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RESEARCH ARTICLE

RESPONSE OF GRAIN YIELD OF WHEAT AND SEED PRODUCTION OF WILD MUSTARD AND WILD OAT TO NITROGEN APPLICATION AND WEED DENSITY

***[1]Pejman Behdarvand, [2]Chinchanikar, G. S. and [2]Dhumal, K. N**

[1]Department of Agriculture, Islamic Azad University, Ahvaz, Iran
[2] Department of Botany, University of Pune, India

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ABSTRACT

To study the response of grain yield of wheat and seed production of wild mustard and wild oat to application of different nitrogen levels and inter and intraspecific competition a field experiment was conducted at Islamic Azad University of Ahvaz-Iran. The results indicated that increasing nitrogen level increased the competitive ability of wild mustard and wild oat as result of this loss in grain yield of wheat was increased. The results showed that reduction of grain yield in single weed species competition of wild mustard and wild oat was less than mixed weed densities. The seed production of wild mustard and wild oat increased with increasing nitrogen levels and their densities while it decreased due to interspecific competition. The mean value of seed production of wild mustard in the application of 90, 150 and 210 kg N ha^{-1} was 3460, 3927.1 and 5478.3 seeds m^{-2} respectively whereas the seed production of wild oat was 1308, 1634 and 1675 seeds m^{-2} respectively. Seed production of wild mustard was very high as compared wild oat.

INTRODUCTION

There are many factors responsible for low yield and weed infestation is one of the major causes. The intensity of weed-crop competition besides soil and environmental factors depends on a number of other factors such as: crop species and cultivars, crop density, weed species, weed density, time of weed emergence, duration of weed competition, efficiency of weed control etc (Anonymous 2008). Intensity of crop-weed competition indicated that increased soil fertility had promoted the growth of weeds than the crop. In the absence of competition for applied nutrients the competitive ability of weeds for factors like soil moisture and light became important (Gupta 2007). Di Tomaso (1995) reported that weeds absorb higher level of nitrogen, phosphorus, potassium, calcium and magnesium than crops and reduce soil nutrient level faster, thereby decrease the crop yield.

Wild oat (Scursoni and Arnold 2002, Daugovish *et al*., 2003) and wild mustard (Mulligan and Bailey 1975, Topal and Kocacaliskan 2006) are two of the worst and troublesome weeds in cereals worldwide, especially in wheat and barley. The research carried by Carlson and Hill (1985) on crop-weed competition and reduction in yield revealed that wild oat's competitive ability and seed production increased with increasing nitrogen level. The grain yield of wheat increased with improving nitrogen when wild oats density was less than 1.6%. Satorre and Snaydon (1992) reported that the competition between spring cereals and *Avena fatua* L. for soil resources especially for nitrogen was stronger than competition for resources like light. Dhima and Eleftherohorions (2005) stated that increasing nitrogen from zero to 150 kg ha^{-1} increased the dry weight of wild mustard, *Sinapis arvensis* L., which had grown with triticale and wheat by 16 and 10%, respectively. The competition of 140 plants of wild mustard caused decrease in the grain yield of wheat and triticale by 26 and 27% respectively. But the grain yield of barley was reduced only by 3.5%. Research on response of weed species to various level of soil fertility required to develop fertilizer management strategy for improving wheat yield. Therefore this study was attempted to investigate competitive ability of wheat, wild mustard and wild oat under different nitrogen levels.

Corresponding author: pbehdarvand@yahoo.com

MATERIALS AND METHODS

To study the effects of wild mustard, *Sinapis arvensis* L. and wild oat, *Avena ludoviciana* L., densities on their seed production and wheat grain yield, *Triticum aestivum* L. Var. Chamran, under different nitrogen levels, two years field experiment was conducted at Agricultural Research Station of Azad University Ahvaz-Iran in growing season of 2007-08 and 2008-09. The experiments were performed in split-factorial and in the randomized complete block design with three replications in additive series. Three nitrogen levels (90, 150 and 210 kg/ha) were maintained in main plots. Wild mustard in four densities (0, 5, 10 and 15 plants m^{-2}) and wild oat in four densities (0, 25, 50 and 75 plants m^{-2}) were maintained into sub-plots. Phosphorous (100 kg P2O5), potassium (100 kg K2O) and 40% of nitrogen (Urea) were broadcasted uniformly at the sowing time and mixed with soil

