International Journal of Agronomy and Agricultural Research (IJAAR)
ISSN: 2223-7054 (Print) 2225-3610 (Online)
http://www.innspub.net
Vol. 7, No. 3, p. 01-08, 2015

INNSPUB

RESEARCH PAPER

OPEN ACCESS

The effect of foliar application of microelements on phenological and physiological characteristics of Mung bean under drought stress

Delbar Chehel Amirani*, Pourang Kasraei

Department of Agroecology, Islamic Azad University, Varamin-Pishva Branch, Varamin-Pishva, Iran

Article published on September 09, 2015

Key words: Drought stress, Micro elements, Mung bean, Pro line, Protein.

Abstract

In order to investigate on the effect of foliar application of microelements on phenological and physiological characteristics of Mung bean under drought stress, factorial experiment based on completely randomized design with three replications was conducted in the Agriculture Faculty greenhouse of Islamic Azad University of Varamin-Pishva branch in2013-2014. The first factor was drought stress at four levels include a control (without stress), applying of drought stress at flowering stage, pod and dough stages and the second factor was foliar application of microelements at three levels include a control (spraying of distilled water), 3 and 6 pm. The results showed that the drought stress decreases plant height, leaf area index, thousand grain weight, chlorophyll a, chlorophyll b and total chlorophyll and increases grain protein percentage and pro line accumulation. The effect of drought stress at flowering stage was higher than other stages. Also, the foliar application of microelements was increased the plant height, leaf area index, thousand grain weight, chlorophyll a, chlorophyll b and total chlorophyll, grain protein percentage and pro line accumulation in with and without stress conditions. Therefore, the most effective concentration of microelements was 6 pm.

* **Corresponding Author:** Delbar-Chehel Amirani ✉ Amirani.1365@yahoo.com

Introduction Mung bean (*Vigna Radiata* L. Wilczek) is a granulelegume with short growing season and cultivated in dry land fields of central and south-eastern of Asia (De costa *et al*., 1999). Mung bean is one of the valuable legumes, because it has high quality protein. Mung bean has an important role in the nutrition o flow-income people in developing countries. This plant is using for enriching and fertilizing of soil through biological fixation of nitrogen, for prevent of soil erosion as a covering plant and for green fodder. Cultivating of this plant re quires little in puts and has a short maturation period, therefore this plant is recommended in multi-product systems (Dodwad *et al*., 1998). Plants are encountered with different stresses such as drought stress, excessive rain fall, temperature changes and lack of nutrient elements. The lack of water is the most important stress in the world which is limited plants production (Umar, 2006; Reddy *et al*., 2004). Drought stress occurs when the moisture around the roots is reducing and plant cannot absorb the water from soil. On the other hands, the drought stress occurs when transpiration is more than water absorption (Benjamin, 2007). The drought stress cause to reduce dry matter and yield of plants, because decreases plant height, leaf area (Sreevalli*et al*.,2001). Water stress had negative effect on many plant processes such as photo synthesis, evaporation, precursor accumulation (Ohashi*et al*., 2006) and cause to substantial reduction in plant production (Reddy *et al*., 2004). Therefore, one strategy for increasing water use efficiency and yield is irrigation at specific developmental stage and/or at all stress condition period. Studying on the effect of drought stress on biomass and harvest index of three Mung bean cultivars have been showed that the Mung bean plant height decreases under drought stress conditions (Sadeghipour, 2009). The growth stages of soybean affected by applying the water stress and increasing its height, but the effect of drought stress at the early flowering stage is more than seed formation, grain filling and the beginning of grain maturation stages (Kumudini *et al*., 2002). The maintaining of leaf chlorophyll and durability of photosynthesis in drought stress is one of the physiological tolerances to the stress (Pessarakli, 1993). Also, the positive effects of nutrient son increasing of plants resistance to water deficit stress have been reported by researchers (Ruan *et al*., 1997). One of the effects of drought stress is disturbance of nutrition al in plant, the completion of the micro elements uses by foliar application of them can be improve the plants growth under stress conditions (Lewis and Farlane, 1986). Microelements are essential and important elements for plant growth and development that uses at lower values than macro nutrients such as nitrogen, phosphorus and potassium. These elements include iron, zinc, copper, molybdenum, boron manganese and chlorine (Hargert, 1999).The experiments showed that the planting of seeds were obtained from foliar application of microelement have more and stronger growth. Researchers have suggested that the effect of microelement fertilizer treatments affected seed number and number of pods in per plant and increases soybean seed yield (Gasemiyan, 2001). It was also reported that the application of microelements increases the yield and yield components of corn (Khalili Mahaleh *et al*., 2004).

