Asian Journal of Biological and Life Sciences | Original Research

The effect of irrigation and manganese foliar treatments on dry matter production in different parts of soybean plants

Soheil Kobraee*, Keyvan Shamsi

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

E-mail : Kobraee@yahoo.com Contact No : 00988317243181

Submitted : 03.07.2014 Accepted : 28.08.2014 Published : 31.12.2014

Abstract

The effects of withholding irrigation and manganese foliar treatments on dry matter production in soybean cultivars was studied in Kermanshah, Iran in 2010 growing season. The experimental design was a split split plot based on Randomized Complete Block design with three replicates. Treatments includes: two irrigation regimes, two manganese foliar treatments, and eight soybean cultivars. At the end of growing season, leaf area and dry weight of soybean shoots were determined. Manganese foliar application in withholding irrigation treatment at flowering stag had a slight effect on leaf area index. In addition, stem dry weight of Pershing and Clark cultivars further increased with manganese foliar application at regular irrigation compared other investigated cultivars. Furthermore, Leaf dry weight decreased with withholding irrigation, and increased with manganese foliar application. The results were shown that irrigation treatments had more effect on grain dry weight of soybean plants compared the manganese foliar application.

Key words : Irrigation, LAI, leaf, pod, soybean

INTRODUCTION

The most important factors that affect the rapid establishment of the crop canopy and biomass production are water availability and nutritional status of plants. Root availability to Manganese is largely influenced by soil moisture, soil temperature and soil pH. Low soil moisture[1], increasing in soil pH[2] and soil temperature[3] are reduced to manganese root access. Manganese is often considered a limiting factor on calcareous soils. In addition, availability of micronutrients in calcareous soil is influenced by soil moisture. Manganese is quite sparingly soluble in calcareous soils and might become plant growth limiting [4]. Capability of micronutrients absorbs and finally plant growth and development were affected by water soil availability. Also, in calcareous soils wet and dry cycles can influence manganese availability and root manganese uptake. In the other side, poor seedbed conditions will result in poor root and soil interrelation resulting decreases in manganese absorption, therefore, manganese foliar application can be useful and more influential as compared to soil application [5]. This is important to note that, when the crop leaf area is small, manganese spraying should be repeated for more influential. Thus, the objective of this study was to evaluate the effects of withholding irrigation and manganese foliar treatments on leaf area index and dry matter accumulation in leaf, stem, pod, seed and plant shoots in eight cultivars of soybean in western areas of Iran.

