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Response of chickpea cultivars to nutrition by Zn under drought water stress condition

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ABSTRACT: This experiment was conducted on clay soil in order to determine the effects of drought stress and zinc fertilizer on some components of chickpea yield. The experiment was split factorial with three replications. The main treatment was drought stress (severe drought stress, moderate drought stress and no drought stress). The secondary treatment was four varieties of chickpeas, Azad, Bevanij, Hashem and ILC482 and 2 zinc levels (using a 1 liter manual sprayer and control). The results showed that the effect of drought stress on yield and yield components, the effect of cultivars on grain yield was significant. With increasing drought stress level, yield and yield components decreased. Therefore, Bevanij cultivar had the highest chickpea seed yield and Hashem cultivar had the lowest yield among them. The application of zinc fertilizer compared to control had a better effect on yield and yield components, and grain yield and biomass yield increased significantly with its application. Therefore, it is possible to increase the yield of chickpeas by irrigation and using zinc fertilizer.

Key words: Chickpea, drought stress, Zn fertilizer and yield

INTRODUCTION

Worldwide, environmental stress is one of the main causes of crop loss worldwide, leading to an average yield loss of more than 50% for major crops each year (Brya, 2004; Chaves and Oliveira, 2004). Drought stress reduces the rate of cell growth and, as a result, reduces the length of the stem by inhibiting the elongation between the nodes and also checking the tillering capacity of the plants (Ashraf and O'Leary, 1996). Drought Several studies have also shown that optimal yield can be obtained by irrigation at the stages of branching, flowering and pod formation (Parihar and Sandhu, 1968). Chickpea is one of the important crops in semi-arid/arid climates. The average yield of chickpeas in different countries of the world such as China (4135 kg/ha), Canada (1427 kg/ha), America (1391 kg/ha) and Pakistan (785 kg/ha) is seen. The performance of peas depends on nutrients. Zinc is one of these important elements, plus it has a high pH that affects the ability to absorb phosphorus as a macronutrient. Zinc plays an important role as a metal component of enzymes (alcohol dehydrogenase, superoxide dismutase, carbonic anhydrase and RNA polymerase) or as a functional, structural or regulatory cofactor of many enzymes (Marschner, 1986). Mahadi (1990) found that foliar application of Zn SO to bean plants increased the number of pods/plant and grain yield/nutrition. Gunis et al. (2003) and Soleimani (2006) reported a significant increase in the number of wheat spike 1 seeds for boron and zinc foliar application, respectively. Soleimani (2006) reported the increase in biological performance for zinc foliar application. Toron et al. (2001) and Grewal et al. (1997) reported an increase in wheat production using zinc and boron over the control. Therefore, this study was conducted with the aim of investigating the effect of drought stress and zinc fertilizer on yield and yield components of chickpea cultivars.

Materials and Methods

The field experiment was conducted in the growing seasons of 2018. The test soil was clay with pH 7.4, organic content 1.63, total P 0.15% and 0.9 mg/kg Zn. The experiment was carried out in the form of a factorial split design with drought stress in the main plots and the variety with zinc trace elements in the secondary plots with three replications. Experimental treatments including three levels of drought stress [severe drought stress (S2), moderate drought stress (S1) and no drought stress (S0)] in the main plots and four chickpea cultivars, Azad, Bevanij, Hashem and ILC482 and 2 levels of zinc in the plot sub-types [Zn0 (use of zinc fertilizer) and Zn1 (non-use of zinc fertilizer)]. Towing spray with zinc (tap water 0.02 and 0.06% zinc EDTA 14% zinc). Zinc chelate (organic material) in the form of ethylene diamine tetraacetic acid was used. The seeds were planted in rows on March 31, 2009. Chickpea plants were sprayed once with an aqueous solution of chelated zinc on day 45 after planting, while control plants were sprayed with tap water. The volume of sprayed zinc aqueous solution was 400 liters per feed (using a 1 liter manual sprayer).

To determine yield, we removed and cleaned all seeds produced per square meter in the field. The seeds were air-dried and weighed, and seed yield was recorded based on dry weight. The yield was defined in terms of grams per square meter and five grams per hectare. The number of pods per plant, the number of seeds per pod and the number of seeds per plant were determined.

