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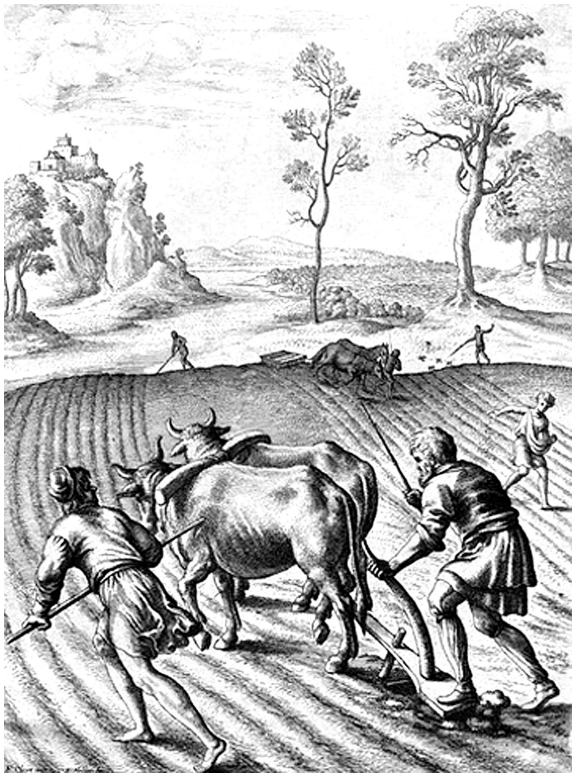

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Economic Thresholds of *Sinapis arvensis* (Wild Mustard) in Winter Wheat Fields

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Abstract: ***Sinapis arvensis*** is one of the most prevalent weed species in wheat in the Middle Black Sea Region of Turkey. In recent years integrated weed control management practices have been increased as a result of disadvantages of herbicides usage in agriculture. The study was carried out to estimate competitive effects of ***S. arvensis*** on wheat and present economic thresholds. The trials were conducted in two different wheat fields between 1998-2001. The effect of different densities of ***S. arvensis*** was calculated as yield losses compared with control plots in percentage. The percentage yield losses were correlated to the weed density by using a non-linear regression model for both weed species. The yield losses of 36.87% were observed at densities of 32 plants $^{-}$1. The economic thresholds of ***S.arvensis*** were between 1.02-5.38 plants m^{-2}. According to results reveal that Florasulam+ Flometsulam and Tribenuron-methyl+Thifensulfuron- methyl to be convenient herbicides in the point of ecological view.

Key Words: *Sinapis arvensis*, economic threshold, wheat, competition

Introduction

Weeds are an important component of crop production in the point of ecologically view. The composition of weed communities is strongly affected by crop species. ***Sinapis arvensis*** is an annual broad-leaved weed and it's one of the most prevalent weeds in winter wheat fields of Turkey (Mennan and Uygur, 1994; Uygur ***et al.***, 1995; Boz, 1997). Also it is widely distributed temperate regions of the world (Wright ***et al.***, 1999).

Several factors are affects weed-crop interference and all of which are related to each other to varying degrees (Radosevich, 1987). In order to decrease yield losses, increasing the crop-seeding rate and growing competitive varieties are important concern of integrated weed management. Sometimes low weed density might be acceptable in integrated weed management system.

Many empirical threshold models have been developed (Cousens, 1985; Streibig, 1989; Heitefuss ***et al.***, 1987; Kropff and Spitters 1991; Debaeke ***et al.***, 1997). Generally, these models were related to crop losses leaf area index, relative time of emergence and biomass. From these

models, crop losses depending on weed density has been preferred to others models. However, the thresholds of crop losses are strongly affected by the efficiency of control treatment, application costs, yield, price of grain, type of crop, weed densities, climatic conditions and soil type.

The objective of this study was to estimate competitive effects of ***S.arvensis*** on wheat and economic thresholds in field experiments.

