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Original Research Article

Interrelationships between Nitrogen Rate and Wild Oat Density on Oilseed Rape Yield Components

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ABSTRACT

In order to evaluate the effect of nitrogen on oilseed rape yield and yield component under wild oat densities, a field experiment was conducted in Shiraz University, Iran, during 2008-2009 and 2009-2010 growing seasons. The experimental design was split plot with three replications. Treatments included four nitrogen levels (zero, 50, 100, and 150 kg ha^{-1}) and four densities of wild oat (zero, 15, 30, and 45 plants m-^{2}). The result showed that number of pods per main stem and secondary branches, number of seeds per main and secondary pods, 1000-seed weight, grain and biological yield was significantly increased by enhancement of nitrogen levels from zero to 150 kg ha^{-1} at weed-free treatments. Also, weed interference significantly reduced grain yield up to 41% under 50 and 100 kg ha^{-1} nitrogen application in comparison 150 kg ha^{-1}. Regardless of oilseed rape yield, weed dry weight was significantly increased with increasing the nitrogen levels, suggesting that high levels of nitrogen favor the crop over the weeds. This experiment suggested that oilseed rape grain and biological yield was affected more by high nitrogen levels at maximum weed density.

Keywords: Oil crop, Weed density, Nitrogen, Yield components

INTRODUCTION

Oilseed rape (*Brassica napus* L.) is a major oilseed crop throughout the world. It has a high demand for crop nutrients, including nitrogen (N) and N deficiency commonly limit canola yield (Grant and Bailey, 1993; Shirani Rad, 2002; Colnenne *et al.* 2002). Nitrogen serves as the most limiting nutrient on global scale and is prerequisite to uptake all fertilizers (Zarin Kafsh, 1992). Therefore, proper N fertilization is an important factor which optimizes the oilseed rape yield and quality (Rathke *et al.*, 2005). Al Kaisi and Yin (2003) stated that nitrogen plays fundamental role as an essential nutrient in changing traits such as plant establishment period, growth, biomass, harvest index, grain filling and grain yield. Nitrogen lowers oil percent and increases grain protein in oilseed rape (Henry and MacDonald, 1978; Holmes and Ainsley, 1977). Oilseed rape traits as plant height, number of branches per plant, number of pods per plant, seed yield and seed oil are directly associated to soil nitrogen (Ahmadi and Bahrani, 2009). Also, weeds have a direct effect on seed yield and the quality of seed oil. Weed competition with canola has reduced crop growth, leaf area and subsequently increased infertile flowers and pods (Tomass, 1992). Wild oat (*Avena fatua* L.) is an annual grass and its control is difficult because its seed shattering occurs before crop maturity. It is a dominant weed in several crop fields such as oilseed rape and wheat (*Triticum aestivum*) which can cause major yield losses as well as lower crop quality (Daugovish *et al.* 2002). Chow and Dorell (1979) stated that wild oat can restrict oilseed rape yield through competition in early growing stages. Key (1974) reported that to 40 days post-emergence of oilseed rape, wild oat lowers its yield to 61%. So that, 100 wild oat plants per square meter resulted in oilseed rape yield loss to 32% (Dew and Keys, 1976). Moreover, weed competition and crop loss in winter-sown oilseed rape will be more severe as compared with the spring-sown variety. Therefore, weed control at initial growth stages is indispensable for gaining a higher seed yield of oilseed rape (Blackshaw *et al.*, 2002). In the other hand, it has been recognized that changed soil nitrogen levels can influence on crop-weed competitive relationships. Results revealed that the growth of many weed species is enhanced by higher soil N levels (Abouziena *et al.*, 2007; Cathcart and Swanton, 2004; Blackshaw *et al.*, 2003; Evans *et al.*, 2003; Mishra and Kurchania, 2001). The application of nitrogen fertilizer in early tillering of wild oat increases the survival and fertility. When nitrogen is used in the emergence of wild oat, it population growth rate is 25% less than that of nitrogen applied at the beginning of tillering (Scursoni and Arnold, 2002). Since, some researches have evaluated the competitiveness of crops with

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wild oat (Ghadiri *et al.* 2008), but there is a limited information about wild oat and oilseed rape competitive interaction under nitrogen levels. Therefore, the aim of this study was to assess interaction effect of nitrogen and wild oat on oilseed rape yield and yield components.

