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# Competition of Wild Mustard (*Sinapis arvense* L.) Densities with Rapeseed (*Brassica napus* L.) under Different Levels of Nitrogen Fertilizer

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## ABSTRACT

**A two year field experiment was carried out to evaluate the competitive effects of wild mustard densities growing with rapeseed (cultivar Talaye) under different nitrogen rates. Treatments were wild mustard densities (0, 10, 20, 30, and 40 plant m$^{-2}$) and nitrogen (N) rates (0, 50, 100, 150, and 200 kg N ha$^{-1}$). The factorial set of treatments was arranged into a randomized complete block design with four replications. Rapeseed yield and the yield components decreased as wild mustard density increased. At 0 and 10 wild mustard plants m$^{-2}$, grain yield increased with increasing N fertilizer up to 150 kg ha$^{-1}$. At higher wild mustard densities, grain yield decreased above 100 kg N ha$^{-1}$. These results indicate that increases in nitrogen application only increased the competitiveness of the weed versus the crop.**

**Keywords:** Interference, Nitrogen rate, Weed density, Wild mustard.



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## INTRODUCTION

Rapeseed (*Brassica napus* L.) provides an alternative for cereal-based agricultural systems, as it is broad leaved and can be grown as a break crop for a continuous run of cereals. It is increasingly becoming a popular oilseed crop in Iran, especially in Fars Province, due to its high oil and protein content. Wild mustard is a dominant weed in the rapeseed fields of Iran, and can cause major yield losses. A strongly persistent seed bank, competitive growth habit, and high fecundity all contribute to its nature as a weed and ensure that it will be a continuing problem (Warwick *et al.*, 2000).

With weed densities of 20-80 plants m$^{-2}$, rapeseed seed yield in Ontario, Canada was reduced by up to 77% through interference from wild mustard, but only by 20 to 25% with lambsquarters (Blackshaw *et al.,* 1987). Dry matter accumulation and seed yield data indicated that the ranking of competitive ability of the species was wild mustard> rapeseed> lambsquarters (Blackshaw and Dekker, 1988). In a field replacement series, competition for available water and light rather than nutrients played a major role in the noted interference, where wild mustard was the strongest competitor for both, followed by rapeseed and then lambsquarters (Blackshaw and Dekker, 1988; Blackshaw *et al.,* 1989). Wild mustard densities of 10 plants m$^{-2}$ can reduce rapeseed yield by 20%, whereas 20 plants m$^{-2}$ can reduce rapeseed yield by more than 36% (Warwick *et al.,* 2000).

In addition to yield losses, wild mustard can reduce rapeseed crop quality even at a low density (Rose and Bell, 1982; Shires *et al.,* 1982). Seeds of rapeseed contaminated with those of wild mustard had increased linolenic and erucic acid levels in the extracted oil and glucosinolate content in the meal (McMullan *et al.,* 1994).

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Nitrogen is a key nutrient element in the production of non legume crops. It is a component in many biological compounds that plays major roles in photosynthetic activities and crop yield capacity (Cathcart and Swanton, 2003). Reducing N inputs to crop production is becoming increasingly important with growing awareness of its negative effects on the environment (Hans and Johnson, 2002). Reductions in N application rates increased the relative competitiveness of weed species in corn (*Zea mays* L.) (Bosnic and Swanton, 1997; Tollenaar *et al.*, 1994).

No information exists on competition for nitrogen between wild mustard and rapeseed in Iran. This study was conducted to evaluate the effects of various densities of wild mustard and N rates on rapeseed yield and yield components in order to determine the optimum rate of N application in a competitive situation.