MATERIALS AND METHODS

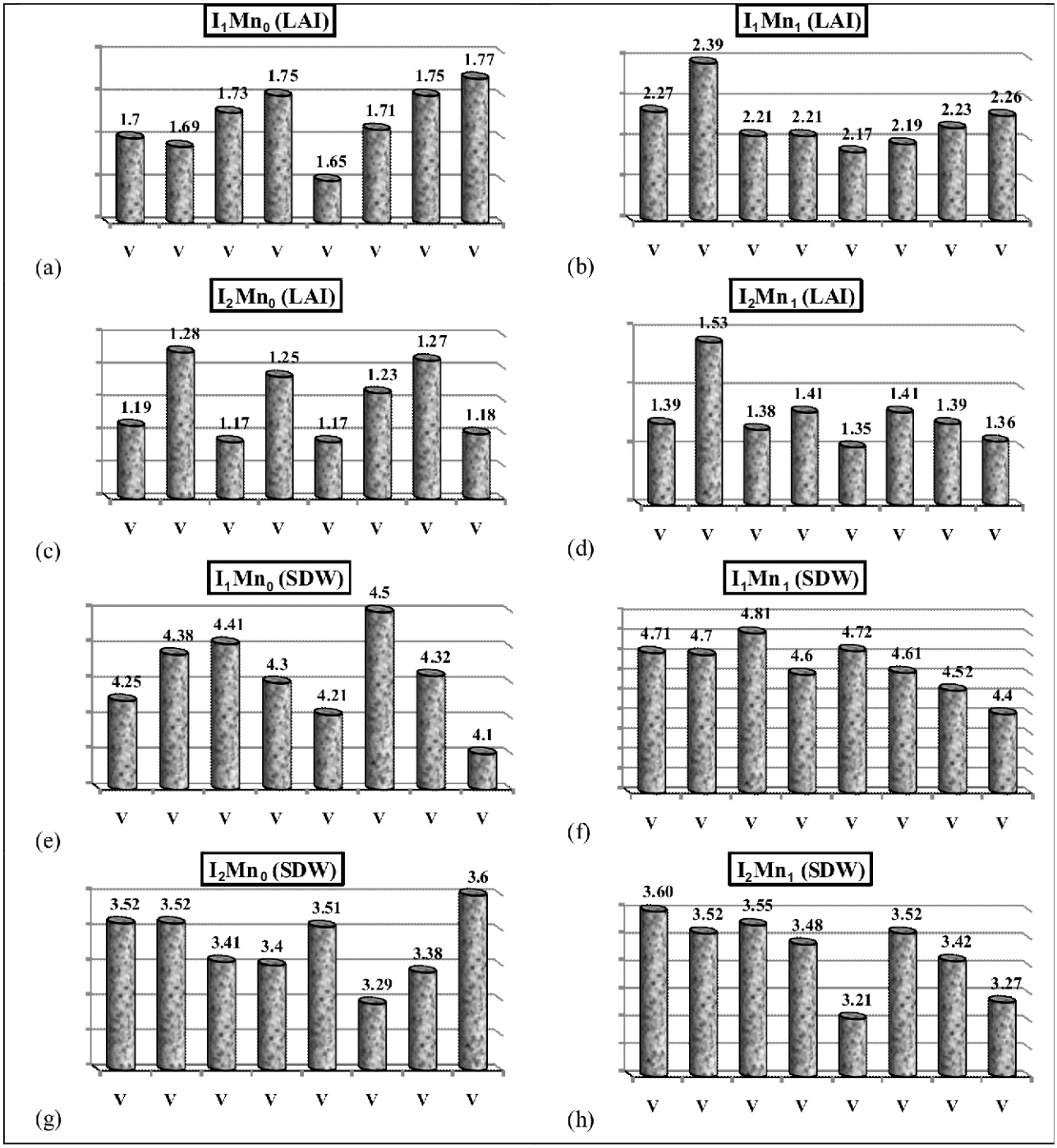
Eight commercial soybean cultivars, Clark (V1), Williams (V2), Sahar or Pershing (V3), Hobbit (V4), Gorgan 3 (V5), M7 (V6), M9 (V7), and DPX (V8), were grown under field conditions at the Experimental site of the Islamic Azad University of Kermanshah province, Iran (34˚23' N, 47˚8' E; 1351 m elevation) during the 2012 growing season. The experimental design was a split split plot in randomized complete block with three replications in 96 plots. Main plot treatments consisted two irrigation regimes: (I1) Irrigation at all of growth stages, (I2) Irrigation Withholding at flowering stage, Subplot included (Mn0) spray with distilled water, (Mn1) manganese spray, and eight soybean cultivars arraigned in sub subplot. Soil samples were collected from experimental area at 0-30 cm depth. The texture of the soil based on silty clay with (silt 49.1%, clay 42.4%, and sand 8.5%), pH 7.3, organic matter 2.6, total nitrogen 0.11%, available phosphorus, potassium, zinc, iron and manganese 8.2, 531, 0.81, 2.76, and 4.49, respectively. All seeds were inoculation with *Bradyrhizobium japonicum* immediately before sowing. Each plot was 6 m in length, 240 cm in width, 60 cm in row spacing, and with density of 33 plants per meter square. The quantity of irrigation water in each plot was calculated according to [6], controlled by counter and exercise irrigation treatment at flowering stage. At the V_4 growth stage [7], the plants were sprayed twice (with one week interval) with 0.5% manganese liquid or distilled water until the leaves were wet. In order to study dry matter accumulation in different parts of soybean plant, at the end of growing season and harvesting time, five plants were selected from each plot randomly, were cut from soil surface with shears, and then, leaves area was measured and different parts were separated, put in paper bags, and placed in oven at 70˚˚ for 48 hr. For determination of dry weight, different parts of plant (leaf, stem, pod, and grain) were separately weighed. Excel software was used to draw figures. Leaf area was measured by leaf area meter and leaf Area Index (LAI) was calculated by using the formula [8]:

$$LAI = \frac{\text{Surface area of sampled leaf}}{\text{Ground area occupied by the sampled plants}}$$

RESULTS

The effects of irrigation regimes and manganese foliar application on leaf area index and steam dry weight were shown in Figure (1). Manganese fertilizer increased LAI across cultivars especially in irrigation at all of growth stages (Fig1b). Leaf Area index values in DPX cultivar at I1MN0 treatment and Williams cultivar at I1Mn1, I2Mn0, and I2Mn1 treatments were greater than the other cultivars (Fig1a to d). Indeed, response of Williams

