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The Effect of *Phalaris minor* (Canary grass) Densities and Seed Rates of Wheat on Yield and Yield Components of Wheat (*Triticum aestivum*)

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ABSTRACT: In order to study the effect of canary grass densities and seed rates on yield and yield components of wheat, field trials were conducted at Sari Agricultural Sciences and Natural Resources University of Iran during the crop season of (2015-2016). The experiment was laid out in randomize complete block (RCB) design with split plot arrangement. Four seed rates viz.120, 140, 160 and180 kg ha^{-1} of wheat was assigned to main plots, while canary grass densities 0, 5, 10, 15, 20, 25 and 30 seed m^{-2} was kept into sub-plots. Data were recorded on number of spikes m^{-2}, spike length (cm), grains spike^{-1}, 1000 grain weight (g), grain yield (kg ha^{-1}) and harvest index (%) of wheat and tillers plant-1 and dry weight (gm^{-2}) of *P. minor*. Results showed that, canary grass densities and wheat seed rates had significant effect on the above mentioned traits. Statistical analysis of the data showed that most of the parameters were statistically affected by canary grass densities and wheat seed rates while their interaction showed non-significant variation. Maximum number of spikes m^{-2} (268.75), spike length (9.18 cm), grain spike^{-1} (48.41), 1000-grain weight (41.96), grain yield (2853.69 kg ha^{-1}) and harvest index (40.63%) were recorded in wheat monoculture (0 canary grass density plot). Seed rate of 160 kg ha^{-1} had significantly higher spikes m^{-2} (286.7), spike length (8.72 cm), 1000-grain weight (48.87 g), grains spike^{-1} (47.33) and grain yield (2813.58 g m^{-2}). Thus a seed rate of 160 kg ha^{-1} of wheat is recommended for suppression of canary grass population at wheat crop.

Keywords: Density, Wheat, Canary grass, Yield components, Grain yield

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INTRODUCTION

Wheat (*Triticum spp*.) is a cereal grain (Bala *et al.,* 2010), originally from the Levant region of the Near East and Ethiopian Highlands, but now cultivated worldwide (Aghaee and Amini, 2011, Anwar, 2011). In 2010, world production of wheat was 651 million tons, making it the third most-produced cereal after maize (844 million tons) and rice (672 million tons) (FAO, 2013). Wheat belongs to the family Poaceae (Bala *et al.,* 2010, Godfray *et al.,* 2010). The annual damage resulting from weed infestation of grain crops in the world is estimated to be more than five billion dollars (Soleymani *et al.,* 2011, White, 2006), approximately equal to the total lost from agricultural and horticultural diseases and pests (Aghaee and Amini, 2013). Weeds are one of the major problems in crop production. They compete with crop plants for light, moisture, nutrients and space (Barton *et al*., 2005).

Weeds also increase harvesting costs, reduce quality of the produce, clog waterways, and increase fire hazards (Bhan and Sushilkumar, 2011). Weed competition with wheat could be either of broadleaf or grasses. *Avena fatua*, *Phalaris minor* and *Lolium temulentum* are the grassy weeds, which have now become a threat to the nutritional requirement of mankind (Lajos *et al*., 2009). Weed control is thus an important element for successful cultivation of wheat throughout the world; even in developed countries(Hussain *et al.,* 2004, Om hari *et al.,* 2002, Sadatian, 2012), weeds reduce grain yield by 5%, and this damage can reach as high as 25% in developing countries (Pisal and Sagarka, 2013, Verma *et al.,* 2013), such as Iran. *P. minor* is a monocot plant and graminaceous weeds (William May *et al.,* 2012). It grows in winter season and found in all parts of the world, especially in tropical and sub-tropical parts of the earth.(William May *et al.,* 2012).

Phalaris minor has increased tremendously in the rain fed and irrigated areas of the world and is difficult to eradicate because the seeds shatter before crop maturation and many of the seeds are plowed into the soil, where they lie dormant for one to many years, and germinate when they are turned up near the surface (Hussain *et al.*, 2004). However, some broad leaf weeds are also causing a threat but their control is comparatively easier and effectively but control of *Phalaris minor* has become a serious challenge (May *et al.*, 2013). Wheat yield losses especially from weed *P. minor* alone are estimated at around 25-50% and in very severe cases, it may go up to 80% to total (May *et al.*, 2012b). Without proper identification and evaluation of weed species, it is impossible to take appropriate measures for weed control. The study was intended to establish a framework for future research, and also to devise basic criteria for weeds

