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Influences of Different Nitrogen Levels on Competition between Spring Wheat (*Triticum aestivum* L.) and Wild Mustard (*Sinapis arvensis* L.)

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Abstract

A field experiment was carried out to investigate the effects of different nitrogen levels on interspecific competition between wild mustard and spring wheat. The experiment was laid out in randomized complete block design under a split plot arrangement, with three replications. The experiment comprised of three nitrogen levels (90, 150 and 210 kg ha^{-1}) assigned to main plots and four wild mustard densities such as 0, 5, 10 and 15 plants m^{-2} kept in sub-plots. The results revealed that yield, yield components and nitrogen use efficiency of wheat were decreased with increasing wild mustard density. The density of 5, 10 and 15 wild mustard plants m^{-2} reduced the grain yield of wheat by 21.4, 32.2 and 40.2% respectively as compared to control. Increasing nitrogen level increased the grain yield of wheat in weed free plots, while in the presence of wild mustard, increasing nitrogen level led to increase the competitive ability of wild mustard and increased the yield losses of wheat. The density of 15 wild mustard plants m^{-2} had decreased the grain yield of wheat by 31.6, 34.4 and 53.3 % under 90, 150 and 210 kg N ha^{-1} respectively.

Key words: competition, nitrogen levels, wheat, wild mustard, yield loss

1. Introduction

In recent years, concern over the environmental effects, costs of cultivation, and long-term efficacy of conventional weed management systems have led to increasing number of farmers and researchers to seek alternative systems that are less reliant on herbicides and more reliant on ecological processes (Davis &Liebman, 2001). Research supporting the development of ecologically based weed management has been scarce over the past 50 year (Benbrook, 1996). An approach for improving weed management and reducing reliance on herbicide technology involves the integration of soil, crop, and weed management (Liebman & Davis, 2000).

The importance of nitrogen usage and effectiveness in wheat and other cereals productions has increased due to increase the cost of manufacturing and distributing of nitrogen fertilizer. Increasing the application of nitrogen fertilizer in agricultural fields increased the worries about groundwater pollution. This worry has forced the growers to increase nitrogen use efficiency in crop production. Increasing nitrogen use efficiency of wheat can reduce N fertilizer requirements and N leaching; therefore, an effective usage of applied nitrogen by plant will decrease the productive costs (Kanampiu et al., 1997). Application of fertilizers to various crops is an important component of integrated weed management system (Blackshaw, 2005) and manipulation in fertilizer doses to crops can reduce the weeds' interference (Di Tomasso, 1995). Nitrogen is the major nutrient added to increase crop yield (Camara et al., 2003), altered soil nitrogen levels can affect crop-weed competitive interactions. Depending on the weed species and density, addition of nitrogen may increase the competitive ability of weeds more than the crop with little or no increase in crop yield (Carlson & Hill, 1985; Dhima & Eleftherohorinos, 2001). Wild mustard (*Sinapisarvesis* L.) is an aggressive weed indigenous throughout most of the temperate regions of Europe, Asia and North Africa. Seed germination ability of wild mustard and rapid early seedling growth under cool spring and fall temperatures, allow wild mustard to compete effectively with crops for light, moisture and nutrients, which are responsible for reduction in crop yield, dockage losses. Populations of wild mustard if controlled throughout the growing season of the crop can reduce yield loss (Buchanan et al., 2009).

Carlson and Hill (1985) found that added nitrogen had increased the density of wild oat (*Avenafatua* L.) panicles and caused reduction in grain yield of wheat. The wild oat competition had reduced the effectiveness of nitrogen fertilizer on increasing grain yield of wheat. Blackshaw et al. (2003) stated that shoot and root growth of weeds such as *Sinapisarvensis* L., *Chenopodium album* L., *Amaranthusretroflexus* L. and *Avenafatua* L., was increased by addition of nitrogen but the magnitude of the response varied greatly among weed species. From the results stated above it is clear that the reaction of weed communities to nitrogen is highly dependent on type of weed species.

Considering these facts present investigation was attempted to study the effects of wild mustard densities on grain yield and yield components of wheat under different nitrogen levels.