Iran is located in arid and semi-arid regions of the world and the water deficiency in these areas and possibility of drought stress in all stages of plants growth is more than other regions. Cultivation of plants with short growth period such as Mung bean can be useful in water management in these areas. According to the importance of microelements on increasing of qualitative and quantitative yield of plants and evaluate of the effect of it on water deficiency, this research is designed to investigation the effect of the foliar application of microelements and drought stress on Mung bean growth.

Materials and methods

Plant material, planting conditions and treatments

This experiment was performed as a factorial experiment based on completely randomized design with three replications in Agriculture Faculty greenhouse of Islamic Azad University of Varamin–Pishva branch in 2013-2014. The experiment site was located in7km distance from the Varamin cityat35° and 19′ of the north longitudinal and51°and 39′of the east latitude with 1000mheight above the sea. The treatments were included drought stress at four levels include control (without drought stress), the applying of drought stress at flowering stage, pod and dough stages and the foliar application of microelements at three concentrations in clued control (foliar application of distilled water), 3 and 6 pm. The Part of cultivar of Mung bean have been used with96% of viability, 99% of Purity and 40-45gr of thousand grain weight and obtained Seed Providing and Plant Improvement Institute, Karaj, Iran.

For planting of Mung bean in green house, 36 plastic pots with 30 cm height and25 cm diameter were prepared and after washing, disinfectedwith2% of sodium hypochlorite. Then 7kg of soil with a ratio of$\frac{2}{3}$field soil and $\frac{1}{3}$blown sand sterilized for 25 minutes at 121° C and soil characteristics were measured and poured into each pot. The soil characteristics shown in Table 1.

In each pot 10 Mung bean seeds were planted in 4 cm depth at 1. After seed germination and seedling establishment (after two weeks), the seedling were thinned and reducedto5seedlings in each pot. The drought stress was applied according to the growth stage at flowering stage on 21thJuly for 10 days, pod filling stage on 28th July for 10 days and dough stage on 7th August for 10 days. The foliar application of micronutrients at 0, 3 and 6 pm were used at flowering stage by nutrient solutions MICROMAX was produced with OMEX England.

Chlorophyll, protein and proline analysis

After maturation, the plants were separated from pots and plant height measured by ruler. The leaf area index was measured by Eijelkamp-ci202 at 2 plants in each pot. The chlorophyll, protein and pro line content of leaf were measured by Arnon (1949), Bradford (1976) and Bates *et al.* (1973) methods respectively.

Statistical analysis

The data analysis were performed using SAS Statistics software and mean comparison were carried out by using Duncan's multiple range test at probability levels of 0.05.

Results

Plant height

According to the variance analysis results (Table 2), drought stress and foliar application of microelements had significant effect (P<0.01) on plant height, but the interaction of drought stress with foliar application of microelements was not significant.

Table 1. Physical and chemical characteristics of the used soilin the pots for Mung bean. Cultivation.

Tissue	pH	EC (ds/m)	OC (%)	Clay (%)	Silt (%)	Sand (%)	N (mg/kg)	P (mg/kg)	K (mg/kg)	B (mg/kg)	Zn (mg/kg)	Se (mg/kg)
Silt-Loam	7	0.35	0.5	20	20	60	3.3	6.4	155	0.83	0.58	12.2

The results showed that the drought stressed creases plant height (Fig. 1). The highest plant height was of 31.82 cm at control. The results indicated that the application of drought stress in different stages of plant growth was not significant. The lowest plant height was 29.29 cm obtained by applying drought stress. The drought stress has significant effect on turgor pressure and cells growth and increases plant height and growth. On the other hand, drought stress at flowering stage decreases the plant height 8.63% than the control. Also, the results showed that foliar application of microelements increases the plant height. So that, the plant height increases 6.9%than the control by 6 pm foliar application of microelements (Fig. 2).