MATERIALS AND METHODS

In order to study the effect of canary grass densities and seed rates on yield and yield components of wheat, field trials were conducted at Sari Agricultural Sciences and Natural Resources University of Iran during the crop season of 2015-2016. The experiment was laid out in randomize complete block Design (RCBD) with split plot arrangement. Having four replications. Four seed rates of wheat viz.120, 140, 160 and 180 kg ha^{-1} was assigned to main plots, while canary grass densities 0, 5, 10, 15, 20, 25 and 30 seed m^{-2} was kept into sub-plots. The soil of experimental field was Lomy Clay in texture for soil analysis, soil samples was taken from different places at site the experimental field from 0-15 cm depth before application of fertilizers. Composite sample was prepared by mixing all soil samples. Recommended dose of fertilizer NPK as 150:75:60 kg h^{-1} through source of Urea (46% N), DAP (18% N & 46% P_2O_5) and MOP (60% K_2O) were used as experimental material during the experiment. Plot size of 5.4 m 3 × 1.8 m) having six rows three meter long with 30 cm apart rows. Wheat variety N80 was planted on 6th November 2014 as a test crop with the help of seed drill. Seeds of *Phalaris minor* were planted manually, the same day as the wheat. All other weeds were removed manually throughout the wheat season and the wheat was harvested on 30th May 2015 with the help of hand sickle. Data were recorded on number of spikes m^{-2}, spike length (cm), grains spike^{-1}, 1000 grain weight (g), grain yield (kg ha^{-1}) and harvest index (%) of wheat and dry weight (g) and seed tillers^{-1} of canary grass. The data recorded for each trait was individually subjected to the ANOVA technique by using MSTATC Computer Software and means were separated by using Fisher's Protected LSD test (Steel and Torrie, 1980). Data on spike length (cm), grains spike^{-1} were recorded from 15 randomly selected plants taken from each plot and averaged. Two random samples of wheat grains were drawn from the produce of each plot to record 1,000 grain weight after counting and weighing on a digital balance. At maturity, the crop was harvested leaving appropriate border rows, tied into bundles and sun dried for a week in respective plots. Total wheat dry biomass was recorded for each treatment and crop was threshed thereafter. Grain yield and biological yield per plot were then converted to kg per hectare (kg ha^{-1}). Straw yield was computed as the difference between biological yield and grain yield. Whereas harvest index was calculated as the ratio of grain yield to total (above ground) biological yield and was expressed as percentage.

RESULTS AND DISCUSSION

A. Number of spikes m^{-2}

Analysis of the data revealed that *Phalaris minor* and seed rates had significant effect on number of spike m^{-2}, while their interaction showed non-significant variation. The data in (Table 2) exhibit that maximum (268.75) spikes m^{-2} were recorded in control plots, while the minimum (260.00) spikes m^{-2} were noted in 30 *Phalaris minor* seeded m^{-2}.

Table 1: Some physical and chemical properties of the soil used in the test.

O.C (%)	T.N.V (%)	So_4 (%)	PH	EC (dS/m)	K (mg/Kg)	P (mg/Kg)	N (%)	Clay (%)	Sand (%)	Silt (%)	Properties
2.35	16.2	0.97	7.5	0.98	265.4	8.2	0.48	31	21.6	46.7	Lomy Clay

Table 2: Effects of wheat and *P. minor* density on number of spikes m^{-2} of wheat.

***P. minor* Density (m^{-2})**	**Seed rates (kg ha^{-1})**				**Density means**
	120	**140**	**160**	**180**	
0	265.25	261.50	288.75	262.50	268.75 b
5	315.25	267.25	276.75	263.00	280.56 a
10	263.50	264.50	274.50	260.75	265.81b
15	261.00	260.25	279.25	258.00	264.63b
20	260.00	255.75	268.50	256.50	262.44c
25	268.50	267.50	270.50	265.00	267.88 b
30	246.50	266.75	272.75	260.00	260.00c
Seed rates means	268.75b	263.36b	275.86a	224.05 c	

Among the seed rates the highest (275.86) spikes m^{-2} was noted in 160 kg ha^{-1}, while the lowest (269.9) spikes m^{-2} was recorded in 180 kg ha^{-1}. For interaction of seed rates with *Phalaris minor* densities the differences although were non-significant statistically yet the maximum (288.75) spikes m^{-2} were recorded in 160 kg ha^{-1} × 0 *Phalaris minor* density. The minimum (260.00) number of spikes m^{-2} was noted in 180 kg ha^{-1} × 30 *Phalaris minor* seeded m^{-2}. Weed competition in wheat reduced yield due to decreases in spike numbers (Carlsonand Hill, 2011; Barton *et al.,* 2005) and spike length (Chhokar and Malik, 2002, Chhokar *et al.*, 2008).

