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Investigation of Growth Parameters of Soybean Cultivars in Different Weeding Regimes

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Abstract—In a field experiment, growth parameters of soybean cultivars in different weeding regimes was investigated. The trial was split plot in a randomized complete block design. The four cultivars and two lines of soybean (*Glycine max* L.) 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. The results showed that during the growth season 033 had the highest dry matter in two weeding. In two weeding regime the dry matter decreased.). In all weeding regimes 033 had the highest CGR (Figs. 3a, 3b and 3c), which cleared this cultivar ability compare to the others. This cultivar by increasing its leaf area could do more photosynthesis, so, have a higher CGR.

Keywords—Crop growth rate, Density, Leaf area index

I. Introduction

MANY crops, including *Glycine max*, are competitive with broadleaf weeds [1; 2]. Selection of competitive cultivars and management practices will improve weed management through competition for light [3]. Comparing 3 soybean cultivars showed the most competitive cultivar with weeds had the highest dry matter, leaf area index, specific leaf area especially in beginning stages and allocated dry matter to leaf [4].

According to Akobundu and Poku [5], all crops have a stage during their life cycle when they are particularly sensitive to weed competition. Soybean usually develops a full canopy cover at about 8 weeks after emergence and it can then compete with weeds until maturity. The longer duration of weed interference, has the strongest suppressive effect on soybean leaf number and stem height. Days to flowering in soybean is also affected by weed interference. The longer interference with weed, the longer the crop takes to flower [6]. Bloomberg *et al.* [7] demonstrated the maximum soybean yield achieved when plant be weed free for four weeks with *Xanthium strumarium*.

But in other experiment *Setaria faberri* L. decreased soybean dry matter after 15 days in first year and after 30 days of soybean emergence in second year [8].

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However, Liebman and Alteiri [9] showed soybean weed control for 3 weeks prevent yield reduction. The goal of the study was investigation of growth parameters of soybean cultivars in different weeding conditions.

II. Materials And Methods

Field experiment was carried out 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.

A split plot design was used, with four cultivars and two lines of soybean (*Glycine max* L.) 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.

Land preparation was carried out by ploughing 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.

In order to determine growth trend of soybean, 35 days after sowing sampling were conducted by 15 days intervals. Each sample were collected from 0.45 m^2 and separated to leaf and stem. The green leaf area was measured using a leaf area meter (LI-3100; Li Cor, Lincoln, NB, USA). The samples were oven dried at 70 °C for 48 h and then weighed.

The functional plant growth curves were developed for the weed biomass and leaf area. All the growth curves were constructed using the number of days after planting as the independent variable. The values of the plant biomass and leaf area were loge-transformed to maintain homogeneity of the variances among the sampling dates. For the curves that followed a sigmoidal pattern, including biomass accumulation and the green leaf area, a third-order polynomial function was used [10].

$$\ln(y) = a + bT + cT^2 + dT^3 \qquad (1)$$

where ln(y) is the loge-transformed leaf area per m^2 in units of cm^2 or the biomass (i.e. the sum of the leaf, stem, and reproductive tissues) per m^2 in units of g and T represents the time in the number of days after planting. The coefficients a, b, c, and d are constants.

A functional approach [11] was used to draw the trend of the crop growth rate (CGR).

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.

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

A. Leaf area index

The soybean leaf area index followed nearly the same trend at all treatments. It means that it increased initially and reached to its peak at the flowering stage. Then, because of the senescence and falling of the leaves, a declining trend was observed at the end of the growth season (Figs. 1, 2 and 3). In all weeding regime, 033 possesses the maximum duration of leaf area (Figs. 1, 2 and 3). The proportion of biomass allocated to the leaves and an index of plant leafiness might reflect the ability of the species to obtain resources and compete with other plants [12].

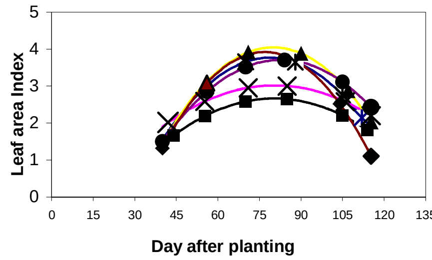

Fig. 1 Leaf area Index in Hill (✳), Sahar (×), 033 (▲), 032 (■), Sari (•) and Tellar (♦). (a) no weeding (b) one weeding and (c) two weeding regime

Increasing the weeding regime caused a significant increase in soybean leaf area index (Figs. 1, 2 and 3). The increased loss of the soybean leaf area index for no weeding can be related to the limitation of resources (e.g. light, water, and nutrients) of soybean because of competition with weeds.