MATERIALS AND METHODS

Field experiments were conducted in 2008-2009 and 2009-2010 growing seasons at the research station of the College of Agriculture of Shiraz University (1810 asl, longitude 52˚, 35΄, and latitude 29˚, 40΄) Iran. The experiment was arranged in split plots with three replicates. The parameters considered in this experiment consisted of four nitrogen levels zero, 50, 100, and 150 kg ha^{-1} as main plots and densities of wild oats in four levels of zero, 15, 30, and 45 plants m-^{2} as subplots. Soil texture was silt-loam with organic matter= 0.75%, total N= 0.05%, phosphorus= 21.8 mg kg^{-1}, potassium= 600 mg kg^{-1}, pH= 7.56 and EC= 0.52 dS m^{-1} in the surface horizon (0-20 cm). Cropping practices involved seed bed preparation (plowing with moldboard plow, disk to crushing clods); and seed sowing by pneumatic seeders in linear manner in spacing 15 cm and oilseed rape cultivar (Talayeh) was planted in 8 kg ha^{-1} in wild oat-infected farm, then farm was divided into plots in dimension 3×3 m. To achieve the desired density of weeds, thinning was performed in wild oat in the 4-leaf stage. At 100 kg ha^{-1} triple superphosphate before planting and nitrogen from urea-based treatments in 2 times (planting (0.0 ZE) and the beginning of stem elongation stage (2.05 ZE)) was applied in plots. To control aphid's oilseed rape two insecticides *Metasystox* (1 liter per hectare) and Primor (5.0 kilograms per hectare) in 3.5 and 1.6 ppt was applied. Plants were irrigated regularly during growing season every nine days. Weeding was done on a regular basis so that except wild oat densities, no other weeds growing in the plots. Finally, the measured parameters included the number of pods per main stem and secondary branches, number of seeds per pod, 1000-seed weight, grain yield and biological yield in oilseed rape and wild oat dry weight. Weeds were harvested from a 2 m^{-2} area per plot and dried at 75°C for 48 h. Regression analyses and analysis of variance for two years study were performed using SPSS ver. 17 and SAS ver. 9.1, respectively and Duncan's multiple range procedure was employed at probability level of 5%.

RESULTS AND DISCUSSION

Number of pods per main stem and secondary branches

The results showed that the effect of nitrogen levels on number of pods per main stem and secondary branches was significant ($p<0.05$) (Table 1). The highest of Number of pods per main stem and secondary branches related to 150 kg N ha^{-1} (Figure 1 and Table 1). However, there was no significant difference between 100 and 150 kg ha^{-1} nitrogen on number of pods per secondary branches (Table 1). Also, increased wild oat densities affected number of pods in oilseed rape; so that the lowest number of pods per main stem and secondary branches related to 45 plant m^{-2} wild oat density (Figure 2 and Table 1). Therefore, number of pods per plant in oilseed rape varied upon nitrogen fertilizer application. Number of pods main stem and secondary branches per plant plays a remarkable role towards the final seed yield of the crop (Sana, *et al.*, 2003). Shojaee *et al.* (2011) reported that the number of pods in main and secondary stem increased with an increase in amount of nitrogen application at 138 kg ha^{-1} significantly in oilseed rape. Also, the higher nitrogen applications (150 kg ha^{-1}) can be increased number of pods in oilseed rape (Kazemeini *et al.*, 2010; Cheema *et al.*, 2001). Although, adding nitrogen up to 150 kg ha^{-1} under low wild oat density led to a significant increase in number of pods. As all treatments showed larger number of secondary pods compared to main ones, because the number of secondary pods is an important component in final yield.