Repeated samples of clean seeds (broken seeds and foreign materials removed) were randomly sampled and 100 seeds were counted and weighed.

Biomass production in the treatment of 10 plants was measured at 40 days after podding (DAP). The harvest index was calculated as follows:

$$HI = (\text{Economical yield} / \text{Biological yield})$$

The statistical analyses to determine the individual and interactive effects of drought stress, Zinc fertilization and cultivar were conducted using JMP 5.0.1.2 (SAS Institute Inc., 2002). Statistical significance was declared at $P \leq 0.05$ and $P \leq 0.01$. Treatment effects from the two runs of experiments followed a similar trend, and thus the data from the two independent runs were combined in the analysis.

Results

The results showed that the effect of drought stress and cultivar treatments on the number of pods per plant was significant at the 1% level (Table 1), but other treatments were not significant. Comparing the average values of the number of pods per plant (Table 3) shows that treatment S0 has the highest (45) number of pods per plant and treatment S2 has the lowest number of pods per plant (9) and the differences. were significant. Among cultivar treatments, the highest number of pods per plant (31/2) belonged to ILC482 variety and the lowest number of pods per plant (21/2) belonged to Azad variety (Table 3). Similar results were reported by Khorgami et al. (2009) and Arya and Khoshva (2000) in chickpea and Mirakhori et al. (2009) in max soybean.

The effect of drought stress and cultivar treatment on the number of seeds in the pod was significant at the 5% level (Table 1), but other treatments were not significant. The comparison of the average values of the number of seeds in the pod (Table 3) shows that the S1 treatment has the highest (1.9) number of seeds in the pod and the S0 treatment has the lowest number of seeds in the pod (1.1) and the differences. were significant. Among cultivar treatments, the highest number of seeds per pod (2) belonged to Hashem variety and the lowest number of seeds per pod (1.01) belonged to Bevanij variety (Table 3).

The effect of drought stress treatment on the number of seeds per plant was significant at the 5% level (Table 1), but other treatments were not significant. A comparison of the average values of the number of seeds per plant (Table 3) shows that treatment S0 has the highest number of seeds per plant (31.55) and treatment S2 has the lowest number of seeds per plant (9.3) and the differences. were significant. Among cultivar treatments, the highest number of seeds per plant (21.7) belonged to the variety ILC482 and the lowest number of seeds per plant (11.2) belonged to the variety Bevanij (Table 3). Similar results were reported by Khurgami et al. (2009) in chickpeas.

Table 1 shows that the effect of cultivar treatment on the weight of 100 seeds is significant at the 1% level, but other treatments were not significant. Comparison of the average weight of 100 seeds (Table 3) shows that Bevanij variety has the highest (32.1 grams) weight of 100 seeds and Hashem variety has the lowest (24 grams) weight of 100 seeds. Drought stress from flowering to maturity resulted in 100 seed weight compared to unstressed chickpea plants. The weight loss of 100 seeds under stress may be due to less photosynthetic capacity in the growing seed. Similar results were reported by Mansour et al. (2010) and Aria and Khoshva (2000) in chickpea. and Segatal Islami et al. (2008) in millet and Nabipour et al. (2007) in safflower and Mirakhori et al. (2009) in Soya Max. The analysis of variance in Table 1 shows the effects of drought stress, cultivar and interaction of drought stress × variety × Zn fertilizer treatments on grain yield are significant at 1% level and effects of Zn fertilizer was significant on it at 5%. Comparison of average grain yield in different irrigation treatments indicated that the S_0 treatment has the highest grain yield (2645.2 kg /ha) and the S_2 treatment has the lowest grain yield (917 kg/ha) and the difference is significant (Table 3).