B. Spike length (cm)

The highest spike length (9.18 cm) was recorded in 0 *Phalaris minor* (control). Lowest spike length (7.47 cm) was observed with 30 *Phalaris minor* seeded m^{-2} (Table 3). Among the seed rates, the highest spike length (8.72 cm) was recorded in 160 kg ha^{-1}, while lowest spike length (8.06 cm) was noted in 180 kg ha^{-1}. The maximum spike length (10.00 cm) was recorded in 160 kg ha^{-1} + 0 *Phalaris minor* density. The minimum (7.00 cm) spike length was noted in 180 kg ha^{-1} + 30 seed m-^{2} treatment. These findings are in close conformity with those reported by Singh (2007) and Singh *et al* (2013) they reported that weeds affected the yield of wheat mainly through reducing spike length.

C. Number of Grains spike^{-1}

Analysis of the data revealed that *Phalaris minor* densities have a significant effect on grains spike^{-1} while the interaction between seed rates and *Phalaris minor* densities on grains spike^{-1} was not significant. The data in Table-3 showed that maximum (48.41) grains spike^{-1} was recorded in control (0 *Phalaris minor* density m^{-2}). Minimum (44.47) number of grains was recorded in 30 *Phalaris minor* seeded m^{-2}. Among the seed rates, the highest number of grains spike^{-1} (47.33) were recorded in 160 kg ha^{-1}, which was closely followed by other seed rates included in the studies. For the interaction of seed rates with the *Phalaris minor* densities the differences although were non-significant statistically, yet the maximum (50.00) grains spike^{-1} were noted in 160 kg + 0 *Phalaris minor* m^{-2}. The minimum numbers of grains spike^{-1} (46.15) were recorded in 180 kg + 30 *Phalaris minor* m^{-2} plot. Chhokar *et al.,* (2008) also found that increasing wheat density decreased the losses from *Phalaris minor*. Weed competition in wheat resulted in yield reduction due to decrease in spike numbers (Akhtar, 2012) or number of grains per spike (Korres *et al.*, 2002).

D. 1000-grain weight (g)

The significantly higher number of 1000 grain weight (30.26) was found in 0 *Phalaris minor* densities (control plot) significantly affected by *Phalaris minor* densities and wealth seed rate, while interaction of seed rates with *Phalaris minor* densities were non-significant statistically. The data (Table 5) revealed that maximum (41.96g) 1000 grain weight was recorded in control plot.

Table 3: Effects of wheat and *P. minor* density on spike length (cm) of wheat.

***P. minor* Density (m^{-2})**	**Seed rates (kg ha^{-1})**				**Density means**
	120	**140**	**160**	**180**	
0	8.96	9.64	10.00	8.12	9.18a
5	8.51	8.72	9.56	8.43	8.81b
10	8.50	8.56	9.00	8.54	8.65c
15	8.29	8.00	8.24	8.10	8.16d
20	8.00	8.20	8.37	8.00	8.14d
25	7.64	7.91	8.00	7.90	7.86e
30	7.34	7.62	7.90	7.00	7.47f
Seed rates means	8.13 c	8.38 b	8.72a	8.06b	

Table 4: Effects of wheat and *P. minor* density on grain spike^{-1} (g) of wheat.

***P. minor* Density (m^{-2})**	**Seed rates (kg ha^{-1})**				**Density means**
	120	**140**	**160**	**180**	
0	47.87	49.58	50.00	46.20	48.41a
5	47.93	48.12	49.34	45.35	47.69b
10	46.80	47.67	48.53	45.61	47.60bc
15	46.63	46.80	46.23	44.81	46.12bc
20	46.18	45.87	46.00	44.21	45.57bc
25	45.58	45.88	45.95	43.57	45.25cd
30	44.28	45.35	45.26	42.97	44.47d
Seed rates means	46.47	47.04	47.33	46.15	

Table 5: Effects of wheat and *P. minor* density on 1000-grain weight (g) of wheat.