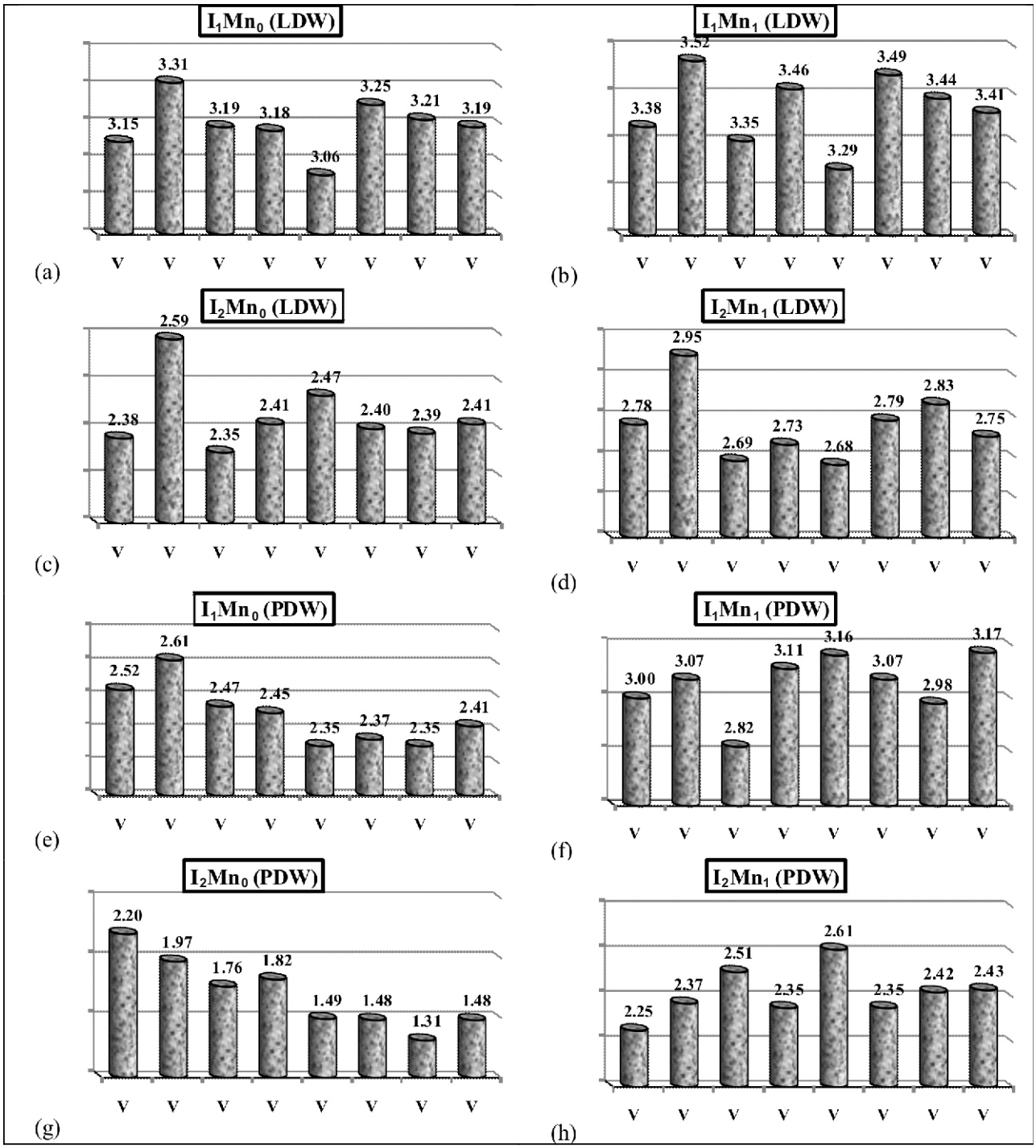
Figure 1: The effect of irrigation regimes and manganese foliar application on leaf area index (a, b, c, and d) and steam dry weight (e, f, g, and h).