Materials and Methods

Seed Material

Seeds of ***S.arvensis*** were collected from wheat fields in Samsun province at the end of June in 1997. The inflorescence of mature plants were hand-harvested cleaned then stored at room temperature until the beginning of trials.

Field Experiment

Wheat and ***S.arvensis*** field competition experiment was conducted in Havza and Bafra district of Samsun between years 1998-2001. The seeds of ***S.arvensis*** and winter wheat were sown (220 kg ha^{-1}) to plots in autumn. In these fields, the plots each 2 m^2 in size and six different weed densities of 1, 2, 4, 8, 16 and 32 plant m^2 were formed after wheat emergence. The weeds were thinned manually in order to reach the required density. All weeds were marked and all other weed species emerged later in the season were removed in biweekly intervals by hand. The experiment was arranged according to randomized plot design with four replication in each different field. Fertilizer was applied with normal levels and in application periods of the farmers in the region.

The entire plots were harvested by hand separately and the yield plot was recorded. The effects of different weed densities were calculated as in percentage yields losses compared with the control parcel for each application separately. The percentage yield losses were correlated to the weed density using a non-linear regression model for ***S. arvensis***. In addition to that, theoretical income calculated from the control plots was correlated with applications costs of different herbicides registered for ***S. arvensis***.

The economic threshold, which represents the weed density of which the cost of treatment equals the economic benefit obtained from that treatment, was counted according to equation fallowing (Uygur and Mennan, 1995):

$$y = \frac{(100/\ H.E \times H.M.) + (U.M.)}{(B.F.\ ) \times (Vort)} \times 100 \qquad (1)$$

Where;

y= yield losses (%) according to weed density, H.E. = herbicides efficiency

H.M.= the cost of herbicides applied, U.M. = the cost of herbicides application

B.F.= the price of grain, Vort. = average yield obtained from the weed-free control plots

The value of economic threshold can be obtained by calculating y in equation 1 and then replacing in non-linear regression model ($y = ax^2 + bx + c$) and resolving it.

Statistical analysis

The data of yield losses and different densities of ***S.arvensis*** were evaluated by analysis of variance (ANOVA). In order to variance stabilizing transformations were applied to yield losses.

Results and Discussion

The yields obtained from each different plot were evaluated by using non-linear regression models. The non-linear regression analysis revealed that there was a close correlation between weed density and yield losses in all years (Fig. 1-4). Equation of regression analysis for 1998-1999, 1999-2000 and 2000-2001 were $y=-0.027x^2+2.029x+0.023$, $y=-0.032x^2+2.154x+1.672$ and $y=-0.032x^2 + 2.113x + 1.454$, respectively. There was a significant effect of ***S. arvensis*** on wheat yields. The differences between groups were found significantly different ($p<0.001$).

Yield reduction in the presence of ***S. arvensis*** were similar in all years with slight variation (Table 1). When ***S. arvensis*** was present only one plant in 1 m^{-2}, the yields were reduced by 3.11 % based on the equation of 3 years average. Wheat yield were reduced with increase in weed density.

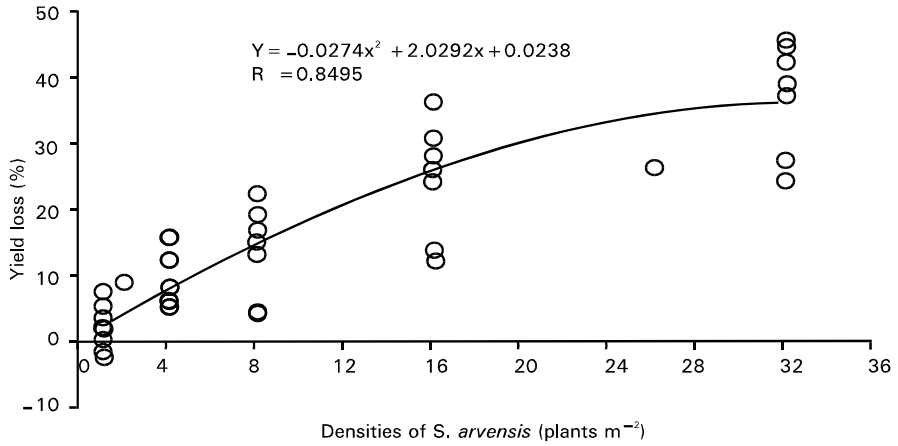

Fig. 1: Regression analysis of percentage yield losses caused by the different densities of ***S. arvensis*** (1998-1999 field experiment)

