.35	3.15
125	98.1	260.5	1.37	3.11
150	99.6	312.0	1.37	3.09
200	99.7	387.5	1.42	3.06
250	100.1	429.0	1.50	3.02
Solid stand of *P. minor*	105.3	508.0	1.61	2.97
SEm$\pm$	2.03	24.01	0.07	0.048
CD (P=0.05)	6.36	70.5	0.120	0.153

Table 2. Plant height, dry matter, leaf area index and number of effective tillers of wheat under different population densities of *Phalaris minor* (Data pooled over two years)

P. minor Plants/m^2	Plant height at harvest(cm)	Dry matter at harvest(g/m^2)	Leaf Area Index 100DAS	Effective tillers at harvest (No's/m^2)
Pure wheat	83.2	11155	4.36	391.2
10	82.7	10365	4.35	385.7
15	83.2	10300	4.46	383.3
25	81.7	9935	4.29	368.9
50	85.0	9745	4.58	329.5
75	89.8	9095	4.65	309.4
100	88.6	8990	4.97	270.4
125	87.8	8360	4.89	235.5
150	82.8	8420	4.91	209.8
200	79.4	8105	4.96	179.7
250	76.5	7665	4.99	168.5
SEm$\pm$	1.65	187.5	0.09	15.8
CD (P=0.05)	5.1	598.5	0.33	48.3

minor were statistically at par with each other. This is because the leaf area for wheat crop was recorded with canopy analyzer and it gives the representative LAI of the whole plot which includes wheat as well as *P. minor*.

The number of tillers decreased with increasing population pressure of *P. minor* due to competition for space, moisture and nutrients between wheat and *P. minor*. The highest (391.95) number of effective tillers were recorded in sole wheat crop and the lowest number (168.50) were recorded with *P. minor* density of 250 plants/m^2, which resulted in reduction of more than 50% effective tillers as compared to sole wheat crop due the intense competition posed by *P. minor.* The higher leaf area index in high weed density plots caused an increasing light extinction which reduced tillering of wheat (Table 2) and increased tiller mortality rate. These results are also supported by the findings of Graf *et al* (1990).

Wheat yield

A linear decrease was recorded in number of grains/spike with increasing population densities of *P. minor*. Highest number of grains/spike (50.05) was produced with 10 plants of *P. minor*/m^2 being at par with solid stand of *P. minor* and 15 plants of *P. minor/*m^2, was significantly superior to rest of the population levels of *P. minor.* Significantly lesser number of grains/spike (36.85) was recorded with 250 plants of *P. minor* /m^2. Lesser number of grains/spike with higher *P. minor* densities compared to the sole wheat stand was due to severe competition faced by wheat crop for light, nutrients and space under high weed densities of *P. minor*.

Sole wheat crop produced bolder grains, and was statistically at par with 10, 15 and 25 plants of *P. minor* /m^2, but significantly superior to rest of *P. minor* density levels. The lowest 1000 grain weight (37.45g) was recorded with

250 plants of *P. minor*/m^2, which was significantly inferior to all other population levels except 200 plants of *P. minor*/m^2, with which it was statistically at par. Weed population densities of 125, 150, 200 and 250 plants of *P. minor*/m^2 recorded 12.1, 13.4, 19.2, 20.2% reduction in the thousand grain weight as compared to sole wheat crop. The reduction in grain weight of wheat in higher weed population treatments was caused by severe competition posed by weeds to wheat crop.

Straw yield increased with increasing population levels of *P. minor* and lowest straw yield (4.56t/ha) was recorded with 10 plants of *P. minor*/m^2 which was statistically at par with sole wheat crop, 15, 25, and 75 plants of *Phalaris minor*/m^2. The highest straw yield (5.92t/ha) was recorded with 200 plants of *P. minor* /m^2 and it was statistically at par with 50, 100, 150 and 250 plants of *P. minor* /m^2. Grain yield of wheat decreased with increasing levels of *P. minor* from 10 to 250 plants/m^2 (Table 3). The highest grain yield (6.31t/ha) was recorded under pure crop stand, which was statistically superior to all other treatments having different population levels of *P. minor* /m^2 except 10 plants of *P. minor*/m^2. Even presence of 25 plants of *Phalaris minor*/m^2 reduced the grain yield of wheat to the tune of 36.28%. A significant reduction in grain yield was recorded ranging from 36.28 to 69.01% with 25 and 250 plants of *Phalaris minor*/m^2 as compared to pure crop stand. The reduction in grain yield with presence of 125, 150, 200 and 250 plants of *P. minor* /m^2 was 57.2, 61.9, 65.5 and 69.0% respectively compared to the pure crop stand. The lowest grain yield (1.95t/ha) was recorded with 250 plants of *P. minor* /m^2 being at par with a density of 150 and 200 of *P. minor* /m^2.