LAI: leaf area index, SDW: stem dry weight (g/plant); V1: Clark, V2: Williams, V3: Pershing, V4: Hobbit, V5: Gorgan3, V6: M7, V7: M9, V8: DPX cultivars; I1: irrigation at all of growth stages, and I2: withholding irrigation at flowering growth stage; Mn0: spray with distilled water, and Mn1: manganese spray.

to manganese spray was better than the others not only in regular irrigation but also at water deficit conditions. In generally, the manganese foliar application in withholding irrigation at flowering stag had a slight effect on leaf area index of soybean plants (Fig1 c and d). Concerning stem dry weight, plants grown on plots where regular irrigation and manganese were used had the highest SDW than those where other treatments were applied (Fig1f). The highest stem dry weight belonged to regular irrigated plants (Fig1 e and f) and SDW decreased when that withholding irrigation was occurred at flowering stag (Fig1 g and h). Manganese spray had slight effect on SDW in both conditions (regular irrigation and water deficit condition) (Compare Figures 1 e-g and f-h). The effects of irrigation regimes and manganese foliar application on leaf and pod dry weight were shown in Figure (2).The highest leaf dry weight in I1Mn0, I1Mn1, I2Mn0, and I2Mn1 treatments were observed in Williams cultivar by

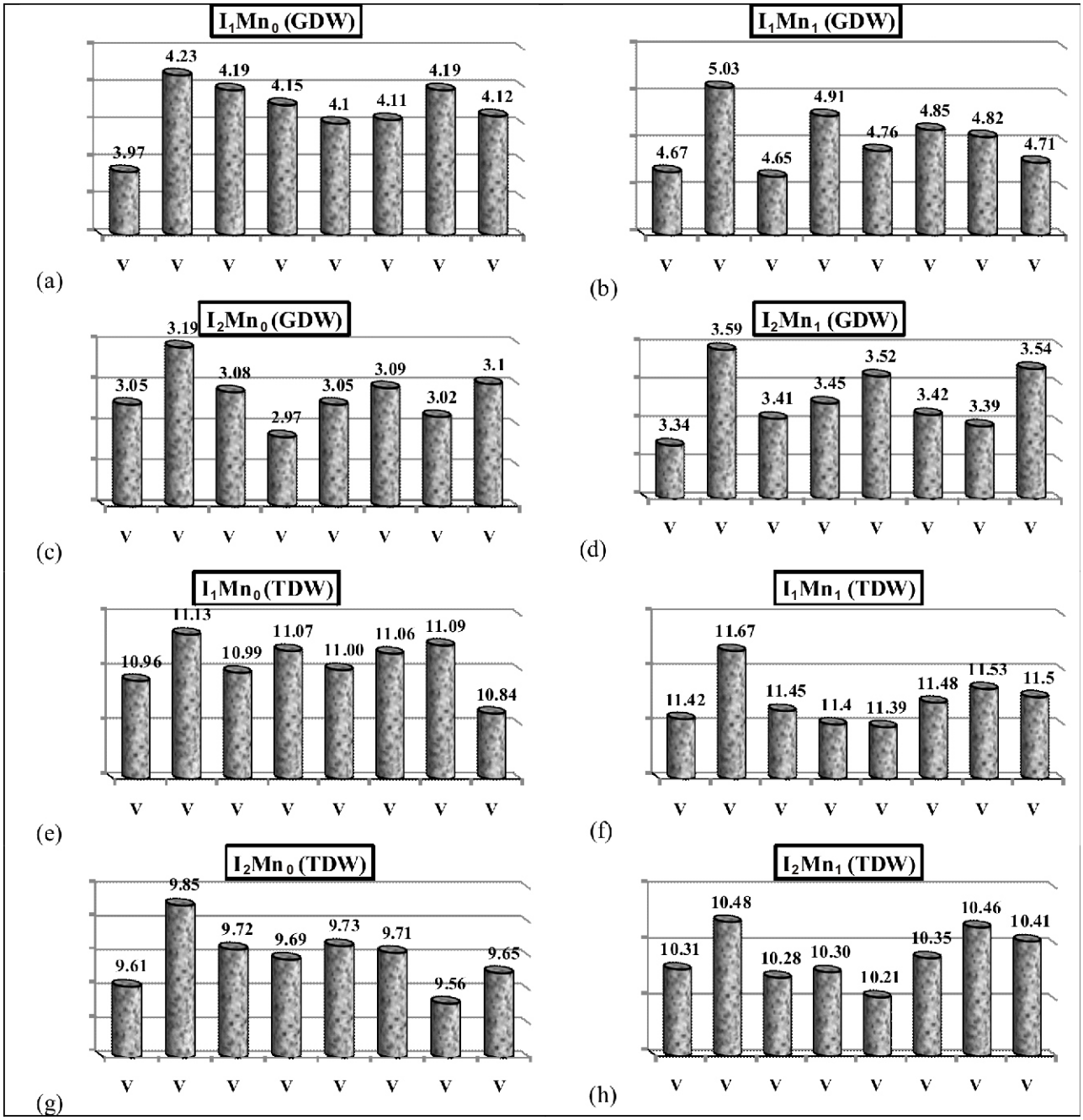
Figure 2: The effect of irrigation regimes and manganese foliar application on leaf dry weight (a, b, c, and d) and pod dry weight (e, f, g, and h).



