Effect of Wheat Cultivars and Berseem Clover as Cover Crop on *Melilotus Alba* Growth

D. Ghanbari and M. Rezvani*

Department of Agronomy and Plant Breeding, Qaemshahr Branch, Islamic Azad University, Qaemshahr, Iran

*Corresponding author Email: m_rezvani52@yahoo.com

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Abstract

Melilotus alba is an exotic weed that infests wheat fields in northern Iran. In two field experiments in Qrakhyl Agronomy Research Station, Iran, the influence of two weed cultural management on the reduction in *M. alba* effect on wheat performance was investigated. In experiment one, the effect of 9 wheat cultivar competitiveness with natural population of *M. alba* was investigated in 2010. In experiment two, the effect of wheat planting distances and berseem clover (*Trifolium alexanderinum*) seeding rate on *M. alba* growth was evaluated in 2011. Morvarid cultivar was significantly taller than the other ones. *M. alba* presence reduced the yield of wheat cultivars. A variation in cultivars in reducing *M. alba* density and biomass were observed. Morvarid suppressed *M. alba* successfully. Results from experiment two showed that interaction between wheat planting distances and berseem clover density had no significant effect on height, tiller number, economical and biological yield and harvest index of wheat. Enhancement of berseem clover seeding rate reduced wheat yield and density and dry matter alfalfa. Results suggest that among the wheat cultivars did not observe any variations in competition with *M. alba*. However, berseem clover seeding rate (6/25 $kgha^{-1}$) was significantly reduced through *M. alba* density and biomass and maintained wheat yield.

Keywords: Competitive cultivars, density and biomass, height, planting distances, weed, yield

Introduction

Chemical agriculture is based on high level application of chemicals such as pesticides and fertilizers that lead to serious environmental impacts, health risks and loss of biodiversity (Jannoyer et al., 2011). Alternative sustainable weed management, such as conservation tillage, cultivars and cover cropping can improve crops, soil fertility and environmental conditions (Ritter et al., 1998).

Weed suppression using competitive cultivars is an ecological approach to weed management. Wheat cultivars are genetically variable in their ability to compete with weeds (Mennan and Zandastra 2005a; Lemerle et al., 2001). Growing highly competitive wheat cultivars with high–weed suppressing potential may improve weed control in an integrated weed management system (O'Donovan et al., 2000). Rezvani et al. (2013) was found variations in soybean [*Glycine max* (L.) MERR.] varieties competitiveness.

Cover crops consist of an inter-row cover of low growing plant species to suppress weed growth, reduce runoff and limit soil erosion (Liebman and Davis, 2000). With a permanent ground cover, runoff and soil erosion also reduces N requirements

(Liebman and Davis, 2000). Cover crop and crop management system can affect weed populations and yield in the short and long term (Ngouajio et al., 2003). Weed emergence was reduced in pepper (*Capsicum annum*) field using cowpea (*Vigna unguiculata*) as a cover crop (Hutchinson and McGiffen, 2000).

Melilotus alba a member of Fabaceae family is an annual or biennial, a strong tap root, a crown which produces 1 up to 10 upright stems, trifoliate leaves with the terminal leaflet stalked and numerous small leaves (Stevenson, 1969). This species is considered as invasive weed in wheat field of Mazandaran province, in the North of Iran. The objectives of this research were to (1) assess the competitive ability of 9 wheat cultivar with *Melilotus alba* and (2) determine the effect of different seeding rates of berseem clover as a cover crop on *M. alba* growth.

Materials and Methods

Experimental site description

In two field experiments, the effect of two cultural weed management approaches on *Melilotus alba* growth was investigated. The experimental site was located in Qarakheyl Crop Research Station (36° 27°N, 52° 46°E), Mazandaran, Iran. The soil properties were 32% sand, 42% silt, 26% clay and pH 8.1. Fertilizer was applied according to soil tests.