Mosier and Oliver [2] reported soybean leaf area decreased when it was in competition with weed during growth season. In crop and weed community, although total leaf area index increased compare to pure stand, but leaf area of crop decreased due to inter and intra species competition, so, crop leaf area index decreased in infestation of weeds [13].

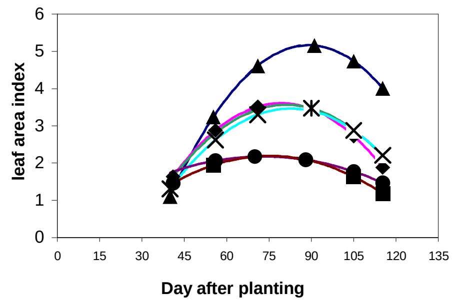

Fig. 2 Leaf area Index in Hill (✳), Sahar (×), 033 (▲), 032 (■), Sari (•) and Tellar (♦). (a) no weeding (b) one weeding and (c) two weeding regime

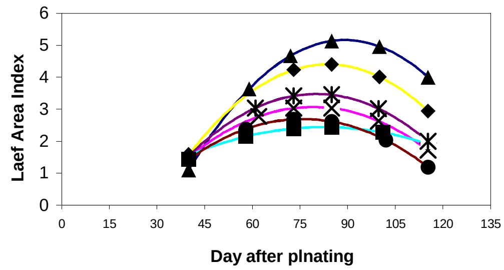

Fig. 3 Leaf area Index in Hill (✳), Sahar (×), 033 (▲), 032 (■), Sari (•) and Tellar (♦). (a) no weeding (b) one weeding and (c) two weeding regime

B. Dry matter accumulation

In beginning of the growth season due to adequate resource and small size of plants, there were no inter and intra species competition, so there was no significant different between treatments (Figs. 4, 5 and 6). But at later because of competition for light, water and nutrients, cultivars showed a significant difference. Weed infestation caused increment of soybean cultivar dry matter because the highest reduction of dry matter was in two weeding regime (Figs. 4, 5 and 6). In no weeding regime, at primary growth season 033, Telar and Hill had the highest dry matter than the others, but at the middle of the growth season 033 and Telar produced the highest dry matter (Fig. 4). In one weeding regime, Telar and 033 had the maximum dry matter (Fig. 5). During the growth season 033 had the highest dry matter in two weeding. In two weeding regime the dry matter decreased (Fig. 6).

C. Crop growth rate

All cultivars and lines had similar trends of CGR, it means that the CGR of soybean increased slowly, at the primary growth stage, then sharply reached its highest degree and, finally, decreased (Figs. 3a, 3b and 3c). In all weeding regimes 033 had the highest CGR (Figs. 3a, 3b and 3c), which cleared this cultivar ability compare to the others. This cultivar by increasing its leaf area could do more photosynthesis, so, have a higher CGR.

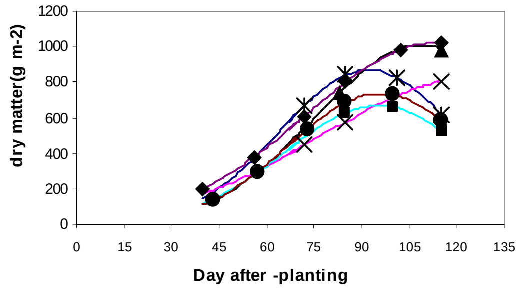

Fig. 4 Dry matter accumulation in Hill (✳), Sahar (×), 033 (▲), 032 (■), Sari (•) and Tellar (♦). (a) no weeding (b) one weeding and (c) two weeding regime

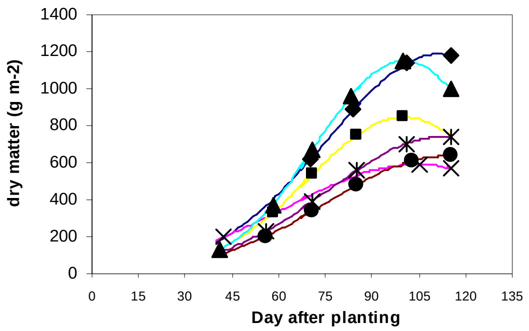

Fig. 5 Dry matter accumulation in Hill (✳), Sahar (×), 033 (▲), 032 (■), Sari (•) and Tellar (♦). (a) no weeding (b) one weeding and (c) two weeding regime