LDW: leaf dry weight (g/plant), PDW: pod dry weight (g/plant); V1: Clark, V2: Williams, V3: Pershing, V4: Hobbit, V5: Gorgan3, V6: M7, V7: M9, V8: DPX cultivars; I1: irrigation at all of growth stages, and I2: withholding irrigation at flowering growth stage; Mn0: spray with distilled water, and Mn1: manganese spray.

3.31, 3.52, 2.59, and 2.95 g.plant^{-1}, respectively (Fig2 a to d). Compared to regular irrigation treatment, manganese foliar application at water deficit conditions had more effect on leaf dry weight and it further increased (Compare Figure 2 e-f and g-h). Results from this study showed that higher soybean pod dry weight was obtained with Mn applications in both irrigation regimes although, manganese used had the more effect at drought stress conditions (Fig2 e to h). In the other side, withholding irrigation at flowering stage reduced pod dry weight in manganese treatments (Fig 2e and g). Between evaluated cultivars, response of V5 (Gorgan3) to manganese application at water deficit conditions was better than the others. Gorgan3 pod dry weight increased from the 1.49 g/plant in I2Mn0 to 2.61 g/plant in I2Mn1 treatment. In contrast, the effect of manganese

Figure 3: The effect of irrigation regimes and manganese foliar application on grain dry weight (a, b, c, and d) and total dry weight (e, f, g, and h).



GDW: grain dry weight (g/plant), TDW: total dry weight (g/plant); V1: Clark, V2: Williams, V3: Pershing, V4: Hobbit, V5: Gorgan3, V6: M7, V7: M9, V8: DPX cultivars; I1: irrigation at all of growth stages, and I2: withholding irrigation at flowering growth stage; Mn0: spray with distilled water, and Mn1: manganese spray.

foliar application on pod dry weight of Clark cultivar in regular irrigated and cutting irrigated plots was very low (Fig2g and h). The response of soybean grain weight to different irrigation regimes and manganese foliar treatments were shown in Figure (3a to d). In all of treatments and across cultivars, Williams cultivar had the highest grain dry weight by 4.23, 5.03, 3.19, and 3.59 in I1Mn0, I1Mn1, I2Mn0, and I2Mn1 treatments, respectively. The highest and lowest TDW (total dry weight) were obtained to V2 (11.67 g/plant) and V7 (9.56 g/plant) in I1Mn1 and I2Mn0 treatments, respectively (Fig3 f and g). There are little differences across cultivars concerning PDW at I1Mn0 treatment (Fig3 e). Manganese applied increased TDW of soybean plants at water deficit conditions in all of investigated cultivars (Compare Fig3 g and h).

DISCUSSION

In our experiment the calculated LAI was significantly different across soybean cultivars. Leaf area index value depends on the cultivar, fertilization, irrigation and other factors [9]. It was also observed that the stem dry weight of Pershing and Clark cultivars further increased with manganese foliar application at regular irrigation compared other investigated cultivars. Also,

LDW decreased with withholding irrigation, and increased with manganese foliar application. Soybean is considered as a sensitive crop to drought [14] and manganese deficiency [15], therefore under drought stress, foliar spraying of manganese can be beneficial [5]. Manganese application increases the dry matter production in wheat [10]. Higher soybean pod dry weight was obtained with Mn applications in both irrigation regimes although, manganese used had the more effect at drought stress conditions. In similar finding, growth and production of crops were reduced severely by manganese deficiency [11 - 13]. In addition, these results were shown that irrigation treatments had more effect on grain dry weight of soybean plants than the manganese foliar application. In our experimental condition, the increase in GDW of soybean cultivars with manganese foliar application was very slightly. There are little differences across cultivars concerning PDW at I1Mn0 treatment. These results are consistent with the findings of [16].