Leaf area index

The drought stress and foliar application of microelements had significant effect on leaf area index at P<0.01 and the interaction of them has significant effect at P<0.05 (Table2). The results showed that drought stressed creases leaf area index but the foliar application of microelements increases the leaf area index in presence and absence of drought stress. So that, the highest amount of leaf area index obtained in control condition and foliar application of 6 pm microelements and the lowest amount of that was obtained in drought stress at flowering stage and foliar application of distilled water(Fig.3).Also, the results indicated that the foliar application of microelements in drought stress conditions increases leaf are index 17.64% than the control at flowering stage.

Thousand seed weight

The variance analysis results showed that drought stress and foliar application of microelements significantly affected thousand seed weight atP<0.01 and the interaction of them significantly affected at P<0.05 (Table 2).

Table 2. The variance analysis of microelements on phenological and physiological characteristics of Mung bean plant under drought stress.

S.O.V	df	Plant height	Leaf area index	Thousand seed weight	Seed protein	Chlorophyll a	Chlorophyll b	Total chlorophyll	Proline
Application (a)	2	13.66^{**}	3.08^{**}	69.75^{**}	7.83^{**}	0.02^{**}	0.18^{**}	0.35^{**}	427.86^{**}
Drought stress (b)	3	12.72^{**}	0.14^{**}	54.91^{**}	15.92^{**}	0.008^{**}	0.05^{**}	0.1^{**}	5.78^{**}
a*b	6	1.2^{ns}	0.041^{*}	5.13^{*}	0.94^{*}	0.001^{**}	0.005^{*}	0.01^{**}	0.48^{*}
Error	24	2.47	0.015	2.08	0.35	0.0003	0.001	0.003	0.17
CV%		5.23	4.41	12.89	3.33	2.41	2.43	2.2	4.07

**, * and ns are significantly at 1%, 5% and not significant, respectively.

The results showed that the drought stress decreases thousand seed weight and foliar application of microelements increases it. Also, foliar application of microelements increases thousand seed weight under drought stress. According to the results, the highest amount of thousand seed weight was 54.98 gr obtained at control conditions and foliar application of 6 pm microelements and the lowest amount of thatwas43.29 gr obtained at drought stress conditions at flowering stage and foliar application of distilled water (Fig. 4).

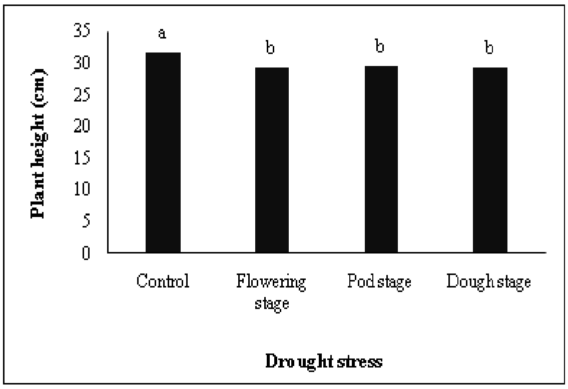

Fig. 1. The effect of drought stress on plant height of Mung bean.

Percentage of seed protein

The variance analysis results indicated that drought stress and foliar application of microelements had significant effect on seed percentage of protein atP<0.01 and interaction of them had significant effect at P<0.05 (Table 2). According to the results the drought stress conditions and foliar application of microelements in drought stress conditions increases percentage of seed protein. The results showed that the highest percentage of seed protein was 19.4%at drought stress treatment applying in flowering stage and foliar application of 6 pm microelements and the lowest percentage of seed protein was 14.31%obtained at control conditions and foliar application of distilled water (Fig. 5).

Chlorophyll a, b andtotal Chlorophyll

According to the variance analysis results, drought stress and foliar application of microelements had significant effect (P<0.01) on chlorophyll a, b and total Chlorophyll and also the interaction of them had significant effect (P<0.05)on chlorophyll a and total Chlorophyll (Table 2). The results showed that the drought stress decreases chlorophyll a, b and total Chlorophyll and foliar application of microelements increases them. The highest negative effect of drought stress was observed at flowering stage and the highest positive effect of foliar application of microelements was observed at 6 pm (Fig. 6, 7and8).