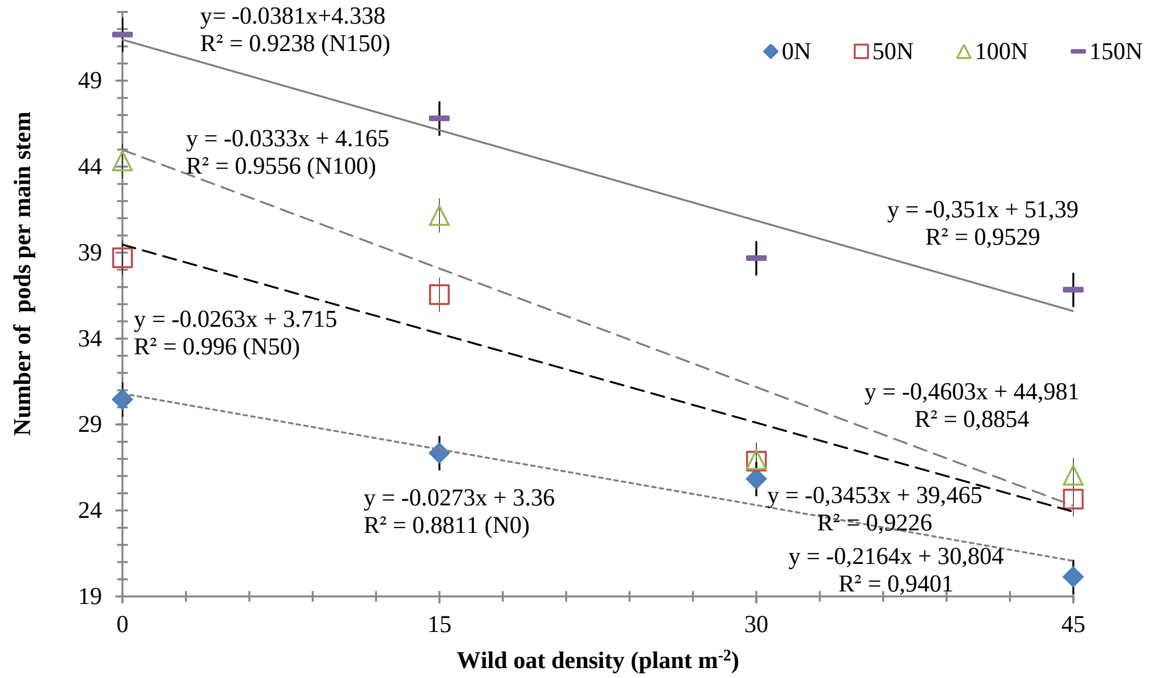

Figure 1. Interaction effect of nitrogen levels (0, 50, 100 and 150 kg ha^{-1}) and wild oat densities (0, 15, 30 and 45 plant m^{-2}) on number of pods per main stem in oilseed rape.

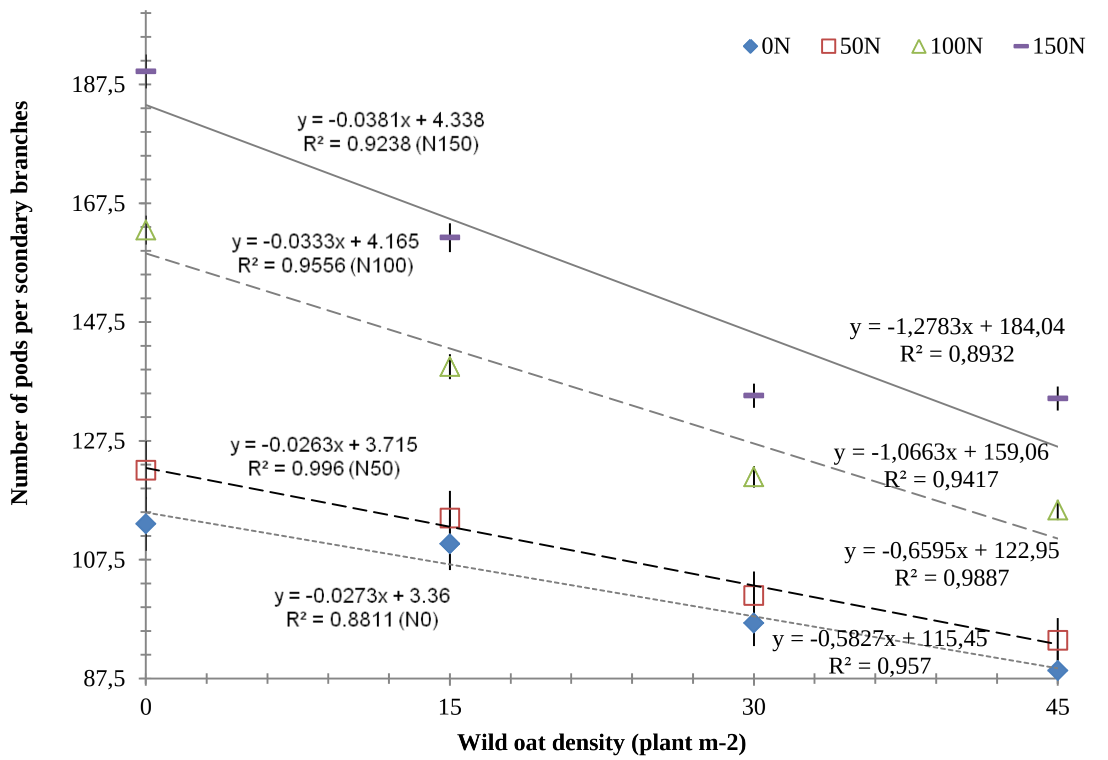

Figure 2. Interaction effect of nitrogen levels (0, 50, 100 and 150 kg ha^{-1}) and wild oat densities (0, 15, 30 and 45 plant m^{-2}) on number of pods per secondary branches in oilseed rape.