2. Materials and Methods

The effects of wild mustard (*Sinapis arvensis* L.) competition on grain yield and yieldcomponents of wheat (*Triticum aestivum* L. Var. Chamran) under different nitrogen levels were examined. The experiment was conducted at research field of Islamic Azad University of Ahvaz-Iran during 2007-08 growing season. The soil texture was silty clay loam (average 48 % clay content, 32 % silt and 20 % sand). The available phosphorous and potassium were 6.4 and 155 ppm respectively. The soil pH was 7.5 and soil electrical conductivity was 3.2 dsm^{-1}.

The experiment was performed in split plot with randomized complete block design having three replications in additive series. Three nitrogen levels (N1: 90, N2: 150 and N3: 210 kg ha^{-1}) were maintained in main plots. Four wild mustard densities (D1: 0, D2: 5, D3: 10 and D4: 15 plants m^{-2}) were maintained into sub-plots. Nitrogen fertilizer was applied to the sub plots as urea (46 % N). All the phosphorous (100 kg P_2O_5 ha^{-1}), potassium (100 kg K2O ha^{-1}) and 40 % of nitrogen according to the treatment level in each plot were broadcasted uniformly at the sowing time and mixed with soil. Remaining 60 % of nitrogen was divided into two topdressings: 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. The seeds of wild mustard and wheat were sown manually at the same day. All other weeds were removed manually throughout wheat growing season. Standard cultural practices were followed uniformly in all the treatments during the experiments. To determine the yield and yield parameters of wheat, an area of two square meters was harvested by sickle after physiological maturity and bagged separately. 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 %.

3. Results and Discussion

3.1 Number of Tillers and Spikes per Square Meter

The tiller number of wheat was significantly increased by increasing nitrogen application. Average tiller number was 598.5, 660.2 and 663.7 m^{-2} by nitrogen application at the level 90, 150 and 210 kg ha^{-1} respectively (Table 1). Wild mustard competition significantly decreased the tiller number in all nitrogen levels. The density of 15 wild mustard plants m^{-2} decreased the tiller number by 9.8, 14.6 and 20.9% under 90, 150 and 210 kg N ha^{-1} respectively (Table 2). Results of present investigation are in agreement with Gill and Blacklow (1984) who reported that the tiller number of wheat was decreased from 605 tillers m^{-2} in weed free treatment to 336 tillers m^{-2} in the presence of great brome (*Bromus diandrus* Roth) with density of 400 plants m^{-2}.

The results shown in table 1 and 2 revealed that the effect of nitrogen levels, wild mustard densities and interaction effect of nitrogen and weed density on spike number per m^{-2} were significant. The highest spike number (504 m^{-2}) was observed in weed free treatment and the lowest spike number (377.4 m^{-2}) was recorded in the density of 15 wild mustard plants m^{-2}. The densities of 5, 10 and 15 wild mustard plants m^{-2} decreased the spike number of wheat by 11.5, 20 and 25.1% as compared to zero density of wild mustardrespectively (Table1). Increasing nitrogen application was more beneficial for wild mustard which was increased the competitive ability of wild mustard and increased the loss of wheat spike number. The density of 15 plants of wild mustard m^{-2} decreased the spike number by 18.2, 21.2 and 35.1 % under 90, 150 and 210 kg N ha^{-1} respectively. Our results are corroborating with Giambalvo et al. (2010). They stated that the interspecific competition of weed, *Hordeum vulgare* L. decreased the spike number of wheat (*Triticum durum* Desf Var. Simeto.) by 8.9 and 27.3 % under zero and 80 kg N respectively whereas the spike number of Valbelice variety was decreased by 19.6 and 26.2 % as affected by zero and 80 kg nitrogen respectively in 2005-6. Also, Rastgoo et al. (2002 reported that wild mustard (*Sinapis arvensis* L.) had significantly caused decrease in spike number of wheat with increasing wild mustard density.

3.2 Number of Grains per Spike and 1000 Grain Weight

The effects of wild mustard density, nitrogen levels and their interaction on the grain number per spike were significant. Among the nitrogen levels, the maximum and the minimum of grain number per spike were produced in the application of 150 and 90 kg ha^{-1} respectively (Table 1). The grain number per spike was decreased by increasing weed density per m^{-2}. The densities of 5, 10 and 15 wild mustard plants per m^{-2} decreased the grain number per spike by 6.6, 11 and 16.7 % as compared to the control plot respectively (Table 1). The reduction of grain number per spike in the presence of wild mustard was because of reduction in the spikelet number per spike (data not shown). Blackshaw et al. (1981) reported that increasing *Setaria veridis* density decreased the spikelet number of wheat, floret fertility and grain number per spike through shading effect of weed. Also, Guillen-Portal et al. (2006) revealed that the grain number per wheat spike significantly decreased in the presence of wild oat (*Avena fatua* L.).

