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Leaf Chlorophyll of Corn, Sweet basil and Borage under Intercropping System in Weed Interference

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***Abstract*—**Intercropping is one of the sustainable agricultural factors. The SPAD meter can be used to predict nitrogen index reliably, it may also be a useful tool for assessing the relative impact of weeds on crops. In order to study the effect of weeds on SPAD in corn (*Zea mays* L.), sweet basil (*Ocimum basilicum* L.) and borage (*Borago officinalis* L.) in intercropping system, a factorial experiment was conducted in three replications in 2011. Experimental factors were included intercropping of corn with sweet basil and borage in different ratios (100:0, 75:25, 50:50, 25:75 and 0:100 corn: borage or sweet basil) and weed infestation (weed control and weed interference). The results showed that intercropping of corn with sweet basil and borage increased the SPAD value of corn compare to monoculture in weed interference condition. Sweet basil SPAD value in weed control treatments (43.66) was more than weed interference treatments (40.17). Corn could increase the borage SPAD value compare to monoculture in weed interference treatments.

***Keywords*—**Borage, Sweet basil, SPAD, Weed Infestation

I. Introduction

INTERCROPPING, the simultaneous growing of two or more species in the same field for a significant period of their growth, is known to increase yield compared to sole crops [1]. Intercropping is considered a practical application of basic ecological principles such as diversity, competition and facilitation [2]. It is an old and widespread practice used in many areas of the world [3] that may provide a balanced diet, reduce labor peaks, minimize adverse effects of biotic and abiotic factors, protect soil against erosion, improve the use of limited resources, increase stability of yield and provide higher outputs [4]. Use of herbicides in agriculture is a risky endeavor and not an eco-friendly approach.

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Biological and cultural weed control are important components of Integrated Weed Management. Although, weed management by ecological means (such as weed management in intercropping) is a hard work, but giving due consideration to minimal use of chemicals with least disturbance to the environment [5].

Recent studies have indicated a close relation between chlorophyll content and leaf nitrogen content, which makes sense because most of the leaf nitrogen is constrained in chlorophyll molecules [6]. Leaf chlorophyll meters (SPAD) have been used as an indirect indicator of plant N status. Use of chlorophyll meters varies with crop type and has been affected by environmental conditions [7]. The relationship between total chlorophyll content and SPAD units was curvilinear [8]. SPAD chlorophyll meter provides a rapid, nondestructive estimate of relative leaf chlorophyll content and can be used to predict nitrogen nutrition index reliably and a useful tool for assessing the relative impact of weeds on crops [9].

II. Materials and Methods

The experiment was conducted during spring and summer seasons of 2011 in a field in Shirvan, north Khorasan, Iran (37° S; 57° E; 1075 m above sea level). The soil texture of experimental site was loam with pH 8.2, organic matter content 1.6%, N 0.14%, P 37.8 ppm, and K 168 ppm (0 to 30 cm depth). The experimental treatments were arranged in a factorial design based on a randomized complete block with 3 replications. Experimental factors were included intercropping of corn with sweet basil and borage in different ratios (100:0, 75:25, 50:50, 25:75 and 0:100 corn: borage or sweet basil) and weed infestation (weed control and weed interference). Each plot consisted of six rows with 4 m long and 50 cm apart. The intra-row plant spacing for corn, sweet basil and borage were 5, 5 and 33 cm, respectively. The corn (*Zea mays* L. cv. S.C. 704), sweet basil (*Ocimum basilicum*) and borage (*borago officinalis* L.) were planted at the same day on 1 June 2011 at their appropriate planting ratios depending on the treatments. Weed control treatments were kept free of weeds by implementing hand hoeing, where necessary. Plant chlorophyll was measured using a chlorophyll meter (SPAD-502, Konika-Minolta Co.). In order to, 5 samples from each plot were selected randomly and from upper, central and lower layers of each plant one leaf was selected. The selected leaves were divided to three hypothetical layers and the means of difference parts were used as leaf SPAD.

Finally, mean of 5 samples leaves were used as plant SPAD for each plot. The SPAD reading was between 10 to 13 O'clock. Data were subjected to analysis of variance (ANOVA) using the SAS (ver. 9.2) statistical software program. Treatment means were compared with Duncan's multiple range tests at 5% level of probability. Also, the EXCEL software was used for drawing of diagram.

III. Result and Discussion

A. The corn SPAD value

The corn SPAD was significantly affected by intercropping ratios (P≤0.01), weed infestation (P≤0.01), and interaction of these two factors (P≤0.05) (data not shown). The highest corn SPAD reading was shown in monoculture of corn, 75: 25 corn: borage and 75: 25 corn: sweet basil treatments with weed control (Fig. 1). Increment of borage and sweet basil proportion in intercropping with corn resulted in decrement of corn SPAD value in weed control treatments (Fig. 1). Generally, intercropping of corn with sweet basil and borage increased the SPAD of corn compare to monoculture in weed interference condition (Fig. 1). The sweet basil had a prominent role compared to borage in this increasing. In addition, in most ratios, weed free treatment showed higher SPAD value than weedy treatments (Fig. 1). Our result is in conformity with the findings of Anwar et al., [10]. In 25: 75 corn: borage treatments was not different between weed control and weedy treatment (Fig. 1), this may be due to the extensive coverage of borage against the growth of weeds, so that there had no effect on corn. SPAD value is proportional to the amount of chlorophyll in leaf and a linear relationship exists between SPAD value and leaf nitrogen concentration. Thus, higher SPAD value indicates healthier plant [10]. On the other hand, there is a significant relationship between SPAD reading and corn yield in the stage of 10 to 11 fully expanded leaves [11]; therefore, the higher SPAD values can be shown that this plant has high yield and health.