Table 1. Comparison of main effect of nitrogen levels and wild oat density on oilseed rape yield and its components (Mean of two years).

Treatments	NPMS	NPSB	NSMP	NSSP	W1000S
Nitrogen (kgha^{-1})					
0	25.93 C	102.36 B	10.26B	900.30 B	2.62 C
50	31.69 B	108.11B	10.86 B	968.50 B	2.79 C
100	34.62 B	135.07A	12.84 A	1042.5 A	3.37 B
150	43.49 A	155.29 A	14.19 A	1214.30 A	3.99 A
Wild oat density (plant m^{-2})					
0	41.29 A	147.20 A	13.56 A	1238.30 A	3.48 A
15	37.96 A	131.59 AB	12.77 B	1011.90 A	3.41 A
30	29.58 B	113.71 BC	11.22 C	972.20 A	3.12 A
45	26.92 B	108.32 C	10.59 D	984.20 B	2.74 B

Means followed by the same letters in each column and row are not significantly different (Duncan 5%).
NPMS= Number of Pod per Main Stem, NPSB= Number of Pod per Secondary Branches, NSMP= Number of Seed per Main Pods, NSSP= Number of Seed per Secondary Pods, W1000S= Weed 1000 Seed weight of oilseed rape

Number of seeds per main and secondary pods, 1000-seed weight

The effects of Nitrogen levels and wild oat density was significant for number of seeds per main and secondary pods and 1000-seed weight in oilseed rape (*$p<0.05$*) (Table 1). The maximum number of seed per main and secondary pods related to 100 and 150 kg ha^{-1} nitrogen at weed-free treatments (Table 1). Thus, number of seeds per pods was increased with nitrogen; however no significant different between 100 and 150 kg ha^{-1} nitrogen (Table 1). Scaribrick, *et al*, (1980) and Chauhan *et al.* (1995) concluded that upon nitrogen application increased number of seeds per pod and 1000-seed weight. In addition, number of seeds per pod on oilseed rape var. Afshar7045 and Hayola308 was increased under nitrogen application (Zangani *et al.* 2006). Data for wild oat densities revealed a significant decreased number of seeds per main pods in oilseed rape, even at the lowest wild oat density (15 plants m^{-2}) (Figure 3). Addition, wild oat densities decreased number of seeds per secondary pods but no significant different between 15 to 45 plant m^{-2} (Figure 4). Although, adding nitrogen up to 150 kg ha^{-1} under low wild oat density was resulted significant increases in number of seeds per plant. Therefore, application of fertilizer improves both crop and weed competitiveness (Liebman and Davis, 2000). Most of weeds uptake much more nitrogen and in this way provide less nitrogen for crop (Qasem, 1992). Results of nitrogen levels and wild oat density showed that maximum 1000-seed weight in oilseed rape was recorded in 150 kg ha^{-1} nitrogen at weed-free (Figure 5). However, 1000-seed weight was reduced under higher wild oat densities which were significant at 45 plants m^{-2} (Figure 5). Ozer (2003) demonstrated that 1000-seed weight increased exponentially in the case of applying up to 240 kg ha^{-1} N, in turn denotes on nitrogen contribute in oilseed rape seed setting.