## MATERIALS AND METHODS

Field experiments were conducted in 2004 and 2005 at the Kooshkak Agricultural Station to the northwest of Shiraz, Iran. Plots were located on a silty loam (Ramjerd, fine, mixed, mesic, Typic calcixerollics) soil with 0.7 - 0.8% organic matter, 15 - 20% sand, 51 - 54% silt, 29 - 31% clay, and pH of 7.7. Seedbed preparation consisted of fall disking and plowing. Commercial rapeseed seeds "cultivar Talaye" were hand sown on 1 October, 2004 and 28 September, 2005, to a depth of 2 cm in 4×5 m plots. Each plot had 9 rows, spaced 40 cm apart, using a seeding rate of 8 kg $ha^{-1}$. Treatments were various wild mustard densities (0, 10, 20, 30 and 40 plants $m^{-2}$) and nitrogen rates (0, 50, 100, 150 and 200 kg N $ha^{-1}$). The factorial set of treatments was arranged into a randomized complete block design with four replications. After using sodium hypochlorite, wild mustard seed germination was 95%. Proper seed number was determined and hand sown on the basis of seed germination percentage and 1000-seeds weight. Appropriately weighed amounts of wild mustard seeds were hand broadcasted to provide the desired densities which were checked using quadrates at three different times. All plots were irrigated as needed throughout the season. The irrigation interval was 10-12 days in spring according to the ordinary local practice. In both years, plots were kept free from pests, diseases, and other weeds (removed by hand) during the growing seasons. At rapeseed maturity, the five middle rows from each plot were sampled for determination of yield and yield components. Also, weeds were harvested from a 2 $m^2$ area per plot, dried at 75°C for 48 hours, and weighed. Analysis of variance over years indicated a significant ($P< 0.05$) year by nitrogen rates by wild mustard density interaction for all data. Thus, data were further analyzed for each year. Visual inspection of the scatter plots between these variables and wild mustard densities indicated that the following quadratic model adequately described the diverse responses of rapeseed and wild mustard variables to the various wild mustard densities across the five nitrogen rates:

$$Y = A + BX + CX^2$$

where $Y$ is the predicted rapeseed yield and wild mustard biomass, $X$ the density of wild mustard, $A$ the intercept value, and $B$ and $C$ the estimated parameters. All statistical analyses were performed using the General Linear Model or Mixed procedures within SAS.

## RESULTS

### Rapeseed Yield

Rapeseed yield varied according to wild mustard density and nitrogen rate in both years (Figures 1 and 2). Models were fitted to rapeseed yield data, and the parameter estimates are presented in Table 1. Weed-free rapeseed yields ranged from 3,360 to 4,191 kg $ha^{-1}$ in this study and were typical of the yields attained in this region. Wild

**Table 1.** Estimated parameter values of quadratic models for rapeseed yield as a function of wild mustard density at the various nitrogen rates.

| Year | Nitrogen rates (kg ha$^{-1}$) | *a* | *b* | *c* | $R^2$ |
|---|---|---|---|---|---|
| 2004 | 0 | 1078.8 | -31.967 | 0.314 | 0.95 |
| | 50 | 1618.6 | -39.976 | 0.376 | 0.95 |
| | 100 | 2844.8 | -41.995 | 0.109 | 0.93 |
| | 150 | 3235.6 | -75.919 | 0.729 | 0.99 |
| | 200 | 3323.4 | -96.961 | 1.077 | 0.98 |
| 2005 | 0 | 1121.3 | -19.34 | -0.024 | 0.94 |
| | 50 | 2004.5 | -42.268 | 0.340 | 0.94 |
| | 100 | 3279.8 | -37.882 | -0.018 | 0.98 |
| | 150 | 4194.9 | -89.834 | 0.714 | 0.99 |
| | 200 | 4252 | -129.53 | 1.405 | 0.97 |

mustard interference caused a large reduction in rapeseed yield in both years. However, at similar weed densities and nitrogen rates, wild mustard reduced rapeseed yield more in 2004 than in 2005. Rapeseed yield decreased as wild mustard density increased (Figures 1 and 2).

Results indicated that, in both years, rapeseed yield and its yield components decreased as the number of wild mustard per unit area increased. Rapeseed grain yield increased with increasing nitrogen rates, but there was no significant yield difference between 150 and 200 kg N ha$^{-1}$. With 0 and 10 wild mustard plants m$^{-2}$, an increase in nitrogen fertilizer up to 150 kg ha$^{-1}$ caused a significant increase in grain yield, whereas at 20, 30, and 40 wild mustard plants m$^{-2}$, with increasing nitrogen fertilizer, significant increases in grain yield occurred only up to 100 kg N ha$^{-1}$ (Figures 1 and 2).