Mahalakshmi and Bidinger (1985) reported that drought stress at grain filling stage reduced grain yield up to 50%. Among the Zn fertilizer treatments, the highest grain yield (1526 kg/ha) was belonged to the Zn_1 treatment and the lowest grain yield (1298 kg/ha) was belonged to the Zn_0 treatment (Table 3). Among the cultivars treatments, the highest grain yield (2126 kg/ha) was belonged to the Bivanij cultivar under non stress conditions and the lowest grain yield (1125 kg/ha) was belonged to the Hashem cultivar under stress conditions (Table 3). Interaction effect of drought stress × variety × Zn fertilizer (S × V × Zn) shows that $S_0Zn_1V_2$ has the highest grain yield (2987 kg/ha) and $S_2Zn_0V_3$ has the lowest grain yield (397 kg/ha) (Table 2). The significance of this interaction clearly shows the differential response of plants under different water regimes to Zn fertilizer. Similar results were reported by Mansur et al (2010) Singh and Dixit (1992) and Arya and Khushwa (2000) in chickpea and seghatoleslami et al (2008) in millet and Nabipour et al (2007) in safflower and Mirakhori et al (2009) in soybean Max.

The effect of drought stress treatment and Zn fertilizer on Biomass yield were significant at 5% level (Table 1) but the other treatments were not significant on it. The comparison of the mean values of the Biomass yield (Table 3) shows that S_0 treatment has the highest (5326 kg/ha) Biomass yield and the S_2 treatment has the lowest Biomass yield (1922 kg/ha) and the differences were significant. Among the Zn fertilizer treatments, the highest grain yield (3526 kg/ha) was belonged to the Zn_1 treatment and the lowest grain yield (3125kg/ha) was belonged to the Zn_0 treatment (Table 3). Among the cultivars treatments, the highest Biomass yield (3856kg/ha) was belonged to the Hashem cultivar and the lowest Biomass yield (2866 kg/ha) was belonged to the ILC482 cultivar (Table 3). harvest index (37%) was belonged to the Hashem cultivar (Table 3). Similar results were reported by Mansur et al (2010) and Arya and Khushwa (2000) in chickpea and Mirakhori et al (2009) in soybean Max.

Table1. Analysis of variance (mean squares) for yield and yield components in chickpea cultivars under drought stress and Zn fertilizer

							Means of	square
Source of variation	**df**	**num of poc per plant**	**num of grain per pod**	**num of grain per plant**	**100grain weight**	**grain yield**	**Biomass yield**	**Harvest Index**
repetation	2	511	0.004	92.5	8	865721	582103.3	101.2
Drought stress	2	6132*	0.03**	1855*	30^{ns}	29325063**	40125936*	1724.9**
Error (Ea)	4	21	0.0051	8.5	7.6	854720	712053	6.6
Zn fertilizer	1	4^{ns}	0.003 ^{ns}	19.3 ^{ns}	9 ^{ns}	913025.8 *	412036.5 *	15.6 ^{ns}
cultivar	3	209*	0.76**	55.3 ^{ns}	2000.6**	40123695**	1856230.2 ^{ns}	55 ^{ns}
Zn fertilizer* stres	2	21 ^{ns}	.000085 ^{ns}	33.7 ^{ns}	3.3 ^{ns}	310256 ^{ns}	1803265 ^{ns}	33 ^{ns}
Zn fertilizer* cultiv	3	61 ^{ns}	0.011 ^{ns}	30 ^{ns}	4.3 ^{ns}	210250 ^{ns}	512458.5 ^{ns}	29.3 ^{ns}
cultivar* stress	6	102 ^{ns}	.0013 ^{ns}	31.8 ^{ns}	9 ^{ns}	865410 ^{ns}	685421.5 ^{ns}	33.2 ^{ns}
stress* cultivar* Z fertilizer	6	74 ^{ns}	0.006 ^{ns}	9 ^{ns}	4.6 ^{ns}	1965280.1**	463206.3 ^{ns}	19 ^{ns}
Error (Eb)	42	411	0.55	33325	12.3	203204.3	32503201	33.25
CV		11.2	8.9	15.3	9	19.3	18.1	8.3

ns: Non-significant, * and **: Significant at 5% and 1% probability levels, respectively

Similar results were reported by Mansur et al (2010) and Singh and Dixit (1992) in chickpea and Kenan and Cafer (2004) in sugar beet and Penuelas et al (1993) in pepper and beans.