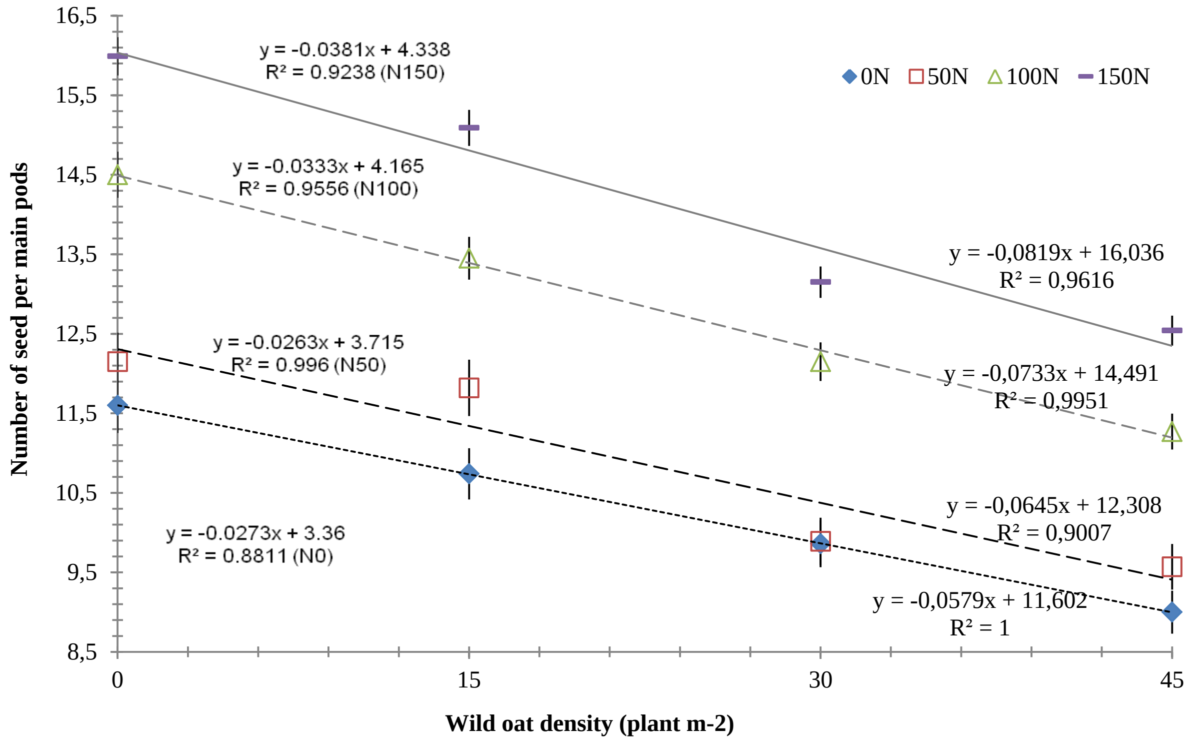

Figure 3. Interaction effect of nitrogen levels (0, 50, 100 and 150 kg ha^{-1}) and wild oat densities (0, 15, 30 and 45 plant m^{-2}) on number of seeds per main pods in oilseed rape.