according to the treatment level in each plot. Remaining 60% of nitrogen was divided into two topdressings such as 40% at the beginning of stem elongation and 20% at the beginning of flowering stage. Wheat seed density was maintained at 400 seeds per square meter. Wild oat and wild mustard were sown between the two rows of wheat. To avoid the risk of non germination, three seeds instead of a single seed of wild oat and wild mustard each were sown and then the population was adjusted as per the requirement through thinning. Excess seedlings of wild oat and wild mustard were removed by thinning process at the four leaf stage and the seedlings of desire density were maintained. Hand weeding method was followed to the removed weeds except wild mustard and wild oat regularly during wheat growth. The recorded data was analyzed statistically by using MSTACTC computer software and a comparison of recorded data was done on the basis of Duncan's multiple range tests at Alfa level 5%.

RESULTS AND DISCUSSION

Grain yield

Among different nitrogen levels, the maximum grain yield (378.6 $g.m^{-2}$) was recorded in 150 kg ha^{-1} treatment, while the minimum (339.3 $g.m^{-2}$) was recorded in 210 kg ha^{-1}. The grain yield decreased in the presence of both weed species. Interspecific competition of 15 plants of wild mustard and 75 plants of wild oat decreased the grain yield of wheat by 31.1 and 27.8% as compared to their zero density respectively (Table 1). Increasing nitrogen level increased the competitive ability of wild mustard and wild oat and it increased the grain yield losses of wheat. Results indicated that the densities of 5, 10 and 15 wild mustard plants m^{-2} had lower competitive ability than 25, 50 and 75 plants of wild oat m^{-2} at low level of nitrogen respectively but, increasing nitrogen led to increase competitive ability of wild mustard more than wild oat. For example, the density of 75 plants of wild oat m^{-2} decreased the wheat grain yield by 26.3 and 30.3% under 90 and 210 kg N ha^{-1}, respectively whereas the density of 15 wild mustard m^{-2} decreased the grain yield by 22.1 and 43.1% with application of 90 and 210 kg N ha^{-1}, respectively (Fig. 1 A and B).

The reduction of grain yield in single weed competition of wild mustard and wild oat was less than mixed weed densities. The grain yield was decreased by 37.7 and 35.8% when 15 plants of wild mustard and 75 plants of wild oat were grown separately. However the reduction of grain yield was 52.7% in the combination of these two densities. Also, it showed that the negative effects of wild mustard on grain yield were decreased in the presence of wild oat and vice versa (Table 2). Regarding additive series of this experiment, increasing weeds density increased the total number of plants in the certain area, decreased the growth space and increased inter and intraspecies competition for limited resources. Therefore, increasing competition decreased the grain yield of wheat mostly through decreasing the tiller number, spike number and increasing unfertile tillers. Barker *et al*., (2006) revealed that increasing crop loss due to interspecific competition of weed in high fertility can be a result of higher plasticity characteristics of weeds in the response to available resources. Moosavi *et al*., (2004) noted that there was a negative correlation between wild mustard, *Sinapis arvensis* L., density and wheat grain yield. Increasing N level from 150 to 225 kg/ha in the presence of *S. arvensis*, increased the wheat yield loss from 42.1 to 50.4%. Ross and Van Acker (2005) found that the competitive ability of *Avena fatua* L., in wheat field was significantly higher when nitrogen fertilizer was applied.

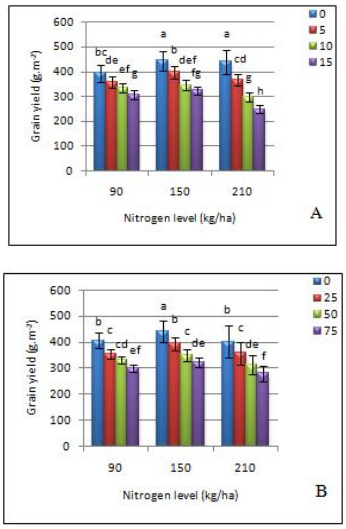


Fig. 1 Effect of wild mustard (A) and wild oat (B) densities on grain yield of wheat under different nitrogen levels