***P. minor* Density (m^{-2})**	**Seed rates (kg ha^{-1})**				**Density means**
	120	**140**	**160**	**180**	
0	40.29	42.92	44.61	40.00	41.96 a
5	39.76	39.98	42.60	37.30	39.91 b
10	35.55	36.75	39.67	37.53	37.38 c
15	34.56	34.65	37.58	33.33	35.03d
20	34.94	35.50	38.45	33.58	35.62d
25	32.27	33.53	37.00	29.90	33.18e
30	32.00	33.40	35.35	29.23	32.50e
Seed rates means	35.62c	36.67b	39.32a	34.41d	

Increased values in these yield attributes might have been due to negligible weed crop-competition and increased nutrients and water uptake by the crop leading to increased rate of photosynthesis, supply of photosynthates to various metabolic sinks might have favoured yield attributes and overall improvement in vegetative growth which favorably influenced the tillering, flowering, fruiting and ultimately resulted into increased grain weight and test weight. These findings are in close conformity with those reported by Singh and Saha, 2001, Yadav, *et al.*, 2001 Minimum (32.50g) 1000 grain weight was noted in 30 *Phalaris minor* seed m^{-2}. Among the seed rate the maximum (39.32g) 1000 grain weight was recorded in 160kg ha^{-1} while the minimum (34.41g) 1000 grain weight was noted in 180kg ha^{-1} seed rates which was closely followed by the other seed rates included in the studies. Maximum 1000-grain weight (44.61g) was recorded in 160 kg ha^{-1} × 0 *Phalaris minor* seed m^{-2}. Minimum (28.83g) 1000 grain weight was noted in 180 kg ha^{-1} × 30 *Phalaris minor* seed m^{-2} plot. These findings are in agreement with the work of Cogliatti *et al.,* (2011), who concluded the strong relation of seeding rates of the *P canariensis* with 1000-grain weight (g) of wheat.

E. Grain yield (kg ha^{-1})

The data in Table 6 revealed that the significantly higher grain yield (2853.69kg ha^{-1}) was found under 0 *P. minor* seed m^{-2}. While *P. minor* seed rates and wheat densities interaction was non-significant statistically. The lowest (2115.85kg ha^{-1}) was recorded in 30 *P. minor* seed m^{-2}. These findings are in parallel to the results of Bhan and Sushilkumar, (2011). For interaction of seed rates with the *P. minor* densities, the highest yield (3366.0kg ha^{-1}) was observed in 160 kg ha^{-1} × 0 *P. minor* seed m^{-2}.

The higher yields under these treatments could be ascribed to better control of weeds might have favored higher uptake of nutrients and water, which helped the wheat to put optimum growth characters viz., effective tillers and enhanced photosynthetic activity and partitioning of assimilates, resulting in improved yield attributes like number of spike, grain weight per plant and test weight by virtue of less weed count and dry weight of weeds.

Table 6: Effects of wheat and *P. minor* density on grain yield (kg ha^{-1}) of wheat.

***P. minor* Density (m^{-2})**	**Seed rates (kg ha^{-1})**				**Density means**
	120	**140**	**160**	**180**	
0	2705.35	2813.85	3356.0	2539.56	2853.69a
5	2312.45	2551.45	2862.45	2300.12	2506.62 b
15	1960.85	2312.60	2709.56	1923.41	2226.61cd
20	1930.00	2234.21	2698.87	1923.00	2196.52cd
25	1921.75	2213.53	2612.43	1934.12	2170.46cd
30	1838.90	2212.34	2590.76	1821.32	2115.83d
Seed rates means	2141.61 b	2063.70c	2813.58a	2105.67 bc	

These growth and yield attributes evidently reflected in higher grain and straw yields under these treatments. These findings are in close conformity with those reported by Yasin and Iqbal (2011. Sukhadia *et al.,* 2000 and Singh and Singh, 2004). Minimum grain yield (1821.32kg ha^{-1}) was observed in 180 kg ha^{-1} × 30 *P. minor* seed m^{-2}.

Wheat yield loss due *P. minor* competition, involving weed densities as a variable, has been extensively reported in the world literature (Singh *et al.*, 2013; Shah *et al.,* 2006; Sattar *et al.,* 2010; Baloch *et al.,* 2012; Akhtar *et al.*, 2012). Earlier researchers have also concluded that weed competition in wheat caused yield reduction via decreases in is very obvious and has also been reported in several studies earlier (Shah *et al.*, 2006; Sattar *et al.*, 2010).