Determination of 9 wheat cultivar to suppression of *M. alba*

A split plot experiment was arranged in a randomized complete block design with four replicates in order to investigate the effect of 9 wheat cultivar competitiveness with natural population of *M. alba* in 2010. Mean temperature and annual total rainfall were recorded 18.01°C and 463.2 mm, respectively. Presence or absence of *M. alba* was seen as the main plots and 9 wheat cultivars including Morvarid, Darya, Nai 60, Milan, N-85-5, N-87-4, N-86-7, N-80-19 and Shanghai randomized as subplots in the main plots. Wheat planted on 9 December 2010 in plots containing six 3 m long rows spaced 20 cm apart. Our observations in previous years on the experimental site indicated a uniform stand of *M. alba*. In the season growth, weed species except *M. alba* were removed in early growth stage in *M. alba* presence plots. Pure stands of wheat were hand-weeded when needed.

Wheat was harvested two weeks after physiological maturity, on 21 June 2011 for grain yield assessment. Two 0.25 m2 quadrates were placed randomly on wheat and *M. alba* plots at the harvest time and *M. alba* density and biomass and wheat tiller number were determined. Samples were dried at 80°C for 24 h, and weighed. Final height of wheat and *M. alba* also were measured.

Data were drawn from the experiment subjected to analysis of variance. Means were compared with LSD test (P = 0.05).

Effect of wheat planting distances and berseem clover (*Trifolium alexanderinum*) seeding rate on *M. alba*

The experiment was a randomized complete block using a split-plot treatment design with four replicates designed in the field of experiment one in 2011. The main plots were wheat two planting distances which include 20 and 30 cm apart. Different density of berseem clover as inter-seeded living mulch and control treatment which were considered as a subplot.

Berseem clover densities included 25 $kgha^{-1}$ (as recommended berseem clover density for farmers in the region), half of the recommended rate (12.5 $kgha^{-1}$), one third of recommended rate (8.33 $kgha^{-1}$) and one fourth of recommended rate (6.25 $kgha^{-1}$). There were six planting rows with three m long in each plot. The wheat cultivar was N-80-19. The experiment was planted on 10 December 2011. Mean temperature and annual total precipitation were 16.31°C and 905.7 mm, respectively. In the entire of season growth, all weed species except *M. alba* were removed.

Two 0.25 m^2 sample area was determined in each plot for phonological events recording and measurements at harvest time. Height of wheat, berseem clover and *M. alba* was measured. Also, *M. alba* and density biomass were determined at the harvest stage.

The data analysis, including analysis of variance and means comparison (LSD, P=0.05) were carried out using SAS software.

Results and Discussion

Wheat characteristics and yield

Wheat cultivars seedling emerged from 17 December to 20 December 2010. *M. alba* emergence occurred on 25 January 2011.

The result of analysis of variance indicated that interaction between wheat cultivars and presence or absence of *M. alba* had no significant influence on height, tiller number, economic and biological yield of wheat. But, harvest index was significantly influenced by interaction (Data not shown).

Presence of *M. alba* reduced markedly wheat height (Table 1) while wheat cultivars had variation in height. Morvarid cultivar was significantly taller than other ones (Table 2). Tiller number in the presence of *M. alba* reduced in comparison to the absence of *M. alba* (Table 1). Wheat cultivars had a different tiller number (Table 2). The maximum tiller numbers were produced at the cultivars of N-86-7, N-80-19 and Shanghai (Table 2).

Table 1 Mean comparison (main effect) of *M. alba* presence or absence effect on wheat traits (exp. 1)

M. alba	Height wheat (cm)	Tiller number	Economic yield ($kgha^{-1}$)	Biological yield ($kgha^{-1}$)
Presence	88.16^{b}	2.53^{b}	2209.40^{b}	4641.20^{b}
Absence	105.39^{a}	2.66^{a}	2627.60^{a}	5613.20^{a}

In each column, numbers with the same letter have not significantly differences.

Competition in *M. alba* declined wheat height and tiller number. Also, wheat cultivars showed variation in wheat height. Deihimfard et al. (2007) experimental results indicated that weed×wheat cultivars interaction had no significant effect on crop height. Their results also showed that response of wheat cultivars height to competition was different among the cultivars. Mennan and Zandestra (2005b) result showed that weed presence has markedly affected wheat cultivars height and that cultivars were different in response to weed. Lemerle et al. (1996) on the other hand, concluded that ground cover and height of wheat cultivars could be the most important characteristics of wheat in competition against the weed. Although, results of Khan et al. (2010) revealed that wild oats (*Avena fatua* L.) population had significant influence on the number of tillers of wheat cultivars. The same result was suggested by Lemerle et al. (2001) who investigated the competitive ability of wheat cultivars. They suggested that greater competitive ability of wheat cultivars against weeds related to high wheat tiller number.