The results indicated that the negative effect of wild mustard competition on the grain number of wheat was increased by increasing nitrogen level. The competition of 15 wild mustard plants m^{-2} as affected by 90, 150 and 210 kg N ha^{-1} had decreased the grain number per spike by 12.8, 16.3 and 20.5% as compared to weed free plot respectively (Table 2). According to Mohajeri and Ghadiri (2003) increasing nitrogen level from zero to 100 kg N ha^{-1} had a significant effect on increasing grain number per spike of wheat. While increasing nitrogen rate more than100 kg ha^{-1} had a non-significant effect on grain number per spike. The negative effect of wild mustard densities (20, 30 and 40 plants m^{-2}) was increased at the nitrogen level of 200 kg ha^{-1}. This finding showed that extra dose of nitrogen had increased the growth and competitive ability of wild mustard instead of wheat.The effect of nitrogen levels on 1000 grain weight was non-significant while wild mustard density significantly decreased the 1000 grain weight. The 1000 grain weight of wheat was decreased by 6.5 % in the presence of 15 wild mustard plants m^{-2} as compared to zero density of wild mustard (Table 1). Interaction between nitrogen levels and wild mustard densities indicated that the highest 1000 grain weight (40.9 g) was noted in wild mustard free as affected by 90 kg N ha^{-1} while the minimum (36.4 g) was observed in the density of 15 plants of wild mustard under 210 kg N ha^{-1} (Table 2).

Table 1. Effect of nitrogen levels and wild mustard densities on yield and yield parameters of wheat

Treatment	No. of tillers m^{-2}	No. of spikes m^{-2}	No. of grains per spike	1000 grain weight (g)	Grain yield (g/m^2)	NUE (kg/kg)
			Nitrogen level ($Kgha^{-1}$)			
90	598.5 b	b424.9	26.9 b	39.5 a	418.3 a	46.5 a
150	660.2 a	a450.2	30.1 a	37.9 a	461.8 a	30.8 b
210	663.7 a	422.8 b	29.9 a	38.2 a	418.7 a	20.0 c
			Weed density (plant m^{-2})			
0	699.4 a	504 a	31.7 a	39.9 a	565.6 a	41.5 a
5	651.9 ab	446 b	29.6 b	38.7 ab	444.4 b	33.3 b
10	620.1 bc	403.1 c	28.2 b	38.3 ab	383.6 c	28.9 c
15	591.7 c	377.4 c	26.4 c	37.3 b	338.1 c	26.0 c

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

3.3 Grain Yield

The effect of nitrogen levels on the grain yield was not significant while wild mustard densities significantly decreased the grain yield of wheat. Among the nitrogen levels, the highest grain yield (461.8 g m^{-2}) was noted in the application of 150 kg N ha^{-1} and the lowest grain yield (418.3 gr m^{-2}) was recorded in 90 kg N ha^{-1}. Increasing wild mustard density led to decrease the grain yield. The densities of 5, 10 and 15 wild mustard plants per m^{-2} reduced the grain yield by 21.4, 32.2 and 40.2 % as compared to zero density of wild mustard respectively (Table

1). Mennan (2003) reported that wheat grain yield was decreased by increasing wild mustard (*Sinapis arvensis* L.) density. The yield losses of 3.11 and 36.87 % were observed at the densities of 1 and 32 *S. arvensis* m^{-2} respectively. Dhima and Eleftherohorions (2005) stated that competition of 140 plants of wild mustard caused decrease in the grain yield of wheat (*Triticum aestivum* L.) and triticale (*Triticosecale*) by 26 and 27 % respectively but the grain yield of barley, *Hordeum vulgare,* was reduced only by 3.5 %.