CONCLUSION

The overall results of this study showed that manganese foliar application in withholding irrigation at flowering stag had a slight effect on leaf area index of soybean plants. In the other side, Manganese spray had slight effect on Stem dry weight in both conditions (regular irrigation and water deficit condition). In contrast, manganese foliar application at water deficit conditions had more effect on leaf dry weight and it further increased. Results from this study showed that higher soybean pod dry weight was obtained with Mn applications in both irrigation regimes although, manganese used had the more effect at drought stress conditions. While, increases in grain dry weight of soybean cultivars with manganese foliar application was very slightly.

ACKNOWLEDGMENTS

Thanks from the Islamic Azad University of Kermanshah Branch for supporting projects.

REFERENCES

1. Heidarian AR, Kord H, Mosafavi K, Lak AP, Amini MF. Investigation Fe and Zn foliar application on yield and its components of soybean (*Glycine max* L.) at different growth stages. *J Agric Biot Sustain Dev*. 2011; 3(9): 189-197.

2. Bromfield SM, Cumming RW, David DJ, Williams CH. Change in soil pH, manganese and aluminum under subterranean clover pasture. *Aust J Exp Agric Anim Husb*. 1983; 23: 181191.

3. Reid JM, Racz G J. Effects of soil temperature on manganese availability to plants grown on an organic soil. *Can. J. Soil Sci*. 1985; 65: 769-775.

4. Tyler G. Soil chemistry and plant distribution in rock habitats of south Sweden. *Nord. J. Bot*. 1996; 16: 609-636.

5. Narimani H, Rahimi MM, Ahmadikhah A, Vaezi B. Study on the effects of foliar spray of micronutrient on yield and yield components of durum wheat. *Arch. Appl. Sci. Res*. 2010; 2(6): 168-176.

6. Karam F, Masaad R, Sfeir T, Mounzer O, Rouphael Y. Evapotranspiration and seed yield of field grown soybean under deficit irrigation conditions. *Agric Water Manag*. 2005; 75: 226-244.

7. Fehr WR, Caviness CE. Stages of soybean development, Spec, Rep, 80, Iowa State Univ., Ames. 1977.

8. Khan H, Khan A Z, Khan R, Matsue N, Henmi T. Soybean leaf area, plant height and reproductive development as influence by zeolite application and allophonic. *J. soil. Plant Sci*, 2008; 3(4): 277-286.

9. Boyd NS, Gordon R, Martin RC. Relationship between leaf area index and ground cover in potato under different management conditions. *Potato Res*. 2002; 45(1): 117129. http://dx.doi.org/10.1007/BF02736107.

10. Nayyar VK, Sadana US, Thakkar TN. Methods and rates of application of Mn and its critical levels for wheat following rice on coarse texture soils. *Fert. Res.* 1985; 8: 173-178.

11. Krahmer R, Sattelmacher B. Determination of Cu and Mn efficiency of crop plants in pot experiments. In: *Plant Nutrition: Food Security and Sustainability of Agro-Ecosystem through Basic and Applied Research*. (Ed.): W.J. Horst. Kluwer Academic Publishers: The Netherlands. 2001; P, 118-119.

12. Cioroi M, Florea T. The study of manganese content in soil, wheat grain and wheat plants. *Ovidius Univ. Annals Chem.*2003; 14(1): 9-11.

13. Hoyt PB, Myovella GGS. Correction of severe manganese deficiency in wheat with chemical fertilizers. *Plant and Soil.* 2005; 52: 437-444.

14. Lobato AKS, Santos FBG Costa RCL, Oliveira Neto CF, Meirelles ACS, Cruz FJR, Alves GAR, Neves HKB, Pita JD, Lopez MJS, Freitas JMN, Monterio BS. And, Ferreira Ramos R. Physiological and Biochemical changes in soybean plants under progressive water deficit during the vegetative phase. *Agric J.* 2008; 3(5): 327-333.

15. Barker AV, Pilbeam DJ. *Handbook of plant nutrition*. Taylor *and* Francis, Taylor *and* Francis Group, LLC. 2007.

16. Olszewska M, Grzegorczyk S. Effect of manganese deficiency on gas exchange parameters, leaf greenness (SPAD) and yield of perennial ryegrass (*Lolium perenne* l.) and orchard grass (*Dactylis glomerata* l.). *J. Elementol*, 2008; 13(4): 589-596.