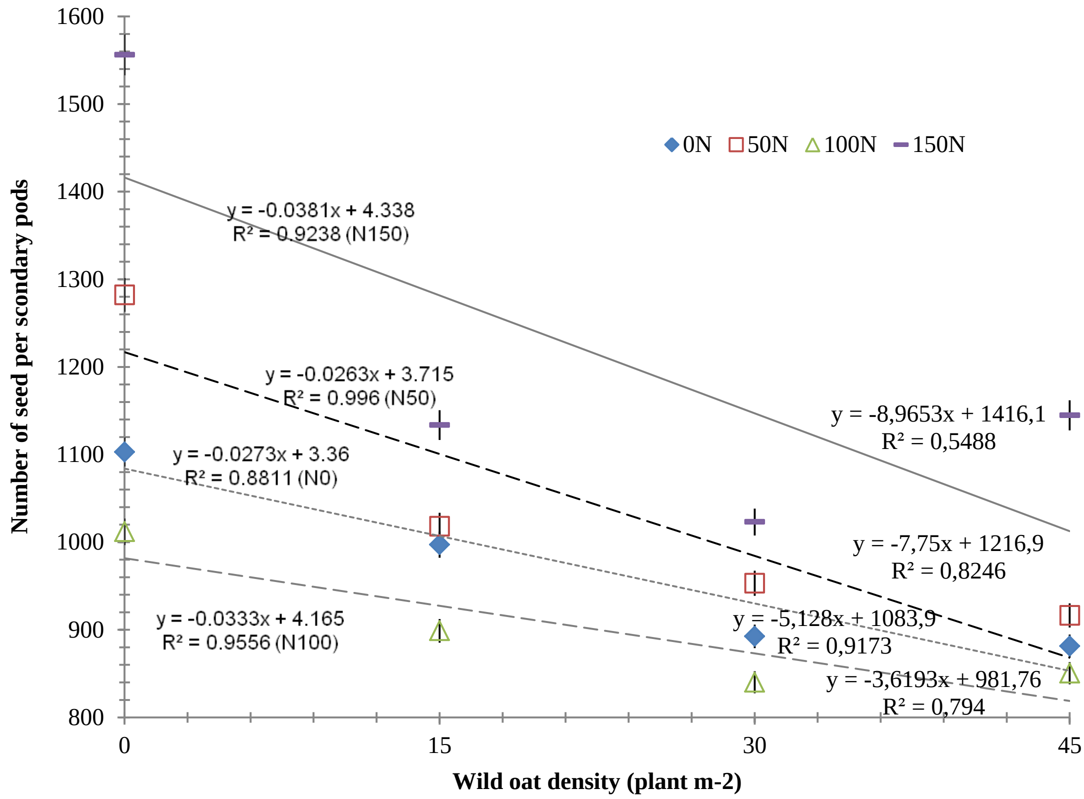

Figure 4. Interaction effect of nitrogen levels (0, 50, 100 and 150 kg ha^{-1}) and wild oat densities (0, 15, 30 and 45 plant m^{-2}) on number of seeds per secondary pods in oilseed rape.

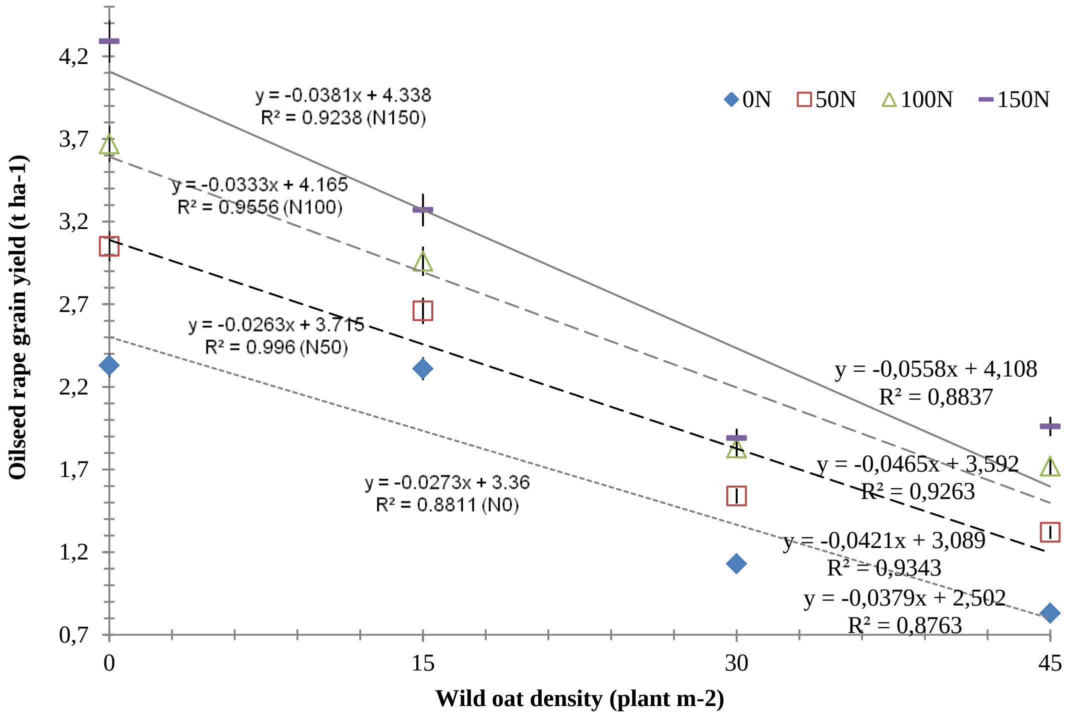

Figure 5. Interaction effect of nitrogen levels (0, 50, 100 and 150 kg ha^{-1}) and wild oat densities (0, 15, 30 and 45 plant m^{-2}) on oilseed rape grain yield (t ha^{-1}).