The effect of drought stress treatment on harvest index was significant at 1% level (Table 1) but the other treatments were not significant on it. The comparison of the mean values of the harvest index (Table 3) shows that S_0 treatment has the highest (44%) harvest index and the S_2 treatment has the lowest harvest index (37.6%) and the differences were significant. Among the cultivars treatments, the highest harvest index (49.1%) was belonged to the ILC482 cultivar and the lowest

The correlation matrix (Table 4), indicated strong and significant ($p<0.01$) correlation of grain yield with number of pod per plant and number of grain per plant (r=0.91 and 0.89) respectively. These results were agreement with the previously reported ones. Such results indicated that selection for these traits would lead to the increase in grain yield of chickpea (El-gizawy and Mehasen, 2004). However number of grain per pod was negatively and significantly ($p<0.05$) correlated with HI (r=-0.79). The number of pod per plant was positively and significantly ($p<0.01$) correlated with number of grain per plant (r=0.88).

Table 2. Interaction effect of drought stress × variety × Zn fertilizer on grain yield

	No stress(S0)		**Moderate stress(S1)**		**Sever stress(S2)**	
cultivars	**No Zinc(Zn_0)**	**Application of Zinc(Zn_1)**	**No Zinc(Zn_0)**	**Application of Zinc(Zn_1)**	**No Zinc(Zn_0)**	**Application of Zinc(Zn_1)**
Azad	2141^{bcd}	2151^{abc}	1111^{def}	1292^{cdef}	653^{gh}	892^{fg}
Bivanij	2543^{abc}	2987^{a}	1356^{cdef}	21456^{bcd}	911^{fg}	1156^{ef}
Hashem	1972^{cde}	2456^{ab}	960^{fg}	1322^{fg}	397^{h}	462^{h}
ILC482	2451^{abc}	2700^{a}	1156^{def}	1943^{cde}	928^{fg}	722^{gh}

ns: Non-significant, * and **: Significant at 5% and 1% probability levels, respectively

Discussion

Drought is detrimental to plant growth, yield and mineral nutrition (Garg et al., 2004; Samare et al., 2004). Soil moisture status during the reproductive stage of chickpea plays an important role in determining the effect of yield components on final seed yield (Singh and Bhushan, 1980). This study showed that with the increase of drought stress, the yield and yield components of chickpea seeds decreased significantly. The decrease in the number of seeds per pod under drought stress treatments may be attributed to the limitation of dry matter partitioning into reproductive sink or even seed formation factors as reported by Turk et al. (1980). The number of pods in the plant increases by 80% in non-stress conditions (S0) compared to severe drought stress conditions (S2) (Table 3).

The significant reduction in the number of harvested pods per plant under drought stress may be attributed to the cutting of reproductive structures. Ziska and Hall (1983) and Gwatmey and Hall (1992) reported similar results. The number of pods per plant in ILC482 was increased by 32% compared to the free variety. The different behavior of different cultivars towards drought stress may be attributed to their variable genetic composition and disturbance in the physiological mechanism of plants in the presence of water.

The number of seeds per plant increases by 42% in non-stress conditions (S0) compared to severe drought stress conditions (S2) (Table 3). The number of seeds per plant of Hashem variety showed an increase of 49.5% compared to Bevanij variety.

Chickpea yield was limited under stress conditions due to limited moisture. The occurrence of drought in relation to the pollination stage causes a severe decrease in yield and yield components (Saqat al-Islami et al., 2007). Also, the results showed that chickpea cultivars had significantly better grain yield in conditions without drought stress than in drought stress conditions, and the cultivar Bionij had relatively the highest grain yield in both conditions. The yield of chickpea seeds in non-stressed conditions (S0) was increased by 65% compared to severe drought stress conditions (S2) (Table 3).