Table 2 Mean comparison (main effect) of wheat cultivars traits (exp. 1)

Wheat cultivars	Wheat height (cm)	Tiller number	Economic yield ($kgha^{-1}$)	Biological yield ($kgha^{-1}$)
N-80-19	93.20^{d}	2.75^{a}	$2,511.70^{ab}$	$5,145.40^{ab}$
Shanghai	97.48^{c}	2.80^{a}	$2,097.10^{b}$	$4,549.80^{b}$
Morvarid	105.05^{a}	2.68^{ab}	$2,514.20^{ab}$	$5,072.70^{ab}$
Darya	99.75^{bc}	2.48^{abc}	$2,759.20^{a}$	$5,882.80^{a}$
Nai60	103.23^{ab}	2.68^{ab}	$2,252.10^{ab}$	$5,320.10^{ab}$
Milan	91.05^{de}	2.71^{a}	$2,251.00^{ab}$	$4,571.00^{b}$
N-85-5	93.00^{d}	2.10^{c}	$2,358.50^{ab}$	$5,191.80^{ab}$
N-87-4	89.10^{e}	2.21^{bc}	$2,571.10^{ab}$	$5,186.10^{ab}$
N-86-7	99.10^{c}	2.96^{a}	$2,451.60^{ab}$	$5,225.30^{ab}$

In each column, numbers with the same letter have not significantly differences.

M. alba presence plots economic and biological yield of wheat to reduce (Table 1). The wheat cultivars produced different grain and biological yield (Table 2). The harvest index of cultivars showed different responses of *M. alba* presence or absence. In the presence of *M. alba* treatments, cultivars Nai 60 and N-86-7 had a lesser harvest index. Harvest index of Morvarid cultivar in the absence of *M. alba* was more than other cultivars

(Figure 1). Harvest index of N-80-19, Shanghai, Milan and N-87-4 both in *M. alba* presence and absence was not changed (Figure 1). Economic and biological yield of cultivars led to reduction in *M. alba* plots. Reduction in wheat cultivars yield using weeds has been reported by Lemerle et al. (2001), Cousens et al. (2003), Khan *et al*. (2008) and Khan et al. (2010).

Accordingly, results from this experiment showed variations among the wheat cultivars in competition with *M. alba*. These variations may be due to differences in height, tiller number and leaf area. Likewise, our results are in agreement with the conclusion of Khan et al. (2010), Mennan and Zandestra (2005b) and Deihimfard et al. (2007).

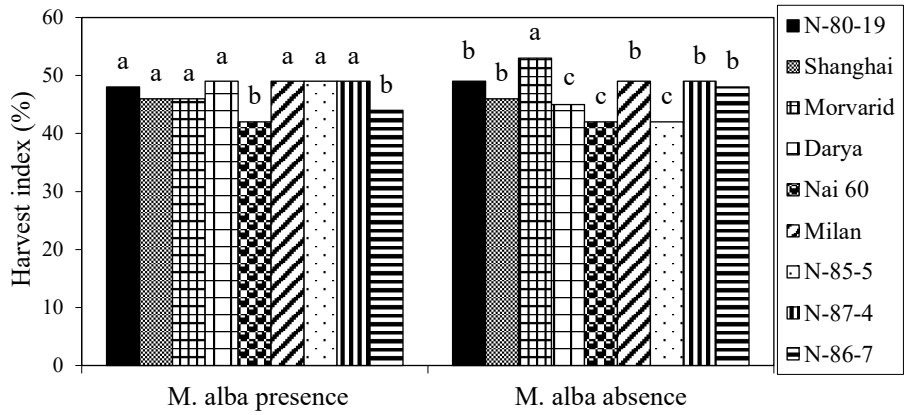

Figure 1 Mean comparison of interaction effect of cultivars and presence or absence of *M. alba* on harvest index