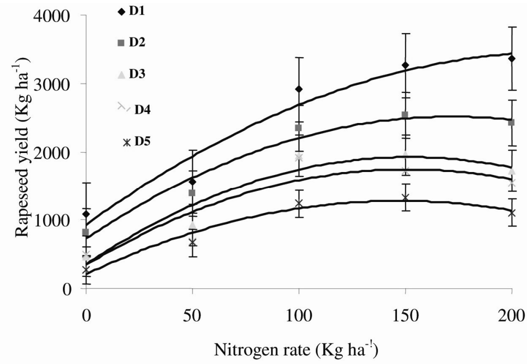


**Figure 1.** Rapeseed yield response to the various wild mustard densities and nitrogen rates (0, 50,100,150 and 200 kg N ha$^{-1}$). Lines represented the fitted quadratic models for each nitrogen rate 2004. Vertical bars indicate SEs.

Rapeseed grain yield in wild mustard-infested plots generally declined with fertilization while the density of wild mustard increased (Figures 1 and 2). Nitrogen fertilization resulted in positive rapeseed yield response up to 150 kg N ha$^{-1}$ only when the wild mustard plant density was below 10 plant m$^{-2.}$

## Wild Mustard Biomass

Wild mustard density and nitrogen rates interacted to affect wild mustard dry weight in both years (Figures 3 and 4). Quadratic

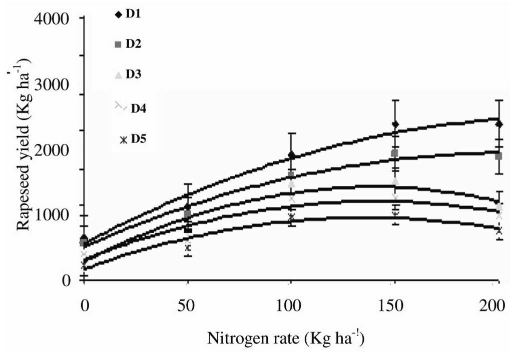


**Figure 2.** Rapeseed yield response to the various wild mustard densities and nitrogen rates (0, 50, 100, 150 and 200 kg N ha$^{-1}$). Lines represented the fitted quadratic models for each nitrogen rate in 2005. Vertical bars indicate SEs.





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**Table 2.** Estimated parameter values of quadratic models for wild mustard biomass as a function of wild mustard density at the various nitrogen rates.

| Year | Nitrogen rates (kg ha$^{-1}$) | *a* | *b* | *c* | $R^2$ |
|---|---|---|---|---|---|
| 2004 | 0 | 10 | 94.6 | -1.3 | 0.99 |
| | 50 | 11.42 | 118.01 | -1.542 | 0.98 |
| | 100 | -92.7 | 257.09 | -4.403 | 0.99 |
| | 150 | -11.71 | 282.64 | -3.678 | 0.98 |
| | 200 | -62.77 | 300.03 | -3.362 | 0.99 |
| 2005 | 0 | 33.286 | 84.943 | -0.928 | 0.98 |
| | 50 | 24.286 | 112.44 | -1.328 | 0.98 |
| | 100 | -15.571 | 223.66 | -3.117 | 0.99 |
| | 150 | -27.143 | 289.33 | -3.935 | 0.99 |
| | 200 | -80 | 307.5 | -3.65 | 0.99 |

models fitted these data well (Table 2). Wild mustard plants produced more dry weight in 2004 than in 2005. With increasing nitrogen rate, wild mustard dry weight increased. There was a highly significant negative correlation between wild mustard dry weight and rapeseed yield (Figures 5 and 6).

