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Review Article

Response of Soybean to Micronutrients, Amino Acid and NPK Foliar Application Under Normal and Drought Stress Condition

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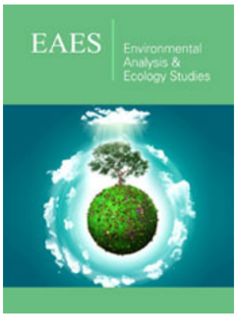
ISSN: 2578-0336



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Submission: : August 26, 2019
Published: September 20, 2019

Volume 6 - Issue 2

How to cite this article: Nemati H, Ajam Norozei H, Faragi A, Soltani A. Response of Soybean to Micronutrients, Amino Acid and NPK Foliar Application Under Normal and Drought Stress Condition. Environ Anal Eco stud. 6(2). EAES.000634.2019.
DOI: 10.31031/EAES.2019.06.000634

Abstract

Soybean (*Glycin max (L.) Merr*), from the legume's family has an important place among the industrial plants in the world. It's a summer plant and faced the heat and drought season During the growing season, its greatly affect soybean yield. Drought stress is one of the most important environmental factors in reducing the growth and yield of many crops, especially in arid and semi-arid regions of the world. The foliar application of the nutrient elements increases the yield, quality, resistance to pests and diseases and resistance to drought stress. A field experiments was carried out at the Agricultural Experimental Station of the Agriculture Research Centre at Iraqi -mahallah during summer seasons of 2016 and 2017 to study the effect of foliar application of Ca Zn, B, N, P, k Amino acid and water on growth, yield and quality of two soybean cultivars under normal and water stress conditions. Result showed the effect of foliar application year on plant height, pod number per plant, seed number per pod and grain yield was significant. the highest grain yield (4021.91kg ha^{-1}) achieved B application in 2017.

The lowest grain yield (237.41kg ha^{-1}) was obtain in 2016 and control treatment, also there was no significant difference between control treatment and water application in two year of experiment. The result showed in 2017 there was no significant difference in treatment in seed protein content. also, there was no significant difference between foliar application and control in seed oil content in 2016. Also, two cultivars have significant different in grain yield in 2017. But there was no significant difference in two cultivars in 2016. In general, results showed that spray application of nutrients, especially B application, improves the yield and yield component (number of pods, number of seed, 1000-seed weight and grain yield) in normal and drought stress.

Keywords: Grain yield; Irrigation; Nutrition; Seed oil; Seed protein

Introduction

Drought stress is one of the most important environmental factors in reducing the growth and yield of many crops, especially in arid and semi-arid regions of the world. Reduced photosynthesis due to close the stomatal, decreasing plant growth, the lack of photosynthetic materials necessary to fill grain and reduce the length of grain filling period is one of the most important drought effects on plants. Drought reduced photosynthetic rate and metabolism of carbohydrates in leaves, and these two processes reduce the amount of material available for transfer to the storage plant's organs, which can increase the abortion of the reproductive organ. During drought stress, due to the increase in soluble concentrations in the root environment and thus the increase of the soil osmotic potential, the absorption of nutrients is greatly reduced.

When the soil pH is rising, the absorption of micronutrient elements is higher than other elements Becomes disturbed. Soybean (*Glycin max (L.) Merr*), from the legume's family has an important place among the industrial plants in the world. According to the Bureau of Statistics and Information of the Iran Agricultural Jahad Organization The total area under cultivation of soybeans in Iran during the 2011-2012 crop year was between 76 thousand hectares, reaching 78 thousand hectares in 2015, that produced 190 thousand tons grain from this area. It's a summer plant and faced the heat and drought season During the growing season, its greatly affect soybean yield. Good and Zaplachiniski (1994), reported Accumulation of compounds such as proline and amino acids in green tissues of rapeseed under drought stress conditions, provide water absorption from the root environment for the plant.

But the plant's reliance on these organic compounds is costly to regulate osmotic and will reduce yield. Suitable Nutrition Under conditions of stress, help plant to Tolerance Different stress [1]. The results of various experiments show that the foliar application of the elements increases the yield, Quality, resistance to pests and diseases and resistance to drought stress. In soybeans, application of Zn increased dry matter, number of pods, number of seeds per pod and 100 seed weight. Zinc may also increase seed yield by increasing the absorption of other nutrients such as nitrogen, phosphorus and potassium. Positive effects of zinc have been reported in the production of growth hormones (auxins) and photosynthesis.

Bergland (2002) has reported that zinc spray application, especially in vegetative growth stages, increases the yield of soybeans. Researchers reported that biomass, grain yield and oil content of *sesamum indicum L.* increased with the Boron foliar application and on effect deficiency of boron, did not produce any seeds in this plant. Riley et al. (2000) also reported increase in oil and protein content of Wheat and canola seeds in using zinc sulfate. Aghei Sarbarzeh (1995) investigating the relationship between zinc and drought tolerance index in wheat showed that Zinc application increased drought tolerance in bread wheat and durum wheat cultivars. Marschner expressed Zinc is involved as a cofactor in activating several enzymes. These enzymes play a role in the metabolism of carbohydrates and proteins. Delaney et al. Zinc and Mn, especially in drought-tolerant cultivars, play a role in the osmotic regulation process with increased proline and soluble sugars. Movahedi Dehnavi (2001) reported an increase in zinc in the seed filling stage in *Carthamus tinctorius L* drought stress conditions, also drought stress at the reproductive stage limits the transfer of Fe and Mn to grain. The present study was conducted to determine the effect of spraying various micronutrient on yield and quality of soybean under drought stress conditions.