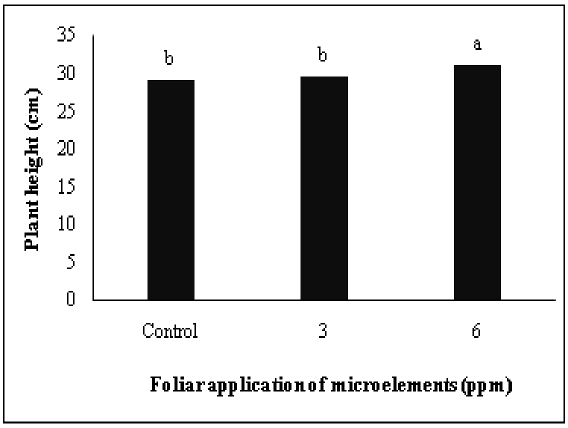

Fig. 2. The effect of foliar application of microelements on plant height of Mung bean.

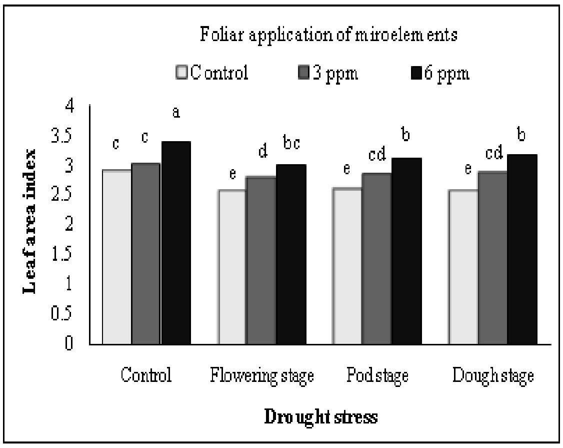

Fig. 3. The effect of foliar application of microelements and drought stress on leaf area index of Mung bean.

Proline content

Variance analysis results showed that the foliar application of microelements and drought stress had significant effect ($P<0.01$) on Mung bean pro line content and interaction of drought stress with foliar application of microelement had significant effect at $P<0.05$ (Table 2). The results showed that drought stress and foliar application of microelements increases pro line accumulation. The highest of pro line content was 37 $mg.gFW^{-1}$obtained at drought stress treatment at flowering stage and foliar application of microelements at 6 pm concentration and the lowest pro line content was 5.92 $mg.gFW^{-1}$ obtained at control conditions and foliar application of distillated water (Fig. 9).

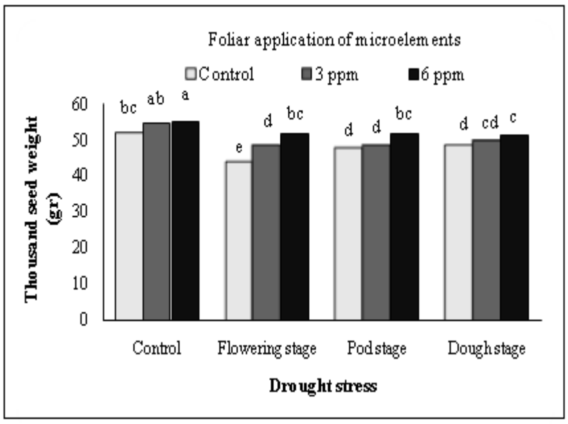

Fig. 4. The effect of foliar application of microelements and drought stress on the thousand seed weight of Mung bean.

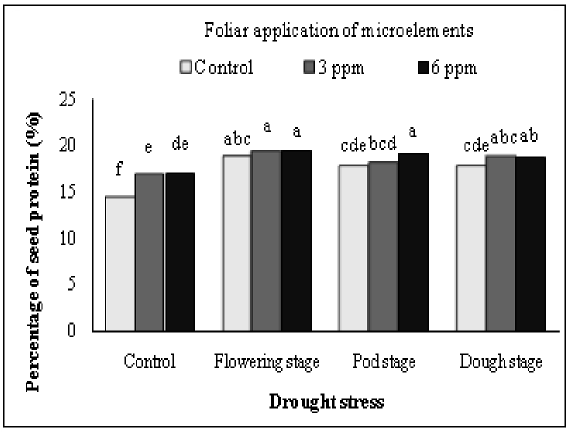

Fig. 5. The effect of foliar application of microelements and drought stress on the percentage of seed protein of Mung bean.