Oilseed rape grain yield

Wild oat densities and nitrogen levels had a significant effect on oilseed rape grain yield ($P < 0.05$) (Table 2). In both years, mean comparison showed that 150 kg ha^{-1} nitrogen at weed-free plots had maximum oilseed rape grain yield (Figure 5). Oilseed rape grain yield was decreased about 41% under 50 and 100 kg ha^{-1} nitrogen application in comparison 150 kg ha^{-1} (Figure 5). Increases of wild oat densities decreased oilseed rape grain yield (Table 2). It seems that, main reason of this enhancement is related to increase of weed number in surface unit leads to reduction of seed number in each pod and 1000-seed weight. Similar this result have been reported by many researchers (Below and Gentry, 1992; Hashemi–Dezfouli and Herbert, 1992). Also, many researchers have also reported that increasing N rate improved the grain yield of spring (Svecnjak and Rengel, 2006) and winter oilseed rape (Behrens *et al.*, 2001; Rathke *et al.*, 2005). Aminpanah *et al.* (2012) also reported that oilseed rape grain yield was significantly increased by enhancement of N rate from 0 to 200 kg N ha^{-1}. Kazemeini *et al.* (2010) showed that wild oat competition led to a large reduction (15-55%) in oilseed rape grain yield, so that the yield was decreased as wild oat density increased.

Table 2. Comparison of main effect of nitrogen levels and wild oat density on oilseed rape grain yield, biologic yield and wild oat dry weight (Mean of two years).

Nitrogen (kg ha^{-1})	**GY**	**BY**	**WDW**
0	1.67 D	8.25 B	0.92B
50	2.14 C	8.82AB	1.09B
100	2.54 B	9.07 AB	1.28 A
150	2.85 A	9.73 A	1.39 A
Wild oat density (plant m^{-2})			
0	3.33 A	10.22 A	0.00 D
15	2.80 B	9.05 B	1.26 C
30	1.60 C	8/59 BC	1.59 B
45	1.47 C	8.01 C	1.85 A

Means followed by the same letters in each column and row are not significantly different (Duncan 5%). GY= Grain Yield of oilseed rape (t ha^{-1}), BY= Biological Yield of oilseed rape, WDW= Wild oat Dry Weight (t ha^{-1}).

Oilseed rape biological yield

The effects of treatments on oilseed rape biological yield revealed that application of nitrogen even low rate (50 kg ha^{-1}) at weed free plots could be affect biological yield (Table 2). Although, application of nitrogen caused an increase in oilseed rape biological yield but no significant differences were found between nitrogen levels (Table 2). However, application of 150 kg ha^{-1} nitrogen was increased biological yield 15.21% approximately compared to 50 kg ha^{-1}. Generally, oilseed rape biological yield in weed-infested plots decreased with fertilization while wild oat density increased (Figure 6). Increased wild oat from 0 to 45 plant m^{-2} lowered biological yield to 21.62% in both years. Talaee and Haghparast (1999) found that applying optimum nitrogen rate improved grain yield, biological yield, grain weight and plant height significantly. In light of foregoing results, under all nitrogen treatment, increased wild oat density lowered oilseed rape biological yield (Figure 6).

