



Competition between Wild Mustard (*Sinapis arvensis*L.) and Wheat (*Triticum aestivum*L.) under Different rate of Nitrogen

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RESEARCH ARTICLE

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ABSTRACT

To study the effects of applied nitrogen levels and wild mustard densities on the growth of wheat and wild mustard, a field experiment was conducted at Re-search and Experimental Field of Islamic Azad University of Ahvaz-Iran. The effects of three nitrogen levels namely 90, 150 and 210 kg.ha⁻¹ and four wild mustard densities such as 0, 5, 10 and 15 plants.m⁻² were evaluated in split plot arrangement with randomized complete block design in three replications. The results indicated that in weed free plots the spike length, plant height, harvest index and grain yield of wheat increased with increasing nitrogen application from 90 to 210 kg.ha⁻¹ by 11.4, 10, 3.7 and 12.5 % respectively, while in the presence of wild mustard these parameters were decreased. Increasing nitrogen level increased the competitive ability of wild mustard and increased loss of wheat grain yield. The results also indicated that the biomass of wild mustard increased by increasing nitrogen level and wild mustard density. The biomass of wild mustard was 108.7, 157.2 and 226.6 g.m⁻² under 90, 150 and 210 kg.ha⁻¹ N, respectively.

Keywords: *Competition, Nitrogen Fertilizer, Weed densities, wheat.*

INTRODUCTION

One of the ways for ensured food supply for world population is to increase the crop production through decreasing wastes which occur due to the several reasons such as weeds (Bhadoria, 2011, Mohajeri and Ghadiri, 2003). In general, weeds reduce the quantity and quality of the crops and increase the cost of production costs. The first consequence of weed present along with crops is to increase plant community density (Giambalvo *et al.*,

2010). The agricultural operations and the environmental conditions affect efficiency of nitrogen use. In other words, one of the factors which lead to water, nutrient and light limitation is existence of weeds along with crop (Hesammi, 2011). If weed density increases, their undesirable effects on crops will increase; although, the rate of decreasing yield is not proportional to increasing weed density (Labbafi *et al.*, 2012).

Wild mustard is an aggressive the weed indigenous throughout most of the temperate regions of Europe, Asia and North Africa. It is a serious weed of cultivated land and it is responsible for reductions in crop yield, dockage losses and for costly chemical and cultural controls (Buchanan *et al.*, 2009, Labbafi *et al.*, 2010). Nitrogen is one of the most important nutrients which can change competition ability of weeds and crops. Nitrogen increases the growth and production of wheat via increasing leaf area and photosynthetic efficiency of leaves. Moreover, it has effects on increasing spike number in unit area (Iqbal and Wright, 1999). With extending semi-dwarf cultivars which are more resistant to lodging, the demand for using fertilizer, especially nitrogen has been increased. As more was fertilizer is used, the yield of these cultivars increased (Callaway, 1995, Hesammi, and Lorzadeh, 2011). On the other hand, increased nitrogen leads to increase interference and competition ability of weeds with crops (Barker *et al.*, 2006, Harbur and Owen, 2006). Therefore, managing crop fertilization may be an important component of integrated weed management systems that protects crop yield and reduces weed population over time (Blackshaw *et al.*, 2002, Blackshaw *et al.*, 2004). The results of studies by Chathcart and Swanton (2004), Delaney and Van Aker (2005) showed that competition strength of weed with crop increases with consumption of nitrogen fertilizer. Blackshaw (2005) reported that shoot biomass of the weeds like *Chenopodium album* L. *Sinapis arvensis* L., *Avena fatua* L. and *Setaria viridis* L. responded positively to higher soil nitrogen, while unfertilized control was among treatments with the lowest weed biomass. Considering these facts present investigation was conducted to quantify the effects of wild mustard on

growth and grain yield of wheat under varying rates of nitrogen application.