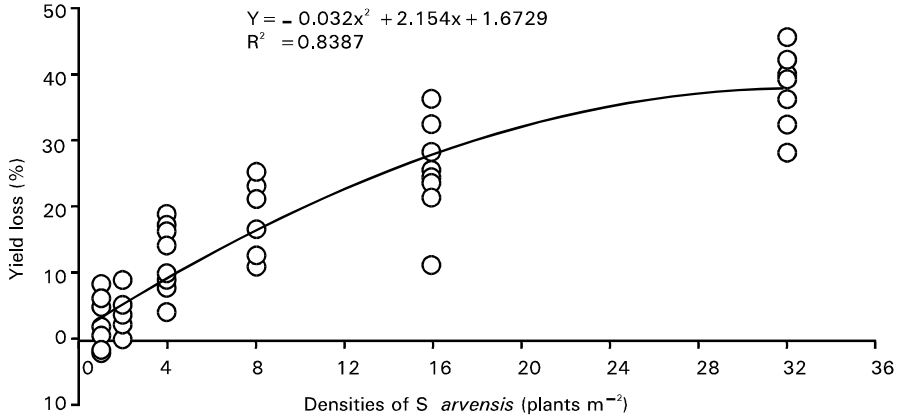

Fig. 2: Regression analysis of percentage yield losses caused by the different densities of *S. arvensis* (1999-2000 field experiment)

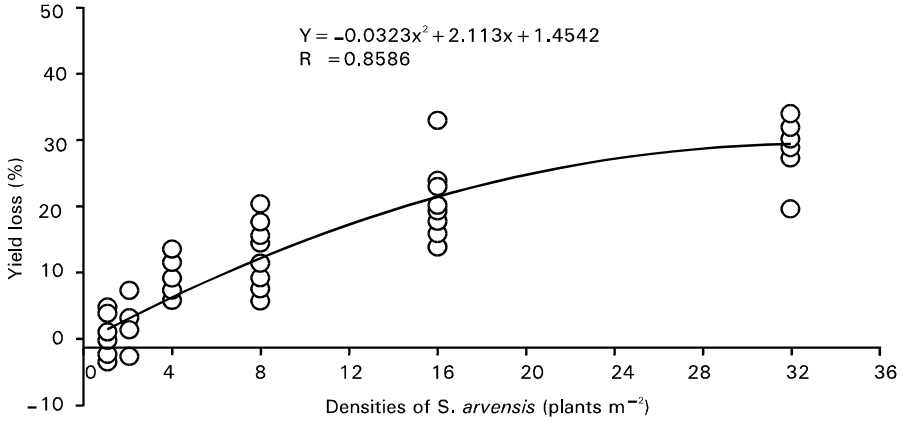

Fig 3: Regression analysis of percentage yield losses caused by the different densities of *S.arvensis* (2000-2001 field experiment)

According to Wright *et al.* (1999) in England, *S. arvensis* was markedly reduced wheat grain yield under different stress conditions. Wheat yields were reduced in the presence of *S. arvensis* by only 0.74 t ha^{-1} at 10% field moisture capacity. In contrast, 2.14 t ha^{-1} yield reduction were observed at 70% field moisture capacity (Wright *et al.*, 1999). In the other previous experiment, Boz (1997) found that one *S. arvensis* in 1 m^{-2} causes 3.63% yield losses in Çukurova region of Turkey.