At higher population levels of *P. minor* (150, 200 and 250 plants of *P. minor* /m^2), there was a gradual increase in DM accumulation by *Phalaris minor* (Table 1) and *Phalaris minor* plants were comparatively taller than wheat plants (Table 1) caused suppression of wheat crop and significantly reduced the grain yield because of lesser LAI, dry matter production and number of effective tillers/m^2 produced by wheat crop.

The findings reported by Walia and Gill (1985 a & b) also showed that depending upon the intensity of *Phalaris minor*, 15-25% losses in grain yield of wheat are quite usual. Dhaliwal *et al* (1997) reported that as density of *Phalaris minor* increased, wheat yield decreased exponentially. Yield losses exceeded 50% with density of 500 plants/ m^2. Reduction in wheat yield is mainly attributed to reduction in the number of ears (effective tillers). Wheat yield losses can also be related to the total dry weight of *Phalaris minor* present at harvest. The relationship between weed dry weight and wheat grain yield fitted reasonably the same exponential model that was used for

Table 3. Yield attributes, grain yield, straw yield and harvest index of wheat as affected by different densities of *Phalaris minor* (Data pooled over two years)

P. minor Plants/m^2	Number of grains/ spike	1,000-grain wt (g)	Grain Yield (t/ha)	Straw Yield (t/ha)	Harvest Index
Pure wheat	49.90	45.00	6.31	4.84	0.56
10	50.05	44.20	5.71	4.65	0.55
15	49.05	43.10	5.45	4.84	0.53
25	46.90	43.05	4.63	5.31	0.47
50	45.00	42.70	4.20	5.55	0.43
75	42.25	41.75	4.00	5.09	0.44
100	42.80	41.15	3.48	5.51	0.39
125	40.90	40.15	2.70	5.66	0.32
150	40.85	39.70	2.40	5.52	0.30
200	39.95	37.75	2.18	5.92	0.27
250	36.85	37.45	1.95	5.71	0.25
SEm$\pm$	1.06	0.79	0.29	0.26	0.024
CD (0.05)	3.04	2.21	0.759	0.848	0.08

Table 4. Correlation studies between Plant height, Dry matter accumulation, Leaf area index, tiller number/plant of *P. minor* and wheat yield

Treatment	Plant Height	Dry matter accumulation	Leaf area index	Number of tillers per plant	Wheat yield
Plant Height	-	0.950	0.970	0.975	-0.855
Dry matter accumulation	-	-	0.937	0.928	-0.759
Leaf area index	-	-	-	0.959	-0.734
Number of tillers per plant	-	-	-	-	-0.772
Wheat yield					-

weed density. The infestation of *Phalaris minor* alone can reduce wheat grain yield up to 40% (Singh *et al* 1997). Losses in yield depend upon the type and intensity of these weeds. Infestation of *Phalaris minor* throughout the crop growth period caused 29-40% loss as compared to weed free treatment (Singh *et al* 1993). Harvest index of wheat decreased with increasing weed density and the lowest harvest index was recorded with 250 plants of *P. minor*/m^2, the highest being in sole wheat crop i.e. the treatment without any competition with weeds.

Correlation studies

The data showed a positive correlation amongst various growth parameters of *P. minor* (Plant height, DM accumulation, LAI, number of tillers /plant) and a negative correlation of these parameters with wheat yield (Table 4). All the growth parameters of *P. minor* adversely and negatively affected the yield of wheat crop as the correlation coefficient (r^2) were higher than 0.5. Among various growth parameters, plant height of *P. minor* had maximum adverse effect on the yield of wheat crop with a correlation coefficient (r^2) of -0.855 followed by number of tillers/plant (r^2= -0.772), dry matter accumulation (r^2= -0.759) and leaf area index of *P.minor* (r^2= -0.734).

It was concluded that *P. minor* competed with the wheat crop for various growth factors and significantly reduced the dry matter accumulation, leaf area index, number of effective tillers, Number of grains/spike, 1000 grain weight and ultimately grain yield of wheat crop depending upon its density. Even the presence of 15 plants of *P. minor*/m^2 significantly reduced the grain yield (13.6%) of wheat.

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