MATERIALS AND METHODS

Field and Treatment Information

To evaluate the wheat responses, *Triticum aestivum* L. Var Chamran, to wild mustard, *Sinapis arvensis* L., under different nitrogen concentrations, a field experiment was conducted at Agricultural Research Station of Azad University of Ahvaz-Iran during 2007-08 growing season. The location of experiment was at 48°, 40' of longitude and 31°, 20' latitude. This research was carried out in split plot experiment based a randomized completely block design (RCBD) with three replications. Three nitrogen levels included: 90, 150 and 210 kg.ha⁻¹ was belonged to main plots and four wild mustard densities included: 0, 5, 10 and 15 plants.m⁻² was belonged to sub-plots.

Application of treatments

Phosphorous (100 kg P₂O₅), potassium (100 kg K₂O) and 40 % of nitrogen 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 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.

Traits measure

To determine the yield and yield parameters of wheat an area of two m²

was harvested by sickle when moisture content in wheat grains was 13-14%.

Statistical analysis

The recorded data was analyzed by using MSTATC software and mean comparison of data was done on the basis of Duncan's multiple range tests at 5 % probability level.

RESULTS AND DISCUSSION

Spike length

The ANOVA result showed effect of nitrogen and wild mustard densities on this trait were none significant and sig-

nificant at 5% probability level, respectively (Table 1). Statistical analysis of data indicated that nitrogen levels showed non-significant effect on spike length, while wild mustard densities showed significant effect. The spike length at zero density of wild mustard was 1.8 cm higher than the density of 15 plants.m⁻² of wild mustard. The densities of 5, 10 and 15 plants.m⁻² of wild mustard decreased the spike length by 6.8, 14.8 and 20.5 % as compared to zero density of wild mustard (Table 2).

Table 1. The ANOVA results effect of nitrogen and wild mustard density on measured traits

S.O.V	df	Spike length (cm)	Plant height (cm)	Grain yield (g.m ⁻²)	Harvest index (%)	Wild mustard biomass (g.m ⁻²)
Replication	2	478.33*	533.5*	233.55*	455.99*	324.43*
Nitrogen	2	1621.2 ^{ns}	2111.33*	987.33 ^{ns}	1076.3 ^{ns}	2234.66*
Error 1	4	2123.1	1229.55	6321.3	5455.2	4567.17
Wild mustard density	3	2390.3*	4559.8*	3498.55*	2598.45*	3417.28*
Nitrogen * wild mustard density	6	3498.87*	2209.7*	3890.6*	2110.3*	6781.37*
Error 2	18	4928.04	470939.06	8156736	23932.09	909543.69
CV (%)	-	9	7.5	6.8	4.55	5.78

Table 2. Effect of nitrogen levels and wild mustard densities on spike length, plant height, grain yield, harvest index of wheat and biomass of wild mustard

Treatments		Spike length (cm)	Plant height (cm)	Grain yield (g.m ⁻²)	Harvest index (%)	Wild mustard biomass (g.m ⁻²)
Nitrogen (kg.ha ⁻¹)	90	7.5±0.2* ^a	89.5±1.7 ^b	418.3±22.6 ^a	35.2±0.9 ^a	108.7±21.9 ^c
	150	8.1±0.3 ^a	93.0 ± 1.9 ^{ab}	461.8±26.2 ^a	36.5±1.0 ^a	157.2±32.4 ^b
	210	8.0±0.3 ^a	95.4±1.7 ^a	418.7±38.3 ^a	34.2±1.5 ^a	226.6±47.3 ^a
Wild mustard density (plants.m ⁻²)	0	8.8±0.3 ^a	95.9±2.3 ^a	565.6±21.3 ^a	39.7±0.4 ^a	0.0±0.0 ^d
	5	8.2±0.2 ^a	93.4±2.1 ^{ab}	444.4±16.2 ^b	36.0±0.8 ^b	134.9±13.9 ^c
	10	7.5±0.2 ^b	91.5±2.1 ^{ab}	383.6±15.5 ^c	33.7±0.9 ^{bc}	222.0±24.3 ^b
	15	7.0±0.2 ^b	89.7±1.7 ^b	338.1±22.2 ^c	31.8±1.3 ^c	299.7±33.2 ^a

* Means designated with the same letter are not significantly different at 5 % level according to Duncan Multiple Range Test.