The foliar application of microelements prepared precursor for pro line synthesis. Therefore, in foliar application of microelements treatments the pro line content was higher than foliar application of distillated water. In drought stress conditions pro line produce for maintains of osmotic potential for absorb required water. Pro line is an amino acid that naturally is found in many higher plants and usually its concentration is increases in response to environmental stress.

Discussion

During the water stress, photosynthesis is limited by stomata closure. Studies showed that water deficiency cause to disruption in communication between proteins and membrane lipid and lead to decrease in enzyme activity and lipid bilayermembrane transmission capacity that ultimately leadstodecreasing of plant growth. The similar results reported by Costa and Morel (1994). The microelement mobility in the soil is decreases by drought stress and according to the root growth limitation, the plant could not absorption them from soil. Therefore, the plant has microelements deficiency. By foliar application of microelements the deficiency of them compensated. Zinc and iron plays an important role in protecting of plant cells. Cell size decreasing in drought stress leads to decreases the tissue and organs size such asstem.

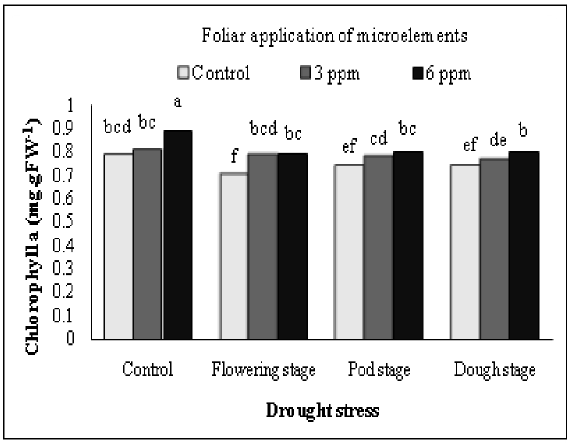

Fig. 6. The effect of foliar application of microelements and drought stress on the chlorophyll a of Mung bean.

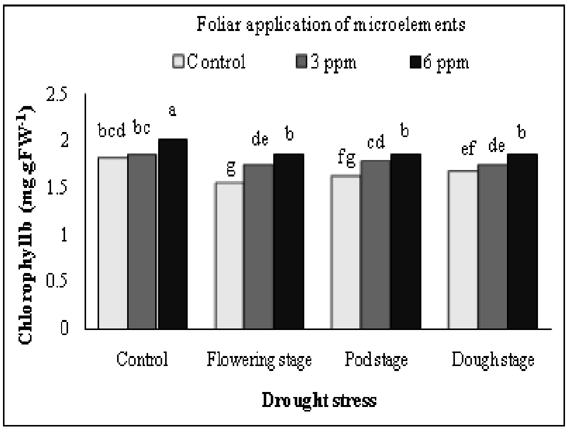

Fig. 7. The effect of foliar application of microelements and drought stress on the chlorophyll b of Mung bean plant.

Drought stress decreases leaf area index by decrease of leaf production and growth. This results similar with Cakir (2004) results. A decrease of leaf area index is the first mechanism of plants for resistance against drought stress. So that, the increasing of leaf area index by application of micronutrients due to providing the some elements such as zinc and iron, which leads to the synthesis auxin hormone in leaves. Since the auxinis an inducer of cell division can be effective in increasing of leaf area index. The similar results were obtained by Mortvedth (2003).

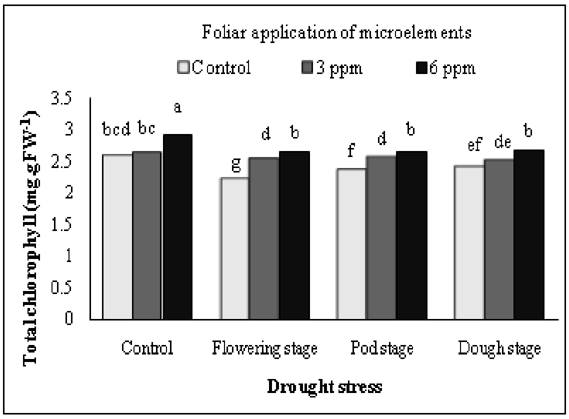

Fig. 8. The effect of foliar application of microelements and drought stress on the total chlorophyll of Mung bean.