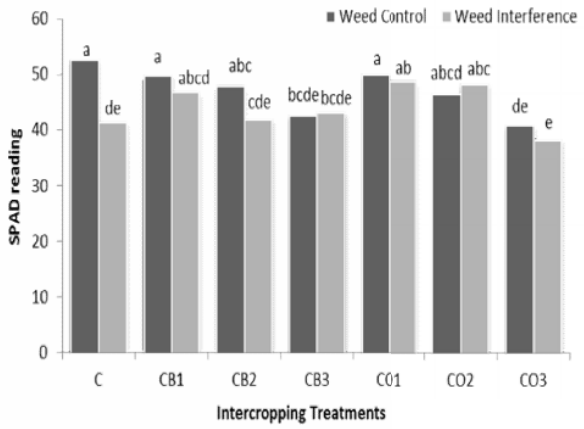

Fig. 1 Interaction of intercropping ratios and weed infestation on SPAD value of corn CB1, CB2 and CB3 indicate 75: 25, 50:50 and 25: 75 corn: borage, respectively. CO1, CO2 and CO3 indicate 75: 25, 50: 50 and 25: 75 corn: sweet basil. C indicated monoculture of corn. Means with same letter are not significantly different at P=0.05 probability level according to Duncan's multiple range tests

B. The sweet basil SPAD value

The results showed that SPAD value of sweet basil were significantly affected by intercropping ratios and weed infestation (P≤0.01), but interaction of these factors had no significant influence on this parameter (data not shown). The SPAD value of sweet basil in cropping ratios with weed control (43.66) was higher than weedy treatments (40.17). On the other hand, the higher SPAD values were related to monoculture of sweet basil and 25: 75 corn: sweet basil (Fig. 2). Generally, the sweet basil SPAD value was decreased with increasing of corn proportion (Fig. 2).

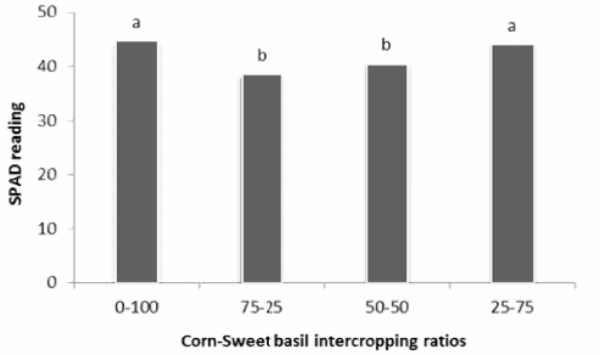

Fig. 2 Intercropping ratios on SPAD values of sweet basil. Means with same letter are not significantly different at P=0.05 probability level according to Duncan's multiple range tests

C. The borage SPAD value

Weed infestation factor had not affected on SPAD values of borage. But in contrast, intercropping ratios and interaction of both factors (P≤0.01) had significant impact on this parameter (data not shown).

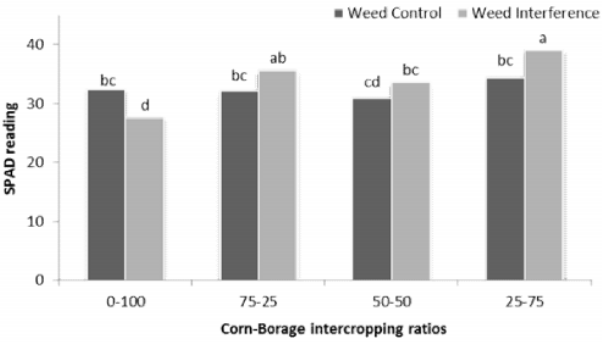

Fig. 3 Interaction of weed infestation and intercropping ratios on SPAD values of borage. Means with same letter are not significantly different at P=0.05 probability level according to Duncan's multiple range tests

The higher and lower SPAD values of borage were showed in 25: 75 corn: borage and sole culture of borage with weed interference, respectively (Fig. 3). Corn could be increased the borage SPAD value compared to monoculture in weed interference condition. However, there was little difference between weed control treatments (Fig. 3). Aminifard et al., [12] stated that leaf chlorophyll content of sweet pepper (*Capsicum annum* L.) was not influenced by plant density.

They have expressed that the effect of nitrogen fertilizer level on SPAD values in this plant was significant.

IV. Conclusion

It can be stated that intercropping is able to reduce weed pressure on crops. Thus, the intercropping with appropriate ratios can be used an ecological strategy for plant health maintenance against weeds. However, these ratios should be considered for economical evaluation.

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