Estimated spike length varied with interaction between wild mustard densities and nitrogen levels. Among treatments, the highest spike length (9.1 cm) was observed in zero density of wild mustard under 210 kg.ha⁻¹ N and the lowest (6.8 cm) was noted in the highest infestation of weed under 210 kg.ha⁻¹ N (Fig.1.). This finding was in agreement with Hassan and Khan (2007) who reported that the spike length of wheat was decreased in the presence of 10 plants of wild oat plants.m⁻².

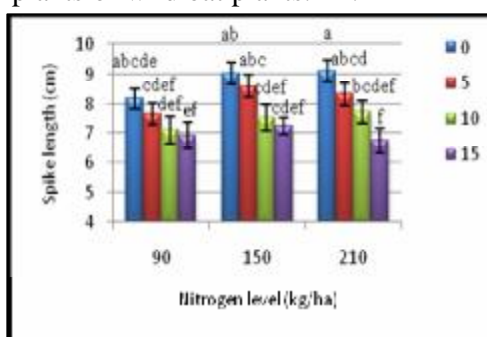


Fig. 1. Interaction effect of nitrogen and wild mustard densities on spike length of wheat, Via Duncan test at 5 % probability level. Wild mustard densities included: 0, 5, 10 and 15 plants.m⁻².

Also Zarea Feizabady *et al.* (2009) concluded that the spike length of wheat, *Triticum aestivum* L., was 14.8 % lower when grown with the 75 plants wild oat, *Avena ludoviciana* L., compared to zero density of wild oat.

Height of wheat

The ANOVA result showed effect of nitrogen and wild mustard densities on this trait were significant at 5% probability level (Table 1). The results showed that the height of wheat responded positively to increasing nitrogen application from 90 to 210 kg.ha⁻¹. Average plant height was 89.5, 93.0 and 95.4 cm under 90, 150 and 210 kg.ha⁻¹ N, respectively. Final height showed a progressive reduction with the succes-

sive increase in wild mustard density. The reduction of the plant height due to 15 plants.m⁻² of wild mustard.m⁻² was 6.5 % compared to zero density of wild mustard (Table 1). Interaction effect of nitrogen levels and wild mustard densities indicated that the highest plant height was observed in the zero density of wild mustard under the application of 210 kg.ha⁻¹ N and the lowest amount was noted in the highest infestation of the wild mustard under 90 kg.ha⁻¹ N (Fig. 2).

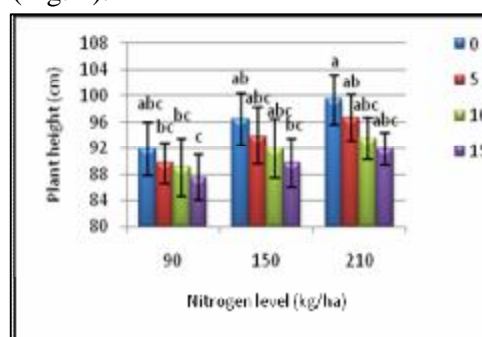


Fig. 2. Interaction effect of nitrogen and wild mustard densities on height of wheat, Via Duncan test at 5 % probability level. Wild mustard densities included: 0, 5, 10 and 15 plants.m⁻².

Naseri *et al.* (2010) found that wheat height was significantly affected by increasing amount of the soil nitrogen. Among the N concentrations (0, 80, 160 and 240 kg.ha⁻¹), highest plant height (125.7 cm) was obtained in treatment with application of 240 kg.ha⁻¹ while the lowest plant height (83.4 cm) was observed in unfertilized treatment. Hassan and Khan (2007) stated that the wheat plant height was affected by the wild oat (*Avena fatua* L.) density. The wheat height at 50 wild oat plants.m⁻² was 83.8 cm as compared with 90.1 cm at zero density of wild oats.m⁻². Kovacs *et al.* (2006) revealed that maize height in weed-free conditions was 20 cm higher than maize infested with *Abutilon theophrasti*.