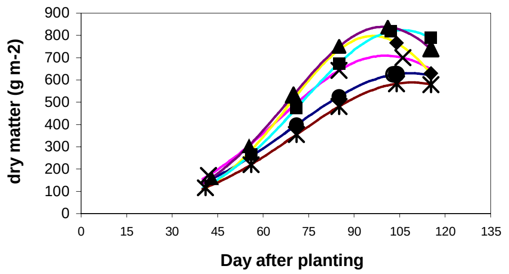

Fig. 6 Dry matter accumulation in Hill (✳), Sahar (×), 033 (▲), 032 (■), Sari (•) and Tellar (♦). (a) no weeding (b) one weeding and (c) two weeding regime

With increasing weeding times CGR decreased. Increasing competitive ability caused increment of CGR (Mohler, 1996). Cavero *et al*. [14] and Pandey *et al*. [15] found that the CGR was reduced by limited resources, such as water, nitrogen, and light deficits**.** Singh *et al*. [16] also detected an increase in the CGR when the sowing rate was increased.

D. Relative growth rate

Relative growth rate demonstrated relative increasing of plant dry matter during the growth season of plant. All treatments had high growth rate at beginning but this index declined during growth (Figs. 7, 8 and 9). 033 had the highest relative growth rate which indicated ability of this line in faster growth at beginning of the season than others, which caused increasing plant ability for up taking resource at initial stage of the growth and decreased resource availability of weeds (Figs. 7, 8 and 9). For declining trend of RGR, we can conclude after time, younger leaves shading increased on older ones [17]. Weed infestation caused decrement of RGR. Weed interference increased RGR reduction, otherwise the maximum RGR were observed in two weeding regime. Board [18] cleared competition caused shading, which lead to faster RGR reduction.

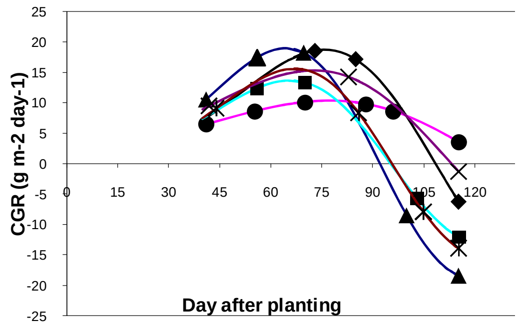

Fig. 7 crop growth rate in Hill (✳), Sahar (×), 033 (▲), 032 (■), Sari (•) and Tellar (♦). (a) no weeding (b) one weeding and (c) two weeding regime

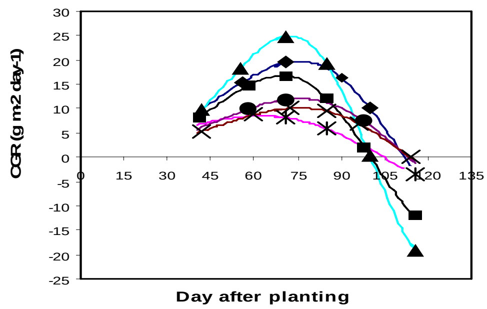

Fig. 8 crop growth rate in Hill (✳), Sahar (×), 033 (▲), 032 (■), Sari (•) and Tellar (♦). (a) no weeding (b) one weeding and (c) two weeding regime

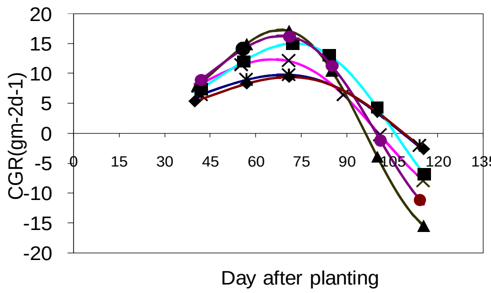

Fig. 9 Crop growth rate in Hill (✳), Sahar (×), 033 (▲), 032 (■), Sari (•) and Tellar (♦). (a) no weeding (b) one weeding and (c) two weeding regime