Note: In each group, the columns with the same letter are not significantly different (exp. 1)

Effect of wheat cultivars on *M. alba* growth

M. alba height in N-86-7 (198.75 cm) and N-87-4 (192.5 cm) cultivars was maximal. Height of *M. alba* in competition to Morvarid (148.13 cm) and (157.88 cm) was the lowest (Table 3). *M. alba* density did not change significantly. There was the highest *M. alba* density in N-86-7 and N-87-4 cultivars (Table 3). The maximum *M. alba* biomass were produced in Milan, N-87-4 and N-86-7 cultivars while Morvarid suppressed *M. alba* successfully and so was the lowest biomass (185 gm-2) of the weed in Morvarid cultivar plots (Table 3). According to Deihimfard et al. (2007) who worked on some Iranian wheat cultivars competitiveness, they observed that wheat cultivars had no significant difference in competitive ability. But, in our results of variation among the wheat cultivars reduction in *M. alba* density and biomass were found. This variation can be due to the significant differences among the cultivars in height and tiller production. Because, these are the most important traits of wheat in relation to suppression of weed (Lemerle et al., 2001; Khan et al., 2010).

Table 3 Mean comparison (main effect) of wheat cultivars effect on *M. alba* characteristics (exp. 1)

Wheat cultivars	Height (cm)	Density (plantm^{-2})	Biomass (gm^{-2})
N-80-19	172.88^{abcd}	77.00^{a}	274.70^{b}
Shanghai	165.88^{bcd}	64.50^{a}	270.50^{b}
Morvarid	148.13^{d}	62.67^{a}	185.00^{c}
Darya	182.50^{abc}	63.50^{a}	241.80^{c}
Nai60	157.88^{cd}	65.00^{a}	244.00^{c}
Milan	178.00^{abcd}	69.50^{a}	391.80^{a}
N-85-5	179.50^{ab}c	63.00^{a}	263.10^{b}
N-87-4	192.50^{ab}	86.00^{a}	386.20^{a}
N-86-7	198.75^{a}	85.50^{a}	354.50^{a}

Note: In each column, numbers with the same letter have not significantly differences.

Wheat and *M. alba* emergence

Wheat and berseem clover were planted on 10 December, 2011, simultaneously. Wheat and berseem clover seedling emergence occurred at 17 December and 20 December, 2011, respectively. *M. alba* seedlings emerged in 22 January 2012.

Wheat traits and yield

The effect of wheat planting distance × berseem clover seed rate interaction on wheat height, tiller number, economical and biological yield was not significant (Data not shown). Mean comparison indicated that wheat height and tiller number do not significantly changed both in 20 cm and 30 cm wheat planting distances (Table 4). The height of wheat in 25 $kgha^{-1}$ berseem clover seeding rate was higher than the other ones (Table 5). Tiller number of wheat was similar to the seeding rate of berseem clover treatment (Table 5).

Both in 20 cm and 30 cm wheat planting distances economical and biological yield was the same (Table 4). Economical and biological yield both in control and 6.25 $kgha^{-1}$ seeding rate of berseem clover treatments was the maximal (Table 5).

Table 4 Mean comparison (main effect) of wheat planting distances effect on some characteristics of wheat (exp. 2)

Biological yield ($kgha^{-1}$)	Economical yield ($kgha^{-1}$)	Tiller number	Wheat height (cm)	Wheat planting distances (cm)
3844.30^{a}	1931.50^{a}	1.90^{a}	86.92^{a}	20
3889.80^{a}	1984.50^{a}	1.90^{a}	85.49^{a}	30

Note: In each column, numbers with the same letter have not significantly differences.

Economical and biological yield both in control and 6.25 $kgha^{-1}$ seeding rate of berseem clover treatments was the maximal (Table 5). There are many reports about yield increase in crops using Fabaceae and Poaceae family plants as cover crops (Masiunas et al., 1995; Campiglia et al., 2010). Weed control using different cover crops could be one of the most important reasons for enhancement of crop yield (Campiglia et al., 2010). In our experiment, berseem clover high density including 25 $kgha^{-1}$, 8.33 $kgha^{-1}$ and 12.5 $kgha^{-1}$ had a negative effect on wheat economical and biological yield using the limitation of space and resource availability through competition. But, in density of 6.25 $kgha^{-1}$ there was no negative effect of berseem clover and so wheat yield was similar to control treatment. Our results are in line with Dhingra et al. (1991) conclusion which suggested that the existence of sufficient space for cover crops and cash crop resulted in higher yield.