Biomass

Increasing nitrogen from 90 to 150 kg ha^{-1} increased the wheat biomass while the application of 210 kg N ha^{-1} significantly decreased the biomass. The results indicated that the wheat biomass decreased due to interspecific competition of wild mustard and wild oat. Average reduction of wheat biomass in the presence of 5, 10 and 15 wild mustard densities was 8, 15 and 20.2% respectively as compared to zero density of wild mustard. Whereas the biomass was 6.7, 12 and 16.9% higher than biomass in the presence of 25, 50 and 75 plants of wild oat respectively (Table 1). Increasing nitrogen level from 90 to 210 increased the biomass loss by weeds and increased the competitive ability of wild mustard and wild oat; however, the competitive ability of *S. arvensis* was increased more than *A. loduviciana*. The density of 15 wild mustard m^{-2} under 90, 150 and 210 kg N decreased the wheat biomass by 13.9, 17.4 and 29% respectively while the density of 75 wild oat m^{-2} reduced the biomass by 15.7, 16.9 and 17.8% as affected by 90, 150 and 210 kg N respectively (Fig. 2 A and B).

The results of present study showed that the wheat biomass reduction in competition of one weed species was less than competition of mixed weed species. Interspecific competition of 15 plants of wild mustard and 75 plants of wild oat decreased the biomass by 25.1 and 22.1% respectively when they were grown separately. However the mixed densities reduced the biomass of wheat by 35% as compared to weed free condition (Table 2). The high and positive correlation between wheat biomass - spike number and biomass-tiller number indicated that the weed competition decreased the biomass of wheat generally through the reduction in tiller number and spike number of wheat (data not shown). Giambalvo *et al*. (2010) concluded that the competition of *Hordeum vulgare* L. under zero and 80 kg N ha^{-1} decreased the biomass of wheat by 8.6 and 23% as compared to the absence of weed respectively.

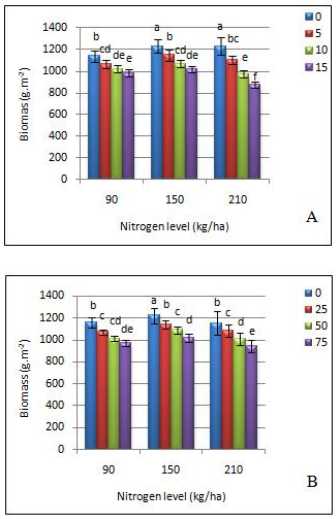
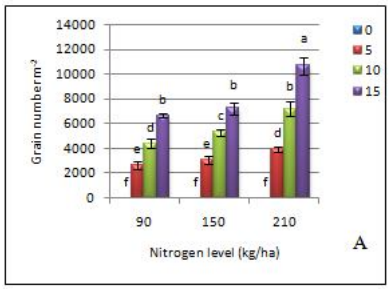


Fig. 2 Effect of wild mustard (A) and wild oat (B) densities on grain yield of wheat under different nitrogen levels

Seed production of wild mustard

The results revealed that the seed production of wild mustard responded positively to the increasing level of nitrogen and its density. The seed production of wild mustard was strongly higher by 58.3% in the application of 210 kg N as compared to 90 kg N respectively. Interspecific competition of wild oat decreased the seed production of wild mustard and the density of 75 plants of wild oat decreased the seed production by 25.1% as compared to zero density of wild oat (Table 1). Increasing nitrogen application decreased the intraspecific competition among wild mustard plants. Increasing nitrogen application from 90 to 210 kg increased the seed production of 5 and 15 plants of wild mustard by 45.4 and 60.3% respectively (Fig. 3 A). Interaction effect of nitrogen levels and wild oat densities indicated that the negative effect of wild oat densities on seed production of wild mustard at higher level of N application was less than other levels (Fig. 3 B). The interactive effect of wild mustard and wild oat densities showed that the highest seed production (9134 seeds m^{-2}) was noted in the presence of 15 wild mustard + zero wild oat and the lowest (2634.8 m^{-2}) was recorded in 5 plants of wild mustard + 75 plants of wild oat m^{-2} (Table 2). These results are consistent with Rastgoo *et al*. (2005) who concluded that the seed production of *Sinapis arvensis* was increased by increasing nitrogen application and its density. They reported that the wild mustard produced 161, 311 and 488 million seeds/ha under 100, 150 and 225 kg nitrogen level respectively. Aguyoh and Masiunas (2003) reported that the seed production of *Amaranthus retroflexus* per meter of row was increased by increasing its density.