Drought stress is affected degree of stomata opening, decreases the Calvin cycleenzymes activity and decreases the photo-assimilates production (Pessarakli, 2001) and directly decreases the weight of seeds (Emam and Niknejad, 2004; Seilsepoor *et al.*, 2006). The use of microelements increases the plant leaf area durability and prevents the decreases of thousand seed weight. Similar results reported by Ghorashi Nasb *et al.* (2009).

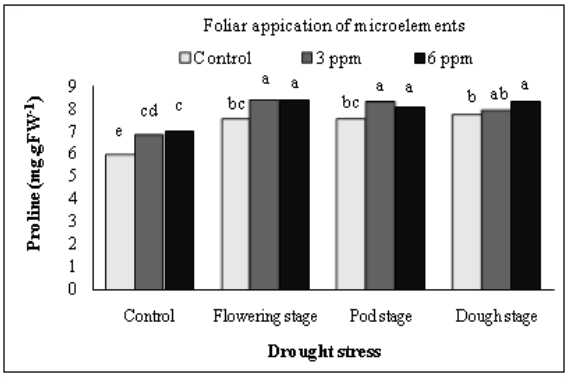

Fig. 9. The effect of foliar application of microelements and drought stress on the pro line content of Mung bean.

The results indicated that the percentage of seed protein increases by drought stress. The studies showed that the drought stressed creases carbohydrate accumulation and increases percentage of protein (Bahrani *et al.*, 2009). The increasing of percentage of protein by microelements application is reported by other researchers (Babhulkar *et al.*, 2000; Sawan *et al.,* 2001).

Drought stress increases the oxygen free radicals in the chloroplast and causes to destruction of the chlorophyll molecules and chloroplasts membranes that lead to decreases the photo synthesis and growth which reported by Takamiya *et al.* (2000). On the other hand, chlorophyll destruction increases by active oxygen species. Also, the chlorophyll destruction was performed with separating of phytolchainofporphyrinring by oxygen free radicals and/or chlorophyll as enzyme. In the sensitive plants expression of chlorophylls enzymes genes are increases (Benedetti and Arruda, 2002). Leaf chlorophyll preservation and photosynthesis durability in drought stress are physiological tolerance indices (Pessarakli, 1993). Therefore, the using of nutrient containing with iron and magnesium, which are the main component of Chlorophyll under drought stress conditions can be prevented this organelle decreases.

References

Arnon DI. 1949. Copper enzymes in isolated chloroplasts. Polyphennoloxidase in *Betavulgaris*. Plant Physiology **4,** 1-150.

Babhulkar PS, Dinesk K, Badole WP, Balpande SS, Kar D. 2000.Effect of sulfur and zinc on yield, quality and nutrient uptake by safflower in vertisols. Journal of the Indian Society of Soil Science **48,** 541-543.

Bahrani AH, Abad HHS, Savestani ZT, Moafpourian G, Ayenehband T. 2009.Wheat (*Triticumaestivum*L.) response to nitrogen and post-anthesis water deficit. American-Eurasian Journal of Agricultural and Environmental Science **6,** 231-239.

Bates LS, Waldren RP, Teare LD. 1973. Rapid determination of free proline for water stress studies. Plant and Soil **39,** 205-208.

Benedetti CE, Arruda P. 2002. Altering the expression of the chlorophyllase gene ATHCOR1 in transgenic Arabidopsis caused changes in the chlorophyll-to-chlorophyllide ratio. Plant Physiology **128,** 1255-1263.

Benjamin J. 2007. Effects of water stress on corn production. USDA Agricultural Research Service, Akron University. P: 3-5.

Bradford MM. 1976. A rapid and sensitive method for the quantitation of microgram quantities of protein utilizing the principle of protein-dye binding. Analytical Biochemistry **72,** 248-254.

Cakir R. 2004. Effect of water stress at different development stages on vegetative and reproductive growth of corn. Field Crops Research **89,** 1-16.

Costa G, Morel L. 1994. Water relation gas exchange and amino acid content in cd-treated lettuce. Plant Physiology and Biochemistry **32,** 561-570.

De Costa WA, Shamigiathasan KN, Joseph KD. 1999. Physiology of yield of yield determination of Mung bean (*Vignarradiation* L.) under various zones of Sri-Lanka. Field Crops Research **61,** 1-12.