Grain yield of wheat

The ANOVA result showed effect of nitrogen and wild mustard densities on this trait were none significant and significant at 5% probability level, respectively (Table 1). Nitrogen concentrations did not show significant effect on grain yield. Grain yields under 90, 150 and 210 kg N.ha⁻¹ were 418.3, 461.8 and 418.7 g.m⁻², respectively. Data indicated that the interspecific competition of wild mustard with wheat significantly reduced wheat grain yield. The percentage of grain yield loss due to 15 plants.m⁻² of wild mustard.m⁻² was 40.2 % (Table 2). The results showed that in weed-free plots, increasing nitrogen application from 90 to 210 kg. ha⁻¹ N increased grain yield of wheat whereas, in the presence of wild mustard, increasing nitrogen level significantly increased grain yield loss of wheat due to increasing competitive ability of wild mustard. For example, competition of 15 wild mustard plants.m⁻² when applied with 90, 150 and 210 kg.ha⁻¹ N decreased wheat grain yield by 31.6, 34.4 and 53.3 % as compared to zero density of wild mustard, respectively (Fig. 3).

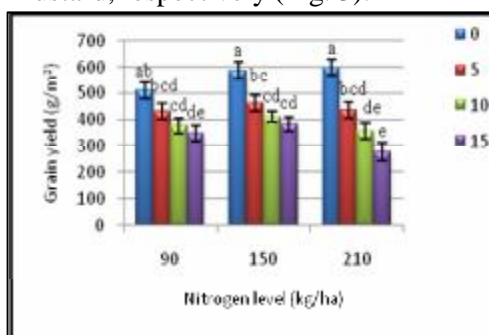


Fig. 3. Interaction effect of nitrogen and wild mustard densities on grain yield of wheat, Via Duncan test at 5 % probability level. Wild mustard densities included: 0, 5, 10 and 15 plants.m⁻².

Pourreza *et al.* (2010) stated that the grain yield of wheat, *Triticum aestivum* L., was reduced due to wild oat, *Avena fatua* L., competition.

The density of 100 plants of wild oat decreased grain yield of wheat by 38.7 % as compared to weed-free treatment. Mohajeri and Ghadiri (2003) reported that the density of wild mustard more than 20 plants.m⁻² significantly decreased the grain yield of wheat under application of zero and 50 kg.ha⁻¹ N, while at the levels of 100, 150 and 200 Kg.ha⁻¹ N, increasing wild mustard density more than 10 plants per m² significantly decreased the wheat grain yield. They concluded that in the presence of high density of weed, increasing nitrogen fertilizer level did not reduce the negative effects of wild mustard on wheat grain yield. Blackman and Templeman (1938) reported that the application of doubling rate of added nitrogen did not increase the yield of weedy oat as compared to application of single rate of nitrogen.

Harvest index of wheat

The ANOVA result showed effect of nitrogen and wild mustard densities on this trait were none significant and significant at 5% probability level, respectively (Table 1). The effect of nitrogen doses on harvest index (HI) was not significant while HI significantly decreased by increasing wild mustard densities. The results showed that 9.3, 15.1 and 19.9 % reduction in HI was recorded at 5, 10 and 15 densities of wild mustard respectively as compared to zero density of wild mustard. The reduction of HI in the presence of wild mustard showed that the negative effect of wild mustard on grain yield was more than biological yield (Table 1). The interaction between different N levels and wild mustard densities also indicated that the maximum HI (40.43 %) was noted in wild mustard free at the level of 210 kg.ha⁻¹ N and the lowest harvest index (28.4 %) was observed in 210 kg.ha⁻¹ N + 15 wild mustard m².

The results indicated that in the presence of wild mustard, the reduction of HI increased by increasing nitrogen levels. It showed that increasing nitrogen application increased the grain yield loss more than biological yield loss due to increasing wild mustard competitive ability (Fig. 4).