The correlation between grain yield and the spike number per m^{-2}, spikelet per spike, grain number per spike and 1000 grain weight were positive and significant (Table 3). The reduction of grain yield in the presence of wild mustard was mainly due to significant reduction in tiller number, spike number and the grain number per spike (Tables 2 and 3). This finding was in the line with Rastgoo et al. (2002) who reported that increasing wild mustard density decreased the biological and grain yield of wheat through decreasing the tiller number, spike number and grain number per spike whereas the reduction in grain yield was higher than reduction in biological yield.

Table 2. Interaction effect of different nitrogen levels and wild mustard densities on yield and yield parameters of wheat

Treatment	No. of tillers m^{-2}	No. of spikes m^{-2}	No. of grains per spike	1000 grain weight (g)	Grain yield ($g\ m^{-2}$)	NUE (kg/kg)
N_1D_1	633.7 bcd	469.0 bc	28.9 cd	40.9 a	511.0 ab	56.8 a
N_1D_2	604.7 cd	445.0 cd	26.9 de	39.6 ab	433.0 bcd	48.1 b
N_1D_3	584.3 cd	402.0 def	26.5 de	39.0 ab	379.3 cd	42.2 bc
N_1D_4	571.3 d	383.7 fg	25.2 e	38.5 ab	349.7 de	38.9 c
N_2D_1	714.7 ab	516.3 ab	32.6 ab	38.7 ab	587.0 a	39.1 c
N_2D_2	671.7 abc	454.0 cd	31.0 abc	37.8 ab	463.0 bc	30.9 d
N_2D_3	644 bcd	423.7 cdef	29.6 bcd	38.2 ab	412.0 cd	27.5 de
N_2D_4	610.3 cd	406.7 def	27.3 de	37.0 ab	385.3 cd	25.7 de
N_3D_1	750.0 a	526.7 a	33.6 a	40.1 ab	598.7 a	28.5 de
N_3D_2	679.3 abc	439.0 cde	30.9 abc	38.6 ab	437.3 bcd	20.8 ef
N_3D_3	632 bcd	383.7 efg	28.5 cde	37.6 ab	359.3 de	17.1 f
N_3D_4	593.3 cd	342 g	26.7 de	36.4 b	279.3 e	13.3 f

Note: Means with different letters are significantly different at P=0.05 , using Duncan's Multiple Range Test

The results showed that interference effect of wild mustard on wheat grain yield was increased by increasing nitrogen application. The presence of 15 wild mustard plants m^{-2} decreased the grain yield by 31.6, 34.4 and 53.3 % under 90, 150 and 210 kg N ha^{-1} as compared to weed free condition in each nitrogen level respectively (Table 2 and Figure 1). It indicates that wild mustard has a higher ability to absorb nitrogen at high levels of nitrogen and because of increasing its biomass and developing root system (data not shown); it was more successful in the competition with wheat. Mohajeri and Ghadiri (2003) reported that application of 0 and 50 kg N ha^{-1}, the presence of wild mustard more than 20 plants m^{-2} significantly decreased the grain yield of wheat, while at the levels of 100, 150 and 200 Kg N ha^{-1}, increasing wild mustard density more than 10 plants per m^{-2} 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.

3.4 Nitrogen Use Efficiency

The Nitrogen Use Efficiency (NUE) of wheat was significantly decreased by increasing nitrogen level and wild mustard density. The NUE of wheat in the application of 90 kg N ha^{-1} was 57 % higher than 210 kg N ha^{-1}. The density of 15 wild mustard plants m^{-2} decreased the NUE by 37.3 % as compared to weed free plot (Table 1). This finding shows that wheat plant cannot use nitrogen efficiently for producing grain in the presence of weed. Interaction between nitrogen levels and weed densities indicated that in the presence of wild mustard, the reduction in NUE of wheat was increased by increasing nitrogen level. Among the treatments the maximum of NUE (56.8 kg/kg) was observed in zero density of wild mustard under 90 kg N ha^{-1} while the minimum of NUE

(13.3 kg/kg) was noted in the presence of 15 plants of wild mustard as affected by 210 kg N ha^{-1} (Table 2). Giambalvo et al. (2010) noted that the interspecific competition of weed, *Hordeum vulgare* L. significantly affected the NUE of wheat (*Triticum durum* Desf.). Interspecific competition decreased the NUE of wheat by 17 % in 2004-2005 and by 39 % in 2005-2006 as compared to weed free condition.