Table3. Mean comparisons for yield, yield components in chickpea cultivars under drought stress and Zinc fertilizer

	Num of pod per plant	Num of grain per pod	Num of grain per plant	100grain Weight (g)	Grain yield (kg/ha)	Biomass yield (kg/ha)	Harvest Index (%)
Drought stress							
No stress	45a	1.9a	31.55a	29a	2645.2a	5326a	44a
Moderate stress	21.6b	1.6a	18.3b	28.5a	1425b	3623b	41a
Sever stress	9c	1.1b	9.3c	24b	917c	1922c	37.6
LSD	2.2	0.052	3.2	2.6	611.3	216.3	3.1
Zn fertilizer							
No Zn fertilizer	24.2	1.33	15.5	27	1295b	3125b	41.2
Application of Zn fertilizer	26.5	1.41	16.2	28.3	1526a	3526a	43.3
LSD	3.2	0.041	3.2	1.71	111.3	400.3	2.89
Cultivars							
Azad	21.2b	1.4b	13.1b	28b	1946ab	3255bb	46b
Bivanij	22b	1.01c	11.2b	32.1a	2126a	3125b	44b
Hashem	25.3b	2a	18.1ab	24c	1125c	3856a	37c
ILC482	31.2a	1.39b	21.7a	24.3c	1452b	2866bc	49.1a
LSD	5.1	0.049	3.4	2.9	182	550.6	4.2

Means by the uncommon letter in each column are significantly different ($p<0.05$)

Table 4. Correlation matrix of mean productivity, effect of drought stress and Zinc fertilizer on yield, yield components in chickpea cultivars

	(GY)	(BY)	(HI)	(NPP)	(NGPod)	(NGPlant)	(100GW)
grain yield (GY)	1.00 ^{ns}	0.42 ^{ns}	0.71 ^{ns}	0.91**	-0.52*	0.89**	0.01 ^{ns}
Biomass yield (BY		1.00	-0.09 ^{ns}	0.55 ^{ns}	-0.09 ^{ns}	0.52 ^{ns}	0.22 ^{ns}
Harvest Index (HI			1.00	0.33 ^{ns}	-0.79*	0.11 ^{ns}	0.11 ^{ns}
number of pod per plant (NPP)				1.00	-0.25 ^{ns}	0.88**	-0.09 ^{ns}
number of grain per pod (NGPod					1.00	-0.27 ^{ns}	-0.62 ^{ns}
number of grain per plant (NGPlant)						1.00	-0.11 ^{ns}
100grain weight (100GW)							1.00

ns :Non-significant , * and **: Significant at 5% and 1% probability levels, respecti

Cultivars differed in their response to drought stress at different growth stages. However, Bivanij cultivar gave the highest grain yield (2987 kh/ha) under non stress condation and application of Zn fertilizer but Hashem cultivar had lowest grain yield (397 kh/ha) under drought stress condation and non-application of Zn fertilizer (Table2). Under non stress condation the grain yield in the Bivanij cultivar in application of Zn fertilizer treatment giving a 33% increase over the Hashem cultivar in non-application of Zn fertilizer treatment (Table 3). Zn fertilizer had a positive effect on the grain yield and biomass yield of chickpea. In chickpea, the final grain yield is dependent upon the number of pods per plant, number of grains per pod and the extent to which grains are filled. In the present study, the reduction in grain yield under drought stress was associated with dramatic decrease in all yield components (Table 3). Supporting evidences were reported by many researchers (Ziska and Hall, 1983; Ludlow and Mushow, 1990; Gwathmey et al., 1992). They attributed the reduction in grain yield under drought stress to the reduction in number of pods per plant, number of grain per pod and grain weight. Turk and Hall (1980) attributed the reduction in grain yield under drought stress to the secondary detrimental effects of drought avoidance on CO_2 assimilation. This result suggests that chickpea cultivars exhibit reproductive plasticity under drought stress conditions.

Decrease biomass yield under lower soil moisture might be due to reduction of leaf area and photosynthesis rate (Sinaki et al., 2007). In different irrigation treatments indicate with increasing drought stress increased the biomass yield significantly. The biomass yield in the non-stress condition (S_0) giving a 64% increase over the sever drought stress condition (S_2) (Table 3). The biomass yield in the Hashem cultivar had a 25% increase over the ILC482 cultivar. Latiri-Soki et al (1998) reported that, irrigation and fertilizers increased biomass yield and grain yield. They suggested the increase might be due to increased leaf area index (LAI) and an increase in the period for which the crop remained green which resulted in increased capture efficiency of radiation energy and consequently more dry matter production.