F. Harvest index (%)

Harvest index significantly affected by *P. minor* and wheat density. Plant density and another interaction had no effect on harvest index (Table 7). Maximum harvest index (40.63) was obtained in 5 *P. minor* seed m^{-2}. Density of wheat and *P. minor* had a significant effect on harvest index (%), while non-significant effect was observed due interaction between wheat seed rate and *P. minor* density. Mean value of the data indicated that among seed rate, harvest index (40.43%) was recorded in those plots which were sown at the rate of (160 kg ha^{-1}). While lighter, harvest index (38.47%) noted in plots sown at the rate of 180 kg ha^{-1}.

The findings of the study are supported by Yasin and Iqbal (2011), that harvest index of wheat declined with the increase in weed density, Sign *et al.,* (2013) suggested that weed extend their less adverse effects if the wheat crop is managed at proper planting density.

G. Tillers plant^{-1} P. minor

Numbers of *P. minor* tillers were counted at different treatment. The data (Table 8) revealed that the maximum (9.73) tillers of *P. minor* plant^{-1} were recorded in 5 *P. minor* seed m^{-2} plots. The minimum (6.85) tillers of *P. minor* plant^{-1} were noted in 30 *P. minor* seed m^{-2}. Among the seed rates the highest (8.98) number of tiller *P. minor* plant^{-1} were recorded in 120 kg ha^{-1}, while the lowest (8.09) number of tiller *P. minor* plant^{-1} were recorded in 160 kg ha^{-1}. For the interaction of seed rates with the *P. minor* densities, the differences although were non-significantly yet the maximum (13.7) number of tillers *P. minor* plant^{-1} were noted in 120kg ha^{-1} × 5 *P. minor* densities m^{-2}. The minimum numbers of tillers (6.52) *P. minor* plant^{-1} were recorded in 160 kg ha^{-1} × 30 *P. minor* densities m^{-2} treatment.

Table 7: Effects of wheat and *P. minor* density on harvest index (%) of wheat.

***P. minor* Density (m^{-2})**	**Seed rates (kg ha^{-1})**				**Density means**
	120	**140**	**160**	**180**	
0	40.10	40.53	41.89	40.00	40.63a
5	40.00	40.56	41.76	39.78	40.53 a
10	39.89	39.90	40.67	39.00	39.62b
15	39.90	39.78	40.84	38.90	40.11ab
20	38.67	38.87	39.54	37.78	38.72bc
25	38.45	38.91	39.43	37.12	38.48bc
30	37.89	37.90	38.87	36.76	37.86c
Seed rates means	39.27b	39.49b	40.43a	38.47c	

Table 8: Effects of wheat and *P. minor* density on tillers plant^{-1} of *P. minor*.

***P. minor* Density (m^{-2})**	**Seed rates (kg ha^{-1})**				**Density means**
	120	**140**	**160**	**180**	
0	0.00	0.00	0.00	0.00	0.0
5	10.75	9.85	8.85	9.45	9.73 a
10	10.57	8.75	9.25	8.50	9.27a
15	9.60	8.97	8.65	8.90	9.03a
20	8.12	8.00	8.00	7.85	7.99b
25	7.00	8.55	7.25	7.65	7.61b
30	7.64	6.75	6.52	6.50	6.85c
Tiller rates means	8.98 a	8.48b	8.09d	8.14cd	

Table 9: Effects of wheat and *P. minor* density on dry weight (gm^{-2}) of *P. minor*

P. minor Density (m^{-2})	Seed rates (kg ha^{-1})				Density means
	120	140	160	180	
0	0.00	0.00	0.00	0.00	0.0
5	56.57	54.90	55.57	54..64	55.42d
10	68.34	65.45	56.45	55.87	61.53c
15	78.67	65.74	56.47	54.25	63.78c
20	78.89	74.62	57.87	54.28	66.42b
25	85.42	74.65	57.17	53.97	67.80a
30	85.01	74.00	56.43	52.65	67.02a
Seed rates means	75.48a	68.23b	56.66cd	54.28d	

H. Dry weight (gm^{-2}) of P. minor

Analysis of the data revealed that *P. minor* densities and wheat seed rates had significant effect on dry weight (gm^{-2}) of *P. minor*, while their interaction had showed non-significant variation. The data in Table 9 indicated that minimum and maximum dry weight (gm^{-2}) of *P. minor* were noted in 5 and 30 *P. minor* seed m^{-2} plots, respectively. Among the seed rates the highest (75.48) dry weight (gm^{-2}) of *P. minor* was recorded in those plots which were sown at the rate of (120 kg ha^{-1}) and lower dry weight (gm^{-2}) of *P. minor* were noted in (180 kg ha^{-1}) wheat seed rate.

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