Table 3. Correlation coefficient among yield parameters and yield of wheat

	No. of tillers m^{-2}	No. of spikes m^{-2}	No. of spikelets per spike	No. of grains per spike	100 grain weight	Biomass
No. of spike m^{-2}	0.84 **					
No. of spikelet per spike	0.99 **	0.79 **				
No. of grain per spike	0.99 **	0.83 **	0.99 **			
100 grain weight	0.31 ns	0.67 **	0.26 ns	0.29 ns		
Biomass	0.88 **	0.99 **	0.83 **	0.87 **	0.66 *	
Grain yield	0.85 **	0.99 **	0.79 **	0.83 **	0.68 *	0.99 **

*, ** significant at 5% and 1% respectively, ns not significant.

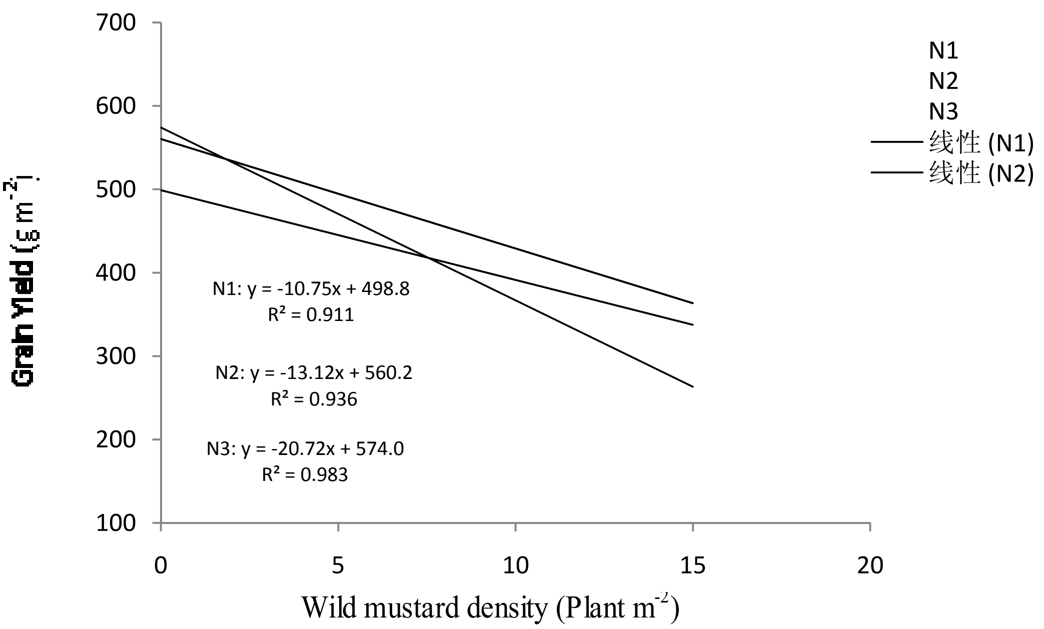

Figure 1. Regression analysis of effect of wild mustard densities on grain yield of wheat under different nitrogen levels

4. Conclusion

The results of this research showed that increasing wild mustard density decreased the yield and yield components of wheat. The grain yield of wheat was decreased through reduction in spikes number and grains number per spike. Increasing the application of nitrogen increased the wheat grain yield in weed free plots while in the presence of wild mustard, increasing the nitrogen level increased the negative effect of wild mustard on wheat grain yield. The NUE of wheat was decreased by increasing wild mustard density and nitrogen level. Results of this experiment indicate that the growers should consider crops as well as weeds while fertilizer application programs are planned. In this plan, managing N application rate can be as a component of integrated weed management system.

References

Benbrook, C. M. (1996). *Pest Management at the Crossroads* (pp. 5-7). Yonkers, NY: Consumers Union.

Blackshaw, R. E., Brandt, R. N., Janzen, H. H., Entz, T., Grant, C. A., & Derksen, D. A. (2003). Differential response of weed species to added nitrogen. *Weed Sci., 51*, 532-539. http://dx.doi.org/10.1614/0043-1745(2003)051[0532:DROWST]2.0.CO;2

Blackshaw, R. E. (2005). Nitrogen fertilizer, manure and compost effects on weed growth and competition with spring wheat. *Agron J., 97*, 1612-1621. http://dx.doi.org/10.2134/agronj2005.0155

Blackshaw, R. E., Stobbe, E. H., & Sturko, A. R. W. (1981). Effect of seeding dates and densities of green foxital (*Setaria viridis*) on the growth and productivity of spring wheat (*Triticum aestivum*). *Weed Sci., 29*, 212-217.