Also, Ziska and Hall (1983) the effect of drought on HI to the reduction in assimilate supply attributed. Harvest index also varied significantly among cultivars, with the introduced cultivar (ILC482) having the highest value compared to the other cultivars (Table 3). This suggests that chickpea cultivars which gave higher grain yield under drought-stressed conditions could play an important role in sustaining crop production in semi arid regions.

Conclusion

The present study concluded that maximum production of chickpea (grain yield and yield components) was recorded for non stress treatment (S_0) and was followed by application of Zn fertilizer, while sever drought stress (S_2) produced minimum production. Therefore, Bivanij cultivar had highest production of chickpea (grain yield and 100 grain weight) and Hashem cultivar had a lowest them. Also, results of these experiment showed that application of Zn fertilizer had better effect on grain yield and yield components compared to the control. Therefore, we can increase yield of chickpea by irrigation and application of Zn fertilizer.

REFERENCES

Ashraf M, Oleary JW. 1996. Effect of drought stress on growth, water relations and gas exchange of two lines of sunflower differing in degree of salt tolerance. Int. J. Plant Sci, 157: 729-732.

Arya RL, Khuswaha BL. 1998. To study the irrigation and phosphorus management in rice chickpea cropping system In : Proc. First Inte. Agron. Congress New Delhi, Inida, Eds. Ahlawat, IPS and Surendrasingh, pp. 23-37.

Chaves MM,Oliveira MM. 2004. Mechanisms underlying plantresilience to water deficits: prospects for water-saving agriculture. J. Exp. Bot, 55: 2365–238.

El-Gizawy N, Mehasen SAS. 2004. Yield and seed quality responses of chickpea to inoculation with phosphorein, phosphourus fertilizer and apraying with iron.. The 4th Scientific Conference of Agricultural Sciences, Assiut, pp. 1-12.

Garg BK, Burman U, Kathju S. 2004. The influence of phosphorus nutrition on the physiological response of moth bean genotypes to drought. J. Plant. Nutr. Soil. Sci, 167: 503–508.

Grewal HS, Zhonggu L, Graham RD. 1997. Influence of subsoil zinc ondry matter production, seed yield and distribution of zinc in oilseed rape genotypes differing in zinc efficiency. Plant and Soil, 192(2): 181-189.

Guenis A, Alpaslan M, Unal A. 2003. Effects of Boron Fertilization on the Yield and Some Yield Components of Bread and Durum Wheat. Turk. J. Agric, 27: 329-335.

Gwathmey CO, Hall AE. 1992. Adaptation to midseason drought of cowpea genotypes with contrasting senescence traits. Crop. Sci 32: 773-778.

Iqbal SH, Ghafoor A, Ayub N. 2005. Relationship between SDS-PAGE markers and Ascochyta blight in chickpea. Pak. J. Bot 37: 87-96.

Kenan U, Cafer GO. 2004. The Effect of Water Deficit on Yield andYield Components of Sugar Beet. Turk J. Agric, 28:163-172.

Khan DF, Peoples MB, Chalk PM, Herridge DF. 2002. Quantifying below-ground nitrogen of legumes a comparison of 15N and non-isotopic methods. Plant. Soil, 239: 277-289.

Khurgami A. and Rafiee, M. 2009. Drought stress, supplemental irrigation and plant densities in chickpea cultivars. African Crop Science Conference Proceedings, Vol. 9, pp. 141 – 143.

Latiri-Soki K, Noitclitt S, Lawlor DW. 1998. Nitrogen fertilizer can increase dry matter, grain production and radiation and water use efficiency for durum wheat under semi-arid conditions. Europian. J. Agronomy 9: 21-34.

Luo C, Branlard G, Griffin WB, McNeil DL. 2000. The effect of nitrogen and sulphur fertilization and their interaction with genotype on wheat glutenins and quality parameters. J. Cereal. Sci, 31: 185–194.