## DISCUSSION

In our study, wild mustard reduced rapeseed yield more in 2004 than in 2005 at similar weed densities and nitrogen rates. This may be partly due to the lack of rainfall in April and May of 2004 (0 mm) compared with the same period in 2005 (71 mm) which benefited the weed (Wiese and Vandiver, 1970). The nonlinear response of rapeseed yield for increasing densities of wild mustard indicates intraspecific competition among wild mustard plants at the higher densities (Figures 1 and 2). An experiment with wild radish interference in canola showed similar results (Blackshaw *et al.,* 2002). The results indicated that increases in nitrogen to high levels can increase weed competitiveness. Similarly, adding nitrogen had less effect on grain yield of wheat grown in competition (Henson and Jordan, 1982). Apparently, wild mustard was better able to utilize the added nitrogen and thus gained a competitive advantage over the rapeseed. This finding is in agreement with those of Dhima and Eleftherohorinos (2001), and Blackshaw and Brandt (2008). The increased competitiveness of wild mustard

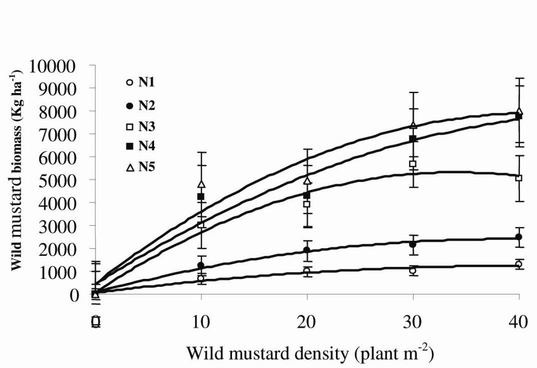


**Figure 3.** Wild mustard biomass response to the various densities and nitrogen rates (0, 50, 100, 150 and 200 kg N ha$^{-1}$). Lines represented the fitted quadratic models for each nitrogen rate in 2005. Vertical bars indicate SEs.

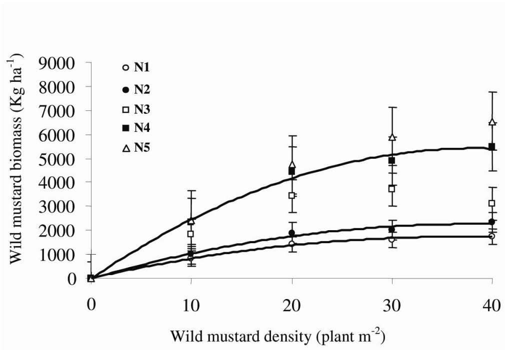


**Figure 4.** Wild mustard biomass response to the various densities and nitrogen rates (0, 50, 100, 150 and 200 kg N ha$^{-1}$). Lines represented the fitted quadratic models for each nitrogen rate in 2004. Vertical bars indicate SEs.





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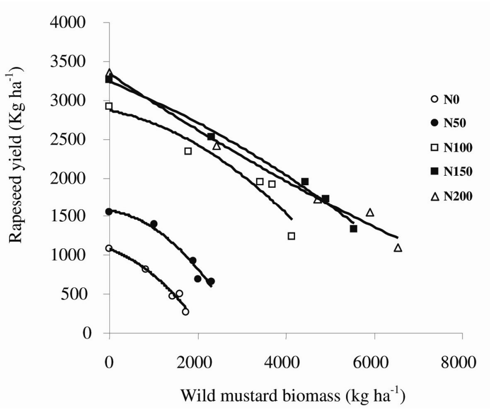


**Figure 5.** Relationship between Wild mustard biomass and rapeseed yield response to the various densities (0, 10, 20, 30, 40 kg N ha$^{-1}$) and nitrogen rates (0, 50, 100, 150 and 200 kg N ha$^{-1}$). Lines represented the fitted quadratic models for each weed density in 2004.