Buchanan, F. S., Swanton, C. J., & Gillespie, T. J. (2009). *Wild mustard*. Retrieved from http://www.omafra.gov.on.ca/english/crops/facts/03-043.htm

Camara, K. M., Payne, W. A., & Rasmussen, P. E. (2003). Long-term effects of tillage, nitrogen, and rainfall on winter wheat yields in the pacific northwest. *Agron J., 95*, 828-835. http://dx.doi.org/10.2134/agronj2003.0828

Carlson, H. L., & Hill, J. E. (1985). Wild oat (*Avena fatua*) competition with spring wheat: Effects of nitrogen fertilization. *Weed Sci., 34*, 29-33.

Davis, A. S., & Liebman, M. (2001). Nitrogen source influences wild mustard growth and competitive effect on sweet corn. *Weed Sci.,* 49, 558-566. http://dx.doi.org/10.1614/0043-1745(2001)049[0558:NSIWMG]2.0.CO;2

Dhima, K. V., & Eleftherohorions, I. G. (2001). Influence of nitrogen on competition between winter cereals and sterile oat. *Weed Sci., 49*, 77-82. http://dx.doi.org/10.1614/0043-1745(2001)049[0077:IONOCB]2.0.CO;2

Dhima, K., & Eleftherohorinos, I. (2005). Wild mustard (*sinapis arvensis* L.) competition with three winter cereals as affected by nitrogen supply. *J. Agron. Crop Sci. 191*, 241-248. http://dx.doi.org/10.1111/j.1439-037X.2005.00152.x

Di Tomaso, J. (1995). Approaches for improving crop competitiveness through the manipulation of fertilization strategies. *Weed Sci., 43*, 491-497.

Giambalvo, D., Ruisi, P. G. D., Miceli, G., Frenda, A. S., & Amato, G. (2010). Nitrogen use efficiency and nitrogen fertilizer recovery of durum wheat genotypes as affected by interspecific competition. *Agron J., 102*, 707-715. http://dx.doi.org/10.2134/agronj2009.0380

Gill, G. S., & Blacklow, W. M. (1984). Effect of great brome (*Bromus diandrus* Roth) in the growth of wheat and great brome and their uptake of nitrogen and phosphorus. *Aus. J. Agri. Res., 35*, 1-8.

Guillen-Portal, F. R., Stougaard, R. N., Xue, Q., & Eskridge, K. M. (2006). Compensatory mechanisms associated with the effect of spring wheat seed size on wild oat competition. *Crop Sci., 46*, 935-945. http://dx.doi.org/10.2135/cropsci2005.08-0270

Kanampiu, F. K., Raun, W. R., Johnson, G. V., & Anderson, M. P. (1997). Effect of nutrition rate on plant nitrogen loss in winter wheat varieties. *J. Plant Nutr., 20*, 389-404. http://dx.doi.org/10.1080/01904169709365259

Liebman, M., & Davis, A. S. (2000). Integration of soil, crop and weed management in low-external-input farming systems. *Weed Res., 40*, 27-47. http://dx.doi.org/10.1046/j.1365-3180.2000.00164.x

Mennan, H. (2003). Economic thresholds of *Sinapis arvensis* (wild mustard) in winter wheat fields. *Pak J. Agro., 2*, 34-39.

Mohajeri, F., & Ghadiri, H. (2003). Competition of different densities of wild mustard (*Brassica kaber*) with winter wheat (*Triticum aestivum*) under different levels of nitrogen fertilizer application. *Iranian J. Agric. Sci., 34*, 527-537. (In Persian)

Rastgoo, M., Ghanbari, A., Banaian, M., & Rahimian, H. (2002). Investigation of amount and timing of nitrogen application effects on wild mustard (*Sinapis arvensis*) impact on yield and yield components of winter wheat. *Pajouhesh-va- Sazandegi 56, 57*, 16-24.