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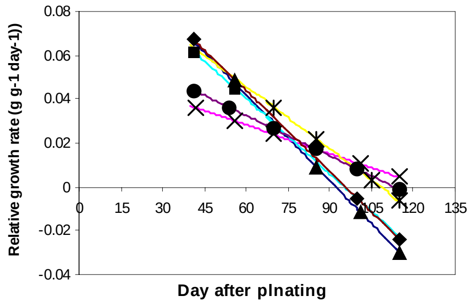

Fig. 4a Relative growth rate in Hill (✳), Sahar (×), 033 (▲), 032 (■), Sari (•) and Tellar (♦). (a) no weeding (b) one weeding and (c) two weeding regime

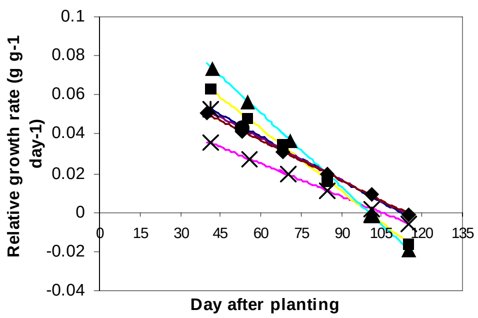

Fig. 4b Relative growth rate in Hill (✳), Sahar (×), 033 (▲), 032 (■), Sari (•) and Tellar (♦). (a) no weeding (b) one weeding and (c) two weeding regime

E. Soybean yield and weed dry matter

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. 5).

The current finding is consistent with Tourééé *et al.* [19]. 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) [20]. 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.

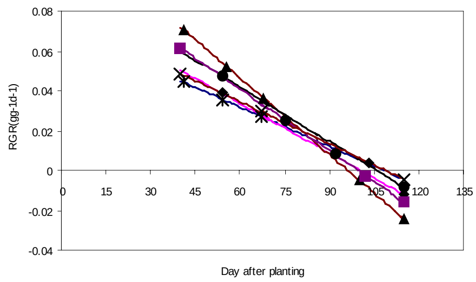

Fig. 4c Relative growth rate in Hill (✳), Sahar (×), 033 (▲), 032 (■), Sari (•) and Tellar (♦). (a) no weeding (b) one weeding and (c) two weeding regime

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. 6). Confirming previous studies [19]. Van Acker *et al.* [21] 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 [22]. Also, there is some evidence that soybean has allelopathic effect on weed growth suppression [23], but this character don't have effective role at primary stages when the root dodn't develop. Except control, in all weeding regimes Telar and Hill produced the maximum and minimum biomass, respectively. Although Hill didn't produce high yield, but caused lower weed biomass. Challaiah *et al*. [24] concluded that wheat cultivar was the most competitive cultivar on the basis of decreasing *B. tectorum* growth, but it had poor grain yield.

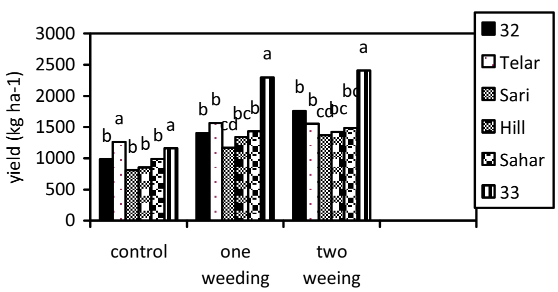

Fig. 5 Interaction effect of cultivar and weeding on yield. In each group, the columns with the same letter are not significantly different ($p < 0.05$)

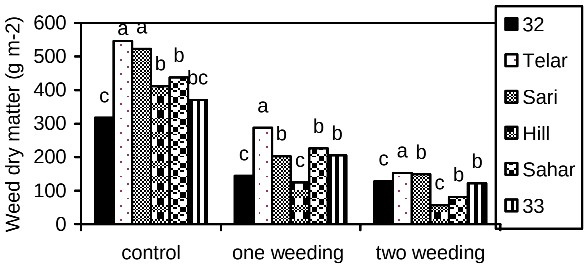

Fig. 6 Interaction effect of cultivar and weeding regime on weed biomass. In each group, the columns with the same letter are not significantly different ($p < 0.05$)

IV. Conclusion

Relative growth rate demonstrated relative increasing of plant dry matter during the growth season of plant. All treatments had high growth rate at beginning but this index declined during growth. Weed infestation caused increment of soybean cultivar dry matter because the highest reduction of dry matter was in two weeding regime. The results also confirm that grain yield in soybean can be increased by increasing the number of hoeing.

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