Effect of Cultivars and Weeding Regimes on Soybean Yields

M. Rezvani, M. Ahangari and F. Zaefarian

***Abstract*—**To study the performance of soybean (*Glycine max* L.) cultivars in varying weeding regimes, a field experiment was conducted in 2010. The experiment was split plot in a randomized complete block design with 3 replicates. The four cultivars and two lines of soybean including: Sahar, Hill, Sari, Telar, 032 and 033 in main plot and weeding regime consist of no weeding (control), one weeding (35 days after planting) and two weeding (35+20 days after planting) were randomized in sub plot. In weed infested plots inevitably had the highest yield reduction in all varieties. On the other hand, plots weeded twice showed the best performance for all cultivars and lines. Although 033 had the highest yield over weeding regimes, but Hill was the best cultivar in suppression of weeds, which indicated the competitiveness of this cultivar. Double weeding, with the use of competitive soybean cultivars would be an effective approach for producing yield.

***Keywords*—**Biomass, Competition, Density, Weed suppression

I. Introduction

WEED control is largely based on herbicide application; however, chemical herbicides are often toxic and cause environmental problems [1; 2].

Use of aggressive cultivars can be effective cultural practice for weed growth suppression [3; 4]. According to Bussan *et al.* [5] the competitive ability of crop can be expressed in two ways. First is the ability of the crop to compete to weeds, reducing weed seed and biomass production. The second possibility is having crop tolerate competition from weeds, while maintaining high yields.

A potential method for reducing herbicide application is development of competitive crop cultivars [6]. Lemerle *et al.* [7] suggested these crop cultivars can act to increase the efficiency of partially weed suppressive like mechanical weeding or reduced-rate herbicide applications and achieve better performance from integrated control.

The competitive ability of crops can be expressed 2 ways. First is the ability of the crop to compete with weeds, reducing weed seed and dry matter production. The second possibility is having crops tolerate competition from weeds while maintaining high yields. Numerous crops exhibited cultivars differences in competitive ability [8].

M. Rezvani (Corresponding author) is with the Department of Weed Science, Qaemshahr Branch, Islamic Azad University, Qaemshahr, Iran, (e-mail:m_rezvani52@yahoo.com).

M. Ahangari is with the Department of Weed Science, Qaemshahr Branch, Islamic Azad University, Qaemshahr, Iran

F. Zaefarian is with the Department of Agronomy and Plant Breeding, Faculty of Crop Sciences, Sari Agricultural Sciences and Natural Resources University, Sari, Mazandaran, Iran, (e-mail: fa_zaefarian@yahoo.com).

In Iran, although the effects of weed competition on crop morphology and yield are well documented [9], but the influence of the number of weeding on different cultivar required to achieve minimum weed competition in soybean is still poorly understood.

II. Materials and Methods

A. Site characterization

Field experiment was set up at Agricultural Sciences and Natural Resources College, Islamic Azad University, Qaemshahr Branch, Iran (26° 29' N; 53° 23' E) during the spring and summer of 2010. Initial soil samples were collected using a screw auger to a 0–20 cm depth. Organic carbon and available N, P and K were analyzed. The soil was well-drained loam clay with a pH of 7.6.

B. Experimental treatments and design

A split plot design was used, with four cultivars and two lines of soybean on the main plot level and a three weeding regimes on on the subplot level in three replicates. The four soybean cultivars and two lines were Sahar, Hill, Sari, Telar and 032 and 033. Weeding regimes were: no weeding (control), one hoe weeding at 35 DAS and two hoe weeding interventions, one at 35 and one at 55 DAS. Each plot consisted of five rows with 6 m long and 50 cm apart.

C. Crop establishment

Land preparation was carried out by a tillage followed by two vertical disks. The fertilizer schedule was according to field soil samples. The crops were raised with weekly irrigations, so, the water was not limited factor for growth. Sowing took placed on 5 of May. Thinning operations (removing extra soybean seedling) were accomplished in the second leaf of trifoliate leaf.

For measuring nod number stem^{-1}, pod number plant^{-1}, branch number plant, seed number pod^{-1} and 1000 grain weight, 10 plant were selected and this parameter were measured. At the end of growing season, all plants in 2 m of 4 rows were harvested in each plot; to evaluate the crop yield and weed biomass.

D. Statistical Analyses

The data were analyzed statistically by an analysis of variance (ANOVA), using the general linear model procedure of SAS Institute. The differences among the means were calculated using Duncan's Multiple Range test ($p \leq 0.05$).

III. Results and Discussion

Pod plant^{-1} was significant under different weeding regime (Table 1). Van Acker (1992) reported pod plant^{-1} is the most sensitive to competition. Shading of weeds and increasing weeds dry matter impact on decreasing of pod plant^{-1}. Cultivars were different in Pod plant^{-1}. In the control treatment, Telar and in one and two weeding regimes, 033 had the highest pod plant^{-1} (Fig. 1). Hume *et al.* [9] declared between yield component pod plant^{-1} have close relationship with yield, thus can be most affected.