Table 5 Mean comparison (main effect) of wheat planting distances effect on some characteristics of wheat (exp. 2)

Berseem clover seeding rate ($kgha^{-1}$)	Height wheat (cm)	Tiller number	Economic yield ($kgha^{-1}$)	Biological yield ($kgha^{-1}$)
Control	82.40^{c}	2.00^{a}	2207.30^{a}	4100.30^{a}
6.25	86.93^{ab}	1.88^{a}	2157.20^{ab}	4292.40^{a}
8.33	85.08^{bc}	1.90^{a}	1773.70^{cd}	3631.10^{bc}
12.5	87.95^{ab}	1.87^{a}	1969.00^{bc}	3936.30^{ab}
25	88.68^{a}	1.87^{a}	1682.70^{d}	3375.30^{c}

Note: In each column, numbers with the same letter have not significantly differences.

***M. alba* density and biomass**

Melilotus alba density both in 20 cm and 30 cm wheat planting distances was maximum in control treatments. Also, the increase in berseem clover density reduced *M. alba* density (Figure 2). The lowest *M. alba* density in 20 cm wheat planting distances was 12.5 $kgha^{-1}$ and 25 $kgha^{-1}$ while in 30 cm wheat planting distance the minimum *M. alba* density was observed in 25 $kgha^{-1}$ (Figure 2). The effect of interaction on weed biomass indicated that control treatment had the highest *M. alba* biomass and berseem clover by increasing density reduction in the weed biomass production. Berseem clover density enhancement reduced *M. alba* density. Hence, increasing berseem clover seed rate declined with the weed biomass production. The reduction in

the weed population in the systems using cover crop was also observed in previous experiments by Liebman and Davis (2000) and Hutchinson and McGiffen (2000). In our experiment, *M. Alba* was a late season weeds that emerged at 11 May 2012, therefore, berseem clover had enough chance for growth and develop its canopy. The early emergence of berseem clover increased its weed suppressive ability and reduced weed density and biomass. Teasdale and Doughtry (1993) also indicated that cover crops have more suppressive influence of weed than desiccated cover crop. Living cover crops competes with emerging and growing weeds for resources and inhibits emergence (Reddy and Koger, 2004).

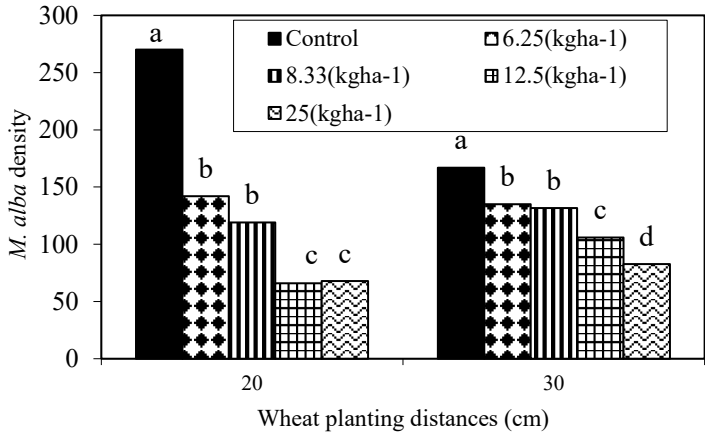

Figure 2 Mean comparison of wheat planting distances × berseem clover seed rate interaction effect on *M. alba* density. In each group, the columns with the same letter are not significantly different (exp. 2)

Conclusions

The cultivars revealed variations in some traits relating to competition ability such as height, tiller number and *M. alba* suppressive ability. Moreover, use of berseem clover as cover crops because of its early emergence suppressed density and biomass of *M. alba*. These results suggest that variety selection and use of berseem clover as cover crop may be important approaches to weed management and reduction in herbicides application.

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