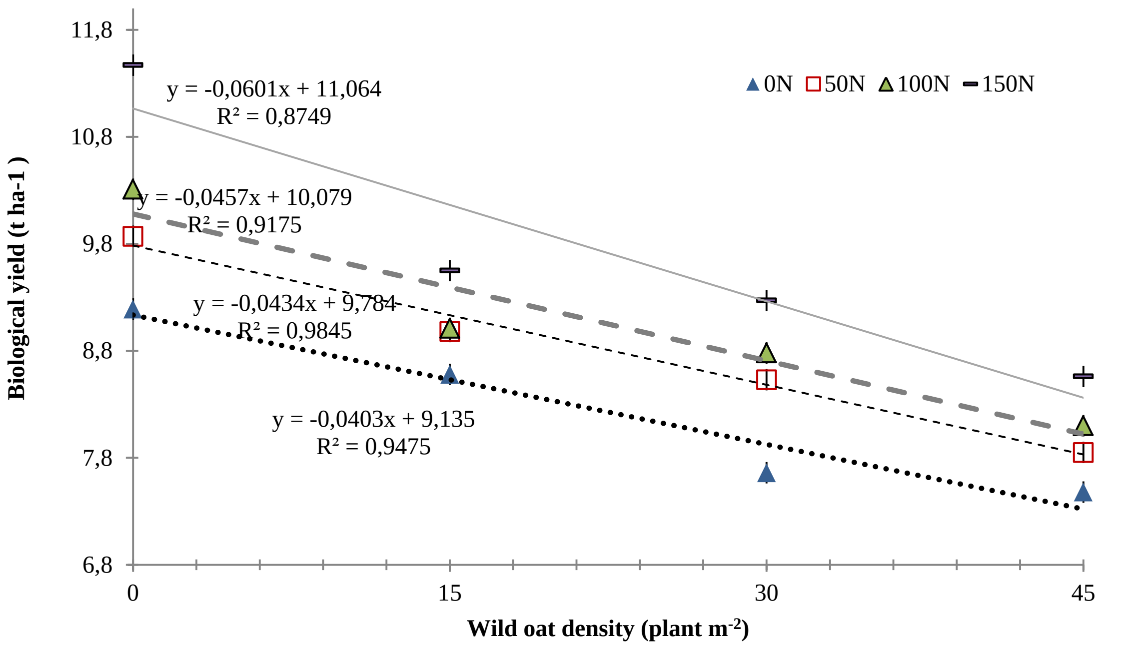

Figure 6. Interaction effect of nitrogen levels (0, 50, 100 and 150 kg ha^{-1}) and wild oat densities (0, 15, 30 and 45 plant m^{-2}) on oilseed rape biological yield (t ha^{-1}).

Wild oat dry weight

Results showed that nitrogen levels and wild oat density was significant for wild oat dry weight (Table 2 and Figure 7) ($P < 0.05$). So that, increasing nitrogen from 50 to 100 and 150 kg ha^{-1}, increased wild oat dry weight to 28.12 and 33.81 %, respectively (Table 2). Wild oat dry weight at 45 plants m^{-2} was higher than the other weed densities in fertilized plots (Figure 7). Some researchers reported that nitrogen fertilizer had no significant effect on the weed biomass in the rape crop (Anderson and Milberg, 1996; Marcinkeviciene *et al.*, 2010). Blackshow *et al.* (2003) illustrated that many weeds exhibited similar or greater responses in shoot and root biomass to increasing amounts of soil N, compared with canola. Aminpanah *et al.* (2012) demonstrated that weed biomass was lower than canola biomass when 200 kg ha^{-1} of nitrogen applied. Therefore, nitrogen application consistently increased wild oat dry weight but a greater proportion of nitrogen was allocated to oilseed rape.

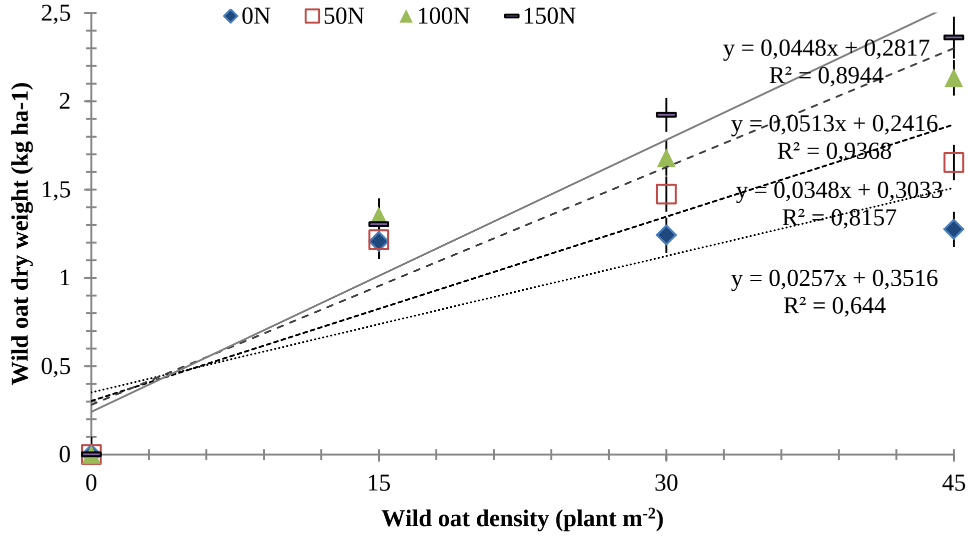

Figure 7. Interaction effect of nitrogen levels (0, 50, 100 and 150 kg ha^{-1}) and wild oat densities (0, 15, 30 and 45 plant m^{-2}) on wild oat dry weight (kg ha^{-1}).

CONCLUSIONS

The results of this study suggested that oilseed rape yield and yield components had association with the wild oat densities and nitrogen levels. Since, weed competition with crops can be affected by nitrogen levels. Therefore, wild oat is highly responsive to higher nitrogen levels and thus could be stronger competitors at higher nitrogen fertilizer rates. Also, it can produce a considerable biomass and seed at various densities and nitrogen levels. Thus, effective weed management should be done to reduce wild oat populations and to prevent its seed production in crops preceding oilseed rape as well as to control the weed at early season in the crop fields.

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