Dodwad IS, Salimath PM, Patil SA. 1998. Evolution of green gram collection for pod and seed character. Legume Research **21,** 183-187.

Emam Y, Niknejad M. 2004. An introduction to the physiology of crop yield. Shiraz University Press, 571 p.

Gasemiyan V. 2001.Study of Fe, Zn and Mn micro-nutrients effect on quality and quantitiy in West Azerbaijan. M.Sc. Theses, Tarbiat Modares University, Iran. 125 p.

GhorashiNasb MJ, Ahmadzadeh V, Pakmehr A, AshouriSahli A. 2009. Effect of microelement nutrients (Fe and Zn) and allopathic compounds from *Amaranthusretroflexus*in yield, yield component and oil yield in herbal plant (*calendula officinalis* L.). In: Proceeding of 6th Iranian Horticultural Science Congress, Faculty of Agricultural Science, University of Guilan, Rasht, Iran. 12-15 July.

Hargert GW, Nordquist PT, Peterson JL. 1999. Iron for improved corn yield. Fluid Journal 1-3.

KhaliliMahaleh J, Roshdi M, Rezadoost S. 2004. Study of micro-nutrient foliar application effects on yield and yield components in corn (var 704). Research Final Report of Khoy Islamic Azad University, Iran. 28 p

Kumudini S, Hume DJ, Chu G. 2002. Genetic improvement in Short-season soybean (nitrogen accumulation, remoblizatioin and partitioning). Crop Science **42,** 141-145.

Lewis DC, McFarlane JD. 1986. Effect of foliar applied manganese on the growth of safflower and the diagnosis of manganese deficiency by plant issue and seed analysis. Australian Journal Agriculture Research **72,** 57-59.

Mortvedth J. 2003. Efficient fertilizer use micronutrient. Florida University Published **166,** 125-139.

Ohashi Y, Nakayama N, Saneoka H, FujitaK. 2006. Effects of drought stress onphotosynthetic gas exchange, chlorophyllfluorescence and stem diameter of soybeanplants. Journal of Biology Plant **50,** 138-141.

Pessarakli M. 1993. Handbook of plant and Crop stress.Marcel Dekker, Inc. 693 p.

Pessarakli M. 2001. Handbook of Plant and Crop Physiology. Second Edition, Marcel Dekker Inc., New York, 997 p.

Reddy AR, Chaitanya KV, Vivekanandan M. 2004. Drought induced responses of photosynthesis and antioxidant metabolism in higher plants. Journal of Plant Physiology **161,** 1189-1202.

Ruan J, Xun W, Hardter R. 1997. TheInteraction between soil water regime andpotassium availability on the growth of tea.Journal of Soil Science Plant Analysis **28,** 89-98.

Sadeghipour O. 2009. The influence of water stress on biomass and harvest index in three Mung bean (*Vignaradata* L.)R.Wilczek Cultivars. Asian Journal of Plant Sciences **8,** 245-249.

Sawan ZM. Hafez SA, Basyony AE. 2001. Effect of nitrogen fertilization and foliar application of plant growth retardant and zinc on cotton seed, protein and oil yields and oil properties of cotton. Journal of Agronomy and Crop Science **186,** 183-191.

Seilsepoor M, Jaafari P, Mollahosseini H. 2006. The effects of drought stress and plant density on yield and some agronomic traits of maize (SC 301). Journal of Research in Agricultural Science **2,** 13-24.

Sreevalli Y, Baskaran K, Chandrashkara R, Kuikkarni R. 2001. Preliminary observations on the effect of irrigation frequency and genotypes on yield and alkaloid concentration in Periwinkle. Journal of Medicinal and Aromatic Plant Science **22,** 356-358.

Takamiya KI, Tsuchiya T, Ohta H. 2000. Degradation pathway(s) of chlorophyll: What has gene cloning revealed? Trends Plant Science **5,** 426–431.

Umar S. 2006. Alleviating adverse effects of water stress on yield of sorghum, mustard and groundnut by potassium application. Pakistan Journal of Botany **38,** 1373-1380.

Xu XF, Mei HW, Luo LJ, Cheng XN, Li ZK. 2002. RFLP-facilitated investigation of the quantitative resistance of rice to brown planthopper (*Nilaparvatalugens*). Theoretical and Applied Genetics **104,** 248-253.