Cultivars and weeding regime had significant effect on grain pod^{-1} (Table 1). 032 produced the highest grain pod^{-1}, while Sahar showed the poorest grain pod^{-1} (Table 2). One and two weeding caused increasing of grain pod^{-1} (Table 2). Weeding time was important, because with increasing competition duration with soybean, grain pod^{-1} decreased. Increasing weed infestation, caused shading on soybean plant, so the quality and quantity of light changed, and photosynthesis efficiency of soybean plant decreased. Also competition for water, nutrients uptake and their allocation to reproductive organ was decreased. Thus, to balance photosynthesis material and usage them, flowering senescence occurred or fertility did not occurred completely, so decreasing in grain pod^{-1} was happened.

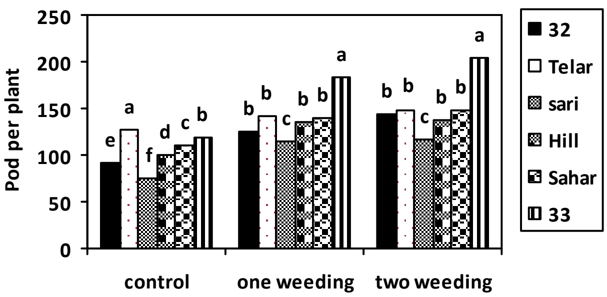

Fig. 1 Interaction effect of cultivar and weeding on pod per plant. In each group, the columns with the same letter are not significantly different ($p < 0.05$)

Cultivar had significant effect on 1000 grain weight (Table 1). Sari and Hill produced the highest and lowest 1000 grain weight, respectively (Table 1). But weeding regime and the interaction of cultivar and weeding had not significant effect. Fellows and Roeth [10] observed weed interference less than 18 weeks between soybean and Shatter cane (*Sorghum bicolor* L.), did not have significant effect on 1000 grain weight, but weed interference more than 18 weeks caused significant enhancement on 1000 grain weight.

In two weeding regime, 1000 grain weight was higher than no and one weeding regimes (Table 2). Weed competition caused shading and also decreasing resource availability and photosynthesis. As there is compensation relationship between yield components [11], with decreasing grain per pod, 1000 grain weight increased.

TABLE I
Mean Comparison of Effect of Cultivar on Grain Pod^{-1} and 1000 Grain Weight

Cultivar	Grain pod^{-1}	1000 grain weight (g)
032	2.58^{a}	156.94^{ab}
Telar	2.38^{bc}	151.98^{abc}
Sari	2.31^{c}	162.51^{a}
Hill	2.29^{c}	144.08^{c}
Sahar	2.28^{c}	147.83^{bc}
033	2.52^{ab}	154.44^{abc}

Means with the same letter at each column are not significantly different ($p < 0.05$)

Soybean yield was affected under weed competition, across cultivars. No weeding regime consistently caused lower yields compare with single and double weeding regimes and soybean yield had reduced till 70% compare with twice weeding (Fig. 2). The results also confirm that grain yield in soybean can be increased by increasing the number of hoeing.

The current finding is consistent with Tourée *et al.* [2]. Yield loss was due to tall weed shading such as velvetleaf and redroot pigweed, flower senescence (for competition and inadequate photosynthesic materials), yield component reduction and allocated more photosynthetic to vegetative growth (because of weed shading and height increasing) [9]. Cultivars and interaction of cultivar and weeding had significant effect on yield. In control treatment, Telar and 033 had the highest yield, while in one and two weeding regimes, 033 had the higher than the others.

TABLE II
Mean Comparison of Weeding on 1000Grain Weight

Weeding regimes	Grain pod^{-1}	1000 grain weight (g)
Control	2.21^{b}	152.37^{a}
One weeding	2.48^{a}	150.35^{a}
Two weeding	2.47^{a}	155.91^{a}

Means with the same letter at each column are not significantly different ($p<0.05$)

The analysis of variance showed that the effect of weeding, cultivar, and their interactions was significant on weed biomass production. Weed biomass decreased significantly under weeding. Average over cultivars, weeding twice at 35 and 55 DAS tended to have lower weed biomass (Fig. 3).

Confirming previous studies [12]. Van Acker *et al.* [13] concluded that 10 and 20 days after emergence weed free caused weed biomass decrement compare with no weeding, till 65% and 95%. If weed controlling period happen simultaneous with critical period, weeds can't compete with crops [14]. Also, there is some evidence that soybean has allelopathic effect on weed growth suppression [15], but caused lower weed biomass. Challaiah *et al.* [16] concluded that wheat cultivar was the most competitive cultivar on the basis of decreasing *B. tectorum* growth, but it had poor grain yield.