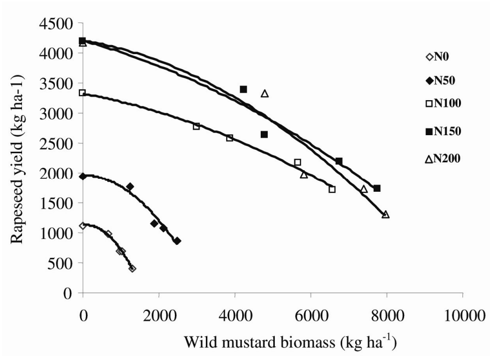


**Figure 6.** Relationship between Wild mustard biomass and rapeseed yield response to the various densities (0, 10, 20, 30, 40 kg N ha$^{-1}$) and nitrogen rates (0, 50, 100, 150 and 200 kg N ha$^{-1}$). Lines represented the fitted quadratic models for each weed density in 2005.

resulted in reduced crop yields. Wheat yield responded negatively to nitrogen at high wild oat density (Carlson and Hill, 1985; Ghadiri *et al.,* 2008). High N concentration in Canada thistle resulted in less N available for wheat (Mamolos and Kalburtji, 2001). The highly significant interaction between weed density and the N rate for crop yield suggests that N is an important factor in the competition between rapeseed and weed. Weed biomass in the high weed density treatment was higher under high N than under low N conditions, suggesting that a high N level did not enhance the relative competitiveness of the rapeseed in our study (Fig. 3 and 4). Burgos *et al.* (2006) in a study on the relative efficiencies of rice and weedy rice (*Oryza sativa*) in recovering applied fertilizer N under competitive conditions also and showed that, with an increase in N fertilizer, weedy rice biomass increased. Our results agree with those of Carlson and Hill (1985) that the adding of nitrogen increased competitive ability of wild oat and consequently decreased the grain yield of wheat. Negative wheat yield response when nitrogen was applied to winter wheat heavily infested with Italian ryegrass (*Lolium multiflorum*) has also been observed (Appleby *et al.,* 1976). Mamolos and Kalburtji (2001) reported that the main factor causing wheat yield loss was Canada thistle (*Cirsium arvense* L.) N concentration, the second factor was Canada thistle biomass, and the last was Canada thistle density. Weed biomass indicated intraspecific weed competition at higher weed density. The highly significant negative correlation between wild mustard dry weight and rapeseed yield obtained in this study agrees with Harker (2000) who reported that weed numbers and weed dry weight had a highly negative association with crop yield.

## CONCLUSIONS

Results indicated that wild mustard can cause serious economic losses in rapeseed. Every effort should be made to reduce wild mustard populations in crops preceding rapeseed. From our results, the N rate of 200 kg ha$^{-1}$ did not provide high yield, even in weed-free conditions. Although the rate of 150 kg N ha$^{-1}$ increased yield at a low density of wild mustard, such high N rates are not helpful at higher weed densities. The information obtained from this study could be used to advise growers on wild mustard control in rapeseed to develop a long-term




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management strategy in their annual cropping systems.

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# رقابت تراکم های خردل وحشی (*Sinapis arvense* L.) با کلزا (*Brassica napus* L.) در سطوح مختلف کود نیتروژن

ر. نادری و ح. غدیری

## چکیده

یک آزمایش مزرعه ای دو ساله به منظور ارزیابی اثرات رقابتی تراکم های خردل وحشی با کلزا -رقم طلایه- در سطوح مختلف نیتروژن انجام شد. تیمارها، تراکم های مختلف خردل وحشی (۰،۱۰،۲۰،۳۰ و ۴۰ بوته در متر مربع) وسطوح مختلف نیتروژن (۰،۵۰،۱۰۰،۱۵۰ و ۲۰۰ کیلوگرم در هکتار) بود. آزمایش فاکتوریل در قالب طرح بلوک های کامل تصادفی با چهار تکرار بود. عملکرد و اجزای عملکرد کلزا با افزایش تراکم خردل وحشی کاهش یافت. در تراکم صفر و۱۰ بوته خردل وحشی در متر مربع افزایش نیتروژن تا ۱۵۰ کیلوگرم در هکتار باعث افزایش معنی داری در عملکرد شد. اما در تراکم های بالاتر، افزایش نیتروژن تنها تا سطح ۱۰۰ کیلوگرم باعث افزایش معنی داری در عملکرد دانه شد. این نتایج نشان داد که افزایش در نیتروژن تنها قدرت رقابتی علف هرز را در مقایسه با کلزا افزایش داد.



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