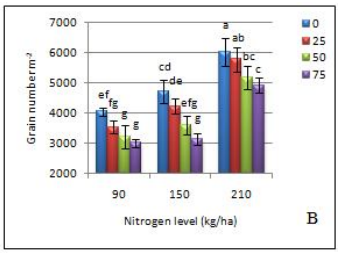


Fig. 3 Effect of wild mustard (A) and wild oat (B) densities on seed production of wild mustard under different nitrogen levels

Seed production of wild oat

The seed production of wild oat increased by increasing nitrogen level and its density (Table 1 and Fig. 4 B). The seed production of wild oat in the application of 150 and 210 kg N ha^{-1} was 24.9 and 28.1% higher than 90 kg N ha^{-1} respectively. The number of seeds per square meter decreased as wild mustard density increased and the density of 15 plants of wild mustard decreased the seed production by 38.8% as compared to zero density of wild mustard (Table 1). The negative effect of wild mustard on seed production of wild oat was increased by increasing nitrogen level (Fig. 4 A). Seed production of wild oat was varied due to inter and intraspecific competition between wild mustard and wild oat. Among the treatments, the highest seed production (3531 seeds m^{-2}) was noted in the density of 75 plants of wild oat + zero density of wild mustard and the lowest (838.1 seeds m^{-2}) was recorded in 25 density of wild oat in the presence of 15 wild mustard (Table 2). Eslami *et al*. (2006) noted that the seed production of wild radish, *Raphanus raphanistrum* L., increased with increasing its density and the density of 60 plants produced 43300 and 61200 seeds m^{-2} in 2003 and 2004 respectively. Blackshaw (2005) reported that the unfertilized plot had the lowest weed seedbank as compared to application of fertilizer. Karimmojeni *et al*., (2010) also noted that the seed production of weed per plant was decreased by increasing weed density and this reduction was higher for *Datura stramonium* than *Xanthium strumarium*.

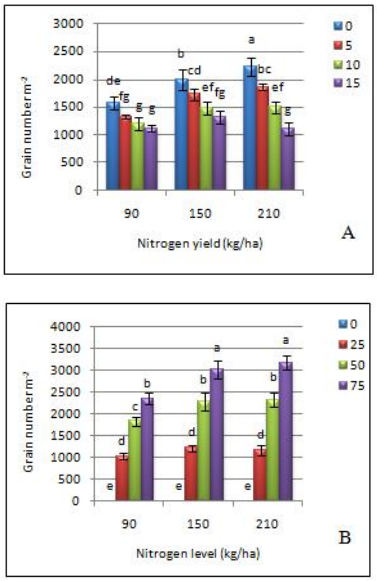


Fig. 4 Effect of wild mustard (A) and wild oat (B) densities on seed production of wild oat under different nitrogen levels

Table 1. Effect of nitrogen levels, wild mustard and wild oat densities on grain yield and biomass of wheat, seed production of wild mustard and seed production of wild oat