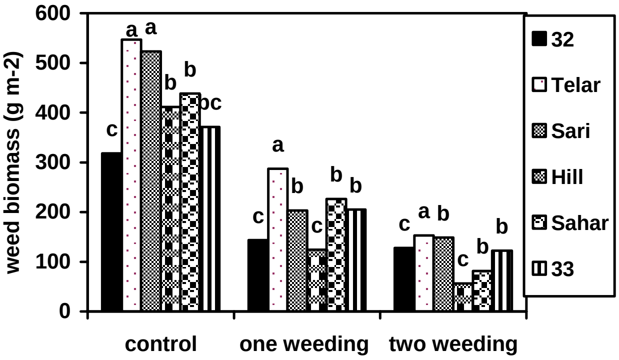

Fig. 3 Interaction effect of cultivar and weeding regime on weed biomass. In each group, the columns with the same letter are not significantly different ($p< 0.05$)

IV. Conclusion

The difference in the ability of cultivars to suppress weed growth than other might be due to the differential rooting patterns, allelochemicals production, higher leaf area index and more light interception, and vegetative growth habit [17; 18]. Double weeding, following with the use of soybean cultivars would be an effective strategy for increasing land and labor productivity.

References

[1] D. R. Batish, M. Kaur, H. P. Singh, R. K. Kohli, Phytotoxicity of a medicinal plant, Anisomeles indica, against Phalaris minor and its potential use as natural herbicide in wheat fields. Crop Protect. 2007, 26, 948–952.

[2] S. Kordali, K. Cakir, T. A. Akcinc, E. Meted, A. Akcine, T. Aydin, H, Kilic, Antifungal and herbicidal properties of essential oils and n-hexane extracts of Achillea gypsicola Hub-Mor. and Achillea biebersteinii (Asteraceae). Indian J. Crop Product. 2009, 29, 562–570.

[3] G. A. Wicks, P. T. Nordquist, P. S. Baenziger, R. N. Klein, R. H. Hammons, J. E. Watkins, Winter wheat cultivar characteristics affect annual weed suppression. Weed Tech. 2004, 18, 988-998.

[4] H. Mennan, B. H. Zandstra, Effect of wheat (Triticum aestivum) cultivars and seeding rate on yield loss from Galium aparine (cleavers). Crop Protection. 2005, 24, 1061-1067.

[5] A.J. Bussan, O. C. Burnside, J. H. Orf, E. A. Ristau, K. J. Puettmann, Field evaluation of soybean (Glycine max) genotype for weed competitiveness. Weed Sci. 1997, 45, 31-37.

[6] M. B. Callaway, A compendium of crop varietal tolerance to weeds. Am J Alt Agric. 1992, 7,169-180.

[7] D. Lemerle, B. Verbeek, N.E. Coombes, Interaction between wheat (Triticum aestivum) and diclofop to reduce the cost of annual ryegrass (Lolium rigidum) control. Weed Sci. 1996, 44, 634–639.

[8] H. M. Munger, J. C. Chandler, F. M. Hons, Soybean (Glycine max) velvetleaf (Abutilon theophrasti) interspesific competition. Weed Sci. 1987, 35, 647-653.

[9] D. F. Hume, S. Shanmugasundaram, W. D. Beversdorf, Soybean (Glycine max L.). In: RJ Summerfield and EH Roberts (eds) Grain Legume Crops. Williams Collins Sons and Co. Ltd. London.

[10] G. H. Fellows, F. W. Roeth, Shattercane (Sorghum bicolor L.) interference in soybean (Glycine max L.). Weed Sci. 1992, 40, 68-73.

[11] R. E. Carson, M. Karimi, R. H. Show, Comparison of the nodal distribution of yield components of indeterminate soybeans under irrigated and rainfed conditions. Agron J. 1982, 47, 531-535.

[12] A. Touréé, J. Rodenburg, K. Saito, S. Oikeh, K. Futakuchi, D. Gumedzoe, J. Huat, Cultivar and Weeding Effects on Weeds and Rice Yields in a Degraded Upland Environment of the Coastal Savanna. Weed Tech. 2011, 25, 322-329.

[13] R. C. Van Acker, C. J. Swanton, S. F. Weise, The critical period of weed control in Soybean (Glycine max L.). Wed Sci. 1993, 41, 194-200.

[14] G. H. Egley, R. D. Williams, Emergence Periodicity of six summer annual weed species. Weed Sci. 1991, 39, 595-600.

[15] E. W. Stoller, S. K. Harrison, L. W. Wax, E. E. Regnier, E. D. Nafziger Weed interference in soybeans (Glycine max L.).Weed Sci. 1987, 3, 155-181.

[16] R. E. Challaiah, O. C. Burnside, G. A. Wicks, V. A. Johnson, Competition between winter wheat (Triticum aestivum) cultivars and downy brome (Bromus tectorum). Weed Sci. 1986, 34, 689-693.

[17] K. Dhima, I. Vasilakoglou, A. Lithourgidis, E. Mecolari, R. Keco, X. Agolli, Phytotoxicity of 10 winter barley varieties and their competitive ability against common poppy and ivy-leaved speedwell. Exp. Agric. 2008, 44, 385-397.