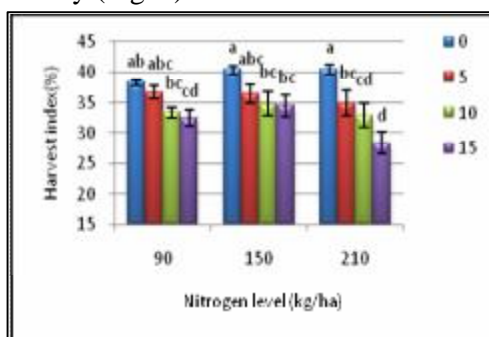


Fig. 4. Interaction effect of nitrogen and wild mustard densities on harvest index of wheat, Via Duncan test at 5 % probability level. Wild mustard densities included: 0, 5, 10 and 15 plants.m⁻².

This finding was in the line with Rastgoo *et al.* (2002) who stated that in the presence of wild mustard the harvest index of wheat decreased by increasing nitrogen levels and among the nitrogen levels (100, 150 and 225 kg.ha⁻¹) the maximum amount of HI loss was observed in the highest level of nitrogen application.

Biomass of wild mustard

The ANOVA result showed effect of nitrogen and wild mustard densities on this trait were significant at 5% probability level (Table 1). Increasing nitrogen level from 90 to 210 kg.ha⁻¹ resulted in a progressive increase in wild mustard biomass. Application of 210 kg.ha⁻¹ N increased the biomass by 108.5 % as compared to 90 kg N treatment. The results indicated that the biomass of wild mustard increased by increasing its density (Table 1). The interaction between nitrogen levels and

wild mustard density revealed that the biomass of wild mustard was progressively increased by increasing wild mustard population from 5 to 15 plants m⁻² in all nitrogen levels. The maximum biomass (421.7 g.m⁻²) was produced at 15 wild mustard density+210 kg N which was significantly higher than other treatments. The minimum (95.4 g.m⁻²) was obtained in the density of five plants of wild mustard treated by 90 kg.ha⁻¹ N (Fig. 5). Ahmadvand *et al.* (2002) in a study to evaluate the competitive ability of wheat and wild oat under different nitrogen rates found that the biomass of 80 plants.m⁻² of wild oat with application of 200 kg.ha⁻¹ N was 70 % higher than 30 kg.ha⁻¹ N. It shows that competitive ability of wild oat increases with increasing doses of nitrogen. Grant *et al.* (2007) reported that increasing biomass with application of potassium and sulphur fertilizer varied among crop and weed species.

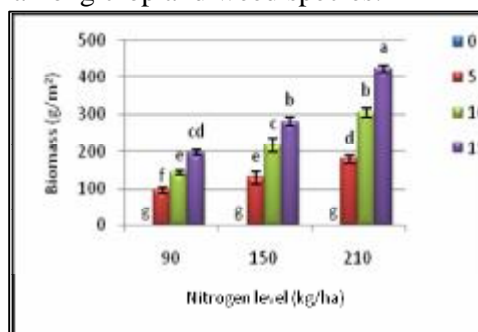


Fig. 5. Interaction effect of nitrogen and wild mustard densities on biological yield of wild mustard, Via Duncan test at 5 % probability level. Wild mustard densities included: 0, 5, 10 and 15 plants.m⁻².

They concluded *Brassica napus*, wild mustard, *Sinapis arvensis* L. were more responsible for sulphur fertilizer than spring wheat. Blackshaw *et al.* (2002) indicated that regarding weed-crop species and density, competitive ability of weeds can be increased more than crop by application of N.

Adding nitrogen from 40 to 240 ppm increased the biomass of many weed species like wild mustard, *Sinapis arvensis*, and redroot pigweed, *Amaranthus retroflexus*, more than wheat and canola.

CONCLUSION

The results of present study indicated that management of nitrogen fertilization level is an important tool to achieve higher wheat production. In this study wild mustard was more active than wheat in using nitrogen added. Increasing nitrogen fertilization increased the competitive ability and growth of wild mustard and increased loss of wheat grain yield.

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