Treatments		Grain yield (g m^{-2})	Biomass (g m^{-2})	Seed production of Wild mustard (m^{-2})	Seed production of wild oat (m^{-2})
Nitrogen levels (kg ha^{-1})	90	349.7 ± 7.0* b	1052 ± 12.4 b	3460.0 ± 300.8 b	1308 ± 105.7 b
	150	378.6 ± 8.1 a	1117 ± 14.9 a	3927.1 ± 334.9 b	1634 ± 144.4 a
	210	339.3 ± 10.4 b	1045 ± 18.8b	5478.3 ± 498.2 a	1675 ± 174.9 a
Wild mustard densities (plants m^{-2})	0	426.3 ± 10.5 a	1201 ± 18.0 a	0.00 ± 0.00 d	1935 ± 182.6 a
	5	375.7 ± 7.4 b	1105 ± 14.0 b	3257.6 ± 148.1 c	1643 ± 166.4 b
	10	327.6 ± 6.8 c	1021 ± 13.5 c	5665.8 ± 253.8 b	1394 ± 148.4 c
	15	293.9 ± 7.7 d	958 ± 13.9 d	8233 ± 352.1 a	1185 ± 123.8 d
Wild oat densities (plants m^{-2})	0	418.2 ± 11.2 a	1176 ± 20.4 a	4938.3 ± 490.0 a	0.00 ± 0.00 d
	25	370.7 ± 8.4 b	1097 ± 15.8 b	4516.3 ± 513.3 b	1148 ± 60.0 c
	50	332.8 ± 7.5 c	1035 ± 14.6 c	4003 ± 481.3 c	2152 ± 87.0 b
	75	301.8 ± 7.2 d	977.8 ± 13.4 d	3697.1 ± 464.1 c	2857 ± 115.8 a

Means with different letters are significantly different at P=0.05, using Duncan's Multiple Range Test.
* Standard error

Table 2. Interaction effect of wild mustard and wild oat densities on grain yield and biomass of wheat, seed production of wild mustard and seed production of wild oat

Wild mustard density (plants m^{-2})	Wild oat density (plants m^{-2})	Grain yield (g m^{-2})	Biomass (g m^{-2})	Seed production of Wild mustard (m^{-2})	Seed production of Wild oat (m^{-2})
0	0	530.2 ± 16.8* a	1367 ± 31.7 a	0.00 ± 0.00 i	0.00 ± 0.00 h
	25	445.9 ± 12.8 b	1232 ± 22.1 b	0.00 ± 0.00 i	1584 ± 110.6 e
	50	388.6 ± 10.6 c	1140 ± 21.5 c	0.00 ± 0.00 i	2624 ± 168.9 c
	75	340.4 ± 11.2 efg	1065 ± 21.9 def	0.00 ± 0.00 i	3531 ± 216.9 a
5	0	441.1 ± 11.1 b	1215 ± 21.3 b	4020.0 ± 276.9 f	0.00 ± 0.00 h
	25	382.1 ± 11.8 cd	1124 ± 22.6 cd	3430.1 ± 252.4 fg	1227 ± 34.7 f
	50	352.2 ± 10.8 def	1073 ± 23.7 def	2944.3 ± 257.5 gh	2273 ± 125.8 d
	75	327.3 ± 10.3 fgh	1009 ± 20.6 fgh	2634.8 ± 200.5 h	3070 ± 198.3 b
10	0	371.0 ± 11 cde	1097 ± 26.9 cde	6600.0 ± 502.4 c	0.00 ± 0.00 h
	25	346.4 ± 10.6 ef	1049 ± 24.2 efg	5961.4 ±550.8 cd	940.9 ± 73.1 g
	50	304.4 ± 11.6 hi	990.5 ± 22.3 ghi	5298.3 ± 401.0 de	2056 ± 125.5 d
	75	288.6 ± 12.5 i	948.9 ± 22.1 hij	4798.5 ± 424.3 e	2580 ± 135.7 c
15	0	330.4 ± 15.1 fgh	1024 ± 28.3 fg	9134.0 ± 614.3 a	0.00 ± 0.00 h
	25	308.3 ± 13.1 ghi	984.2 ± 24.0 ghi	8674.0 ± 695.0 a	838.1± 47.8 g
	50	286.2 ± 14.0 i	936.1 ± 25.1 ij	7768.3 ± 759.7 b	1655 ± 103.8 e
	75	250.9 ± 13.8 j	888.1 ± 24.3 j	7356.3 ± 694.8 b	2246 ± 106.4 d

Means with different letters are significantly different at P=0.05 , using Duncan's Multiple Range Test.
* Standard error

Conclusion

The results indicated the competitive ability of weeds was increased by increasing nitrogen application than the crop. From the results of present study in can be concluded that increasing nitrogen application was more beneficial for wild mustard and wild oat which increased the grain yield loss of wheat. Wild mustard was stronger competitor than wild oat in higher levels of nitrogen application and seed production of it was very high. Farmers should consider crops as well as weeds when fertilizer application programs are planned. Managing N application is a key component of integrated weed management.

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