Ludlow MM, Muchow RC. 1990. A critical evaluation of traits for improving crop yields in water limited environments. Advances in Agron, 43: 107-153.

Mahady AEM. 1990. Effect of phosphorus fertilizer, some micronutrients and plant density on growth and yield of broad beans. Ph.D. Thesis, Fac. of Agric., Moshtohor, Zagazig Univ., Egypt

Mahalakshmi V, Bidinger FR. 1985. Flowering response of pearl millet to water stress during panicle development. Ann. Appl. Biol, 106: 571-578.

Mansur CPY, Palled B, Salimath PM, Halikatti SI. 2010. An analysis of dry matter production, growth and yield in kabuli chickpea as influenced by dates of sowing and irrigation levels. Karnataka. J. Agric. Sci, 23: 457-460.

Marschner H. 1986. Mineral nutrition of higher plants. Academic Press Inc., USA, pp: 269-369.

Mirakhori M, Paknejad F, Moradi F, Ardakani M, Zahedi H. Nazeri P. 2009. Effect of Drought Stress and Methanol on Yield and Yield Components of Soybean Max (L 17). American Journal of Biochemistry and Biotechnology, 5 : 162-169.

Nabipour M, Meskarbashee M, Yousefpour H. 2007. The effect of water deficit on yield and yield components of safflower. Pak J. Biol Sci 10: 421-426.

Ottman MJ, Doerge TA, Martin E. 2000. Durum grain quality as affected by nitrogen fertilization near anthesis and irrigation during grain fill. Agron. J, 92: 1035–1041.

Penuelas J, Biel C, Estiarte M. 1993. Changes in biomass, chlorophyll content and gas exchange of bean and pepper nder nitrogen and water stress. Photosynthetica 29:535-342.

Prihar SS, Sandhu BS. 1968. Irrigation of field crops, Indian Council of Agric. Res. New. Delhi, pp 142.

Samarah N., Mullen, R. and Cianzio, S. 2004. Size distribution and mineral nutrients of soybean seeds in response to drought stress. J. Plant. Nutr 27: 815–835.

Seghatoleslami M.J., Kafiv, M. and Majidi, E. 2008. Effect of drought stress at different growth stages on yield and water use efficiency of five proso millet (*panicum miliaceum* L.) genotypes. Pak. J. Bot 40: 1427-1432.

Sinaki J.M., Heravan, E.M., Rad, A.H.S., Noormohammadi, G.h.. and Ghasem, Z.G.h. 2007. The effects of water deficit during growth stages of canola (*Brassica napus* L.). American-Eurasian Journal of Agricultural and Environmental Science 2: 417-422.

Singh V. and Bhushan, L.S. 1980. Wateruse efficiency by fertilization and srored soil water and season rainfall. Agric. Water. Management., 2: 299-305.

Singh V.K. and Dixit, R.S. 1992. Effect of soil moisture regime and sowing date on chickpea (*Cicer arietinum* L.) Indian Journal of Agronomy 37 :739-743.

Soleimani R. 2006. The effects of integrated application of micronutrient on wheat in low organic carbon conditions of alkaline soils of western Iran. 18th World Congress of Soil Science.

Tanksley S.D. Jones, R.A. 1981. Application of alcohol dehydrogenase allozymes in testing the genetic purity of F_1 hybrids of tomato. Hort. Sci 16: 179-181.

Torun A., ltekin, I.G.A., Kalayci, M., Yilmaz, A., Eker, S. and Cakmak, I. 2001. Effects of zinc fertilization on grain yield and shoot concentrations of zinc, boron, and phosphorus of 25 wheat cultivars grown on a zincdeficient and boron-toxic soil. J. Plant Nut., 24(11): 1817-1829.

Turk K.J. and Hall, A.E. 1980. Drought adaptation of cowpea. IV: Influence of drought on water use and relation with growth and seed yield. Agron. J 72: 440- 448.

Ziska L.H. and Hall, A.E. 1983. Seed yields and water use of cowpeas (Vigna unguiculata L. Walp.) subjected to planned-water deficit. Irrigation Science 3: 237-246.