The values of economic thresholds were calculated for *S.arvensis* using the data of yield losses obtained in regression analysis. The mean yields of crops in the control plots were determined as 3600 kg ha^{-1}. The costs of herbicides application and grain price were found to be 12.5€ ha^{-1} and 160 € t^{-1} respectively. The costs of herbicides were estimated using the prices of herbicides registered in Turkey and considering their efficiency and application dosage.

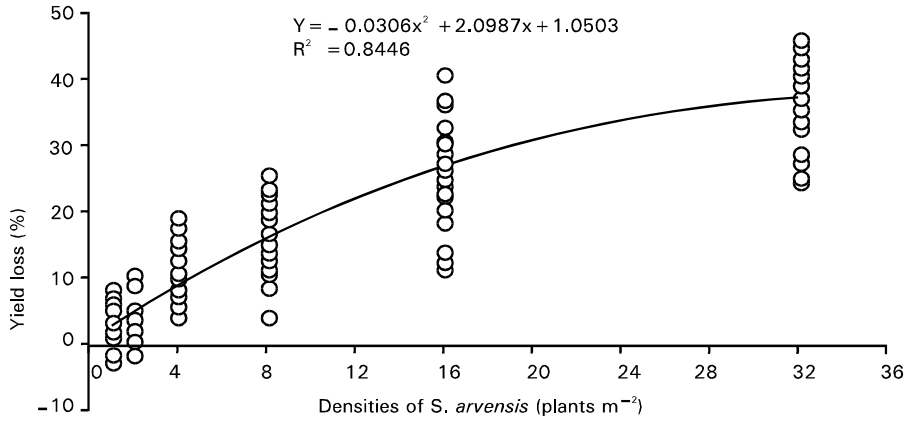

Fig. 4: Regression analysis of percentage yield losses caused by the different densities of *S. arvensis* (1998-2001 field experiment)

Table 1: Influence of *S. arvensis* densities on wheat grain yield

Weed density (plants m^{-2})	Yield loss (%)		
	1998-1999	1999-2000	2000-2001
1	2.02	3.79	3.53
2	3.97	5.85	5.55
4	7.70	9.77	9.38
8	14.50	16.85	16.29
16	25.47	27.94	26.99
32	36.90	37.83	36.00

Table 2: Economic thresholds of *S. arvensis* in terms of different herbicides in winter wheat

Herbicides (Active ingredients %)	Application rate (g ha^{-1})	Application cost* ∈ ha^{-1}	Economic threshold (plants m^{-2})
2,4-D Amin 500 g l^{-1}	2000	18.21	1.02
Chlorsulfuron 75%	10	19.64	1.14
Florasulam+Flometsulam 75+100 gl^{-1}	60	21.07	1.26
Imazamethabens-methyl 250 gl^{-1}	2250	60	4.19
Tribenuron-methyl 75%	10	19.64	1.14
Tribenuron-methyl+Thifensulfuron Methyl 25%+50%	20	22.5	1.38
Mesosulfuron-methyl+ Lodosulfuron-methyl sodium 6+3%	250	66.07	5.38

The economic threshold of ***S. arvensis*** varied between 1.02 and 5.38 plants m^{-2} depending on the herbicides use (Table 2). The economic threshold of ***S. arvensis*** was found between 0.1-0.3 plants m^{-2} in Çukurova region (Boz, 1997). The reasons of this difference between two researches are depending on many factors such as efficiency of control treatment, application costs, yield, price of grain, type of crop, weed densities, climatic conditions and soil type.

The seed potential of ***S.arvensis*** can be change according to ecological conditions. High germination percentages observed under hot and dry years climatologic conditions. Taking competitiveness and seed potential into consideration this species should be controlled. Most of herbicides that registered against to broad-leaved in wheat are effectively controlled this species. According to results reveal that Florasulam+Flometsulam and Tribenuron-methyl+Thifensulfuron- methyl to be convenient herbicides in the point of ecological view.

The threshold value indicates the weed density at which the economic advantage obtainable with the treatment balances the cost of weed control (Zanin ***et al.***, 1993). In this concept the determination of economic thresholds is a basic requirement for Integrated Weed Management System.

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