Material and Methods

The study was conducted at Agricultural Research Station of Gorgan, Golestan province, Iran (5m a.s.l., 36 N, 54°E). Based on Coupon classification the region could be classified as warm and humid climate. Experiment was conducted during summer seasons of 2016 and 2017 to study the effect of foliar application of Ca Zn, B N, P, K Amino acid and water on growth, yield and quality of two soybean cultivars under water stress conditions. Soil chemical and mechanical characteristic are presented in Table 1. Characteristics of the genotypes tested in this research presented in Table 2. Also, the meteorological statistics of the test site during the two cultivation years are presented in Table 3.

Table 1: Some of physicochemical characteristics of field soil.

Year	Depth	Ec (Ds/Z)	Organic Carbon	Anion	Cation	Phosphorous	Potassium	Ca	Na	Cl
2016	0-30	0.86	0.42	19.6	19.6	7.8	397	15.35	3.85	5.48
2017	0-30	0.92	0.45	17.5	17.5	6.1	376	15	3.6	5.46

Table 2: Characteristics of the genotypes tested in this research.

Genotype Name	Ripening Group	Company Name That Released	Year of Release
Katul	5, late matured	Golestan Agricultural and Natural Resources Research and Education Center.	2012
Amir (PE)	5, early matured	Golestan Agricultural and Natural Resources Research and Education Center.	2016

Table3: Variation of temperature and rainfall in Hashemabad meteorology station during 2016-2017 growing seasons.

Evap (mm)			Sunshine(h)			Mean of Temperature(°C)			Rain (mm)			
Year Month	Long term	2017	2016	Long term	2017	2016	Long term	2017	2016	Long term	2017	2016
Jan	4.5	2.26	2.2	7.33	164	166	20.97	14.05	14.65	38.11	40.4	76.6
Feb	4.52	3.48	3.6	7.45	176.3	215.1	20.67	20.3	20.85	34.22	37.1	36.5
March	6.77	6.63	5.4	8.42	265.2	267.4	25.9	25.15	25	28.55	2.2	62.6
April	6.75	7.62	6.3	7.72	277.8	260.1	28	28.45	27.9	40.77	5	13.2
May	6.67	8.86	7	8.67	333.7	294.4	28.7	30.35	28.65	15.65	0	16.2
June	5.72	7.42	5.5	7.82	311.5	263.4	27.35	28.95	27	21.22	0	28.9
July	3.85	3.09	3.2	6.72	194.9	181.8	21.85	19.75	20.15	68.47	89.1	37.9
Aug	2.07	2.18	1.5	5.57	181.8	126	15.82	17.75	14.3	42.12	17	82.5
Sept	1.15	1.18	0.9	4.27	159.7	137.3	10.52	9.95	7.4	66.82	71.8	26.2
Oct	1.02	1.08	1.1	4.12	120	155.4	9.34	9.6	8	68.17	60	2.5

A factorial split-plot design in a randomized complete block with three replicates was applied in two condition normal (irrigation after 60mm Evaporation from the evaporation pan and water stress (120mm Evaporation from the evaporation pan). The main plots included: normal and drough stress condition. also, Ca Zn B N, P, K. Water and control (no- spraying) and two soybean genotypes (DPX and Amir) were located in subplots. Each subplots size into main plot were 3.6×5m and consisted of six planting rows. The distance between the blocks and the main plot was 2m, the distance between the plants was 8cm, the distance between the rows was 60cm. The cultivation was in joly of both years. for seed emergence an Irrigation was Done after planting. To apply drought stress, irrigation was continued when 120mm Evaporation from the evaporation pan. Phonological stages were recorded during the experiment with Fehr & Caviness (1977) method.

Foliar application of these treatments was used according to the manufacturer's recommendation during three stages of the beginning of flowering (R1 stage), beginning of seed filling (R3 stage) and termination of seed filling (R5 stage). In each year after harvesting maturity, sampling for measurement grain yield and yield components from each experimental unit was performed taking into account marginal effects. For Ca, Zn and B treatments were used CaCl, $ZnSO_4$ and H_3BO_3. Foliar application of these treatments was used during two stages of the beginning of flowering (R1 stage), beginning of seed filling (R3 stage) and termination of seed filling (R5 stage) according to the manufacturer's recommendation.

The measurements included the final plant height, the height of the first node from the soil surface, the number of nodes in the main steam and the number of branches in 5 randomized plants. Also, the yield components were including number of pods per plant, number of pods per square meter, number of seeds per pod, weight of 100 seeds and grain yield (kg/ha). For estimation of total oil content, 10g of seeds were crushed and extracted with petroleum ether for 4h in a Soxhlet apparatus according to the method described by AOAC. The extract was concentrated under reduced pressure. The total seed oil content was calculated as percentage of sesame seeds (Hussein et al. 2016). Oil yield was calculated by using grain yield × Oil percent (Malacrida et al. 2011). All of the data obtained for two consecutive years were subjected to analysis of variance using SAS software (Statistical Analysis Software, 9.1). Differences among the treatments were assessed with the LSD (least significant difference) only when the ANOVA F-test showed significance at P=0.05 and Excel 2010 software was used for calculating and plotting charts.

Result and Discussion

Analysis variance of data showed that year had significant effect on pod number per plant, number of seeds per pod, number of seeds per plant, 100 seed weight and grain yield at p<0.1%. The results showed Irrigation had significant effect on seed protein and oil content. interaction effect of year × irrigation on seed number per plant was significant but had no significant effect on seed oil and protein percent. Also, interaction effect of irrigation × cultivar and irrigation × cultivar × cultivar on any of the mentioned traits was not significant. The results showed that interaction effect of irrigation × foliar application on pod number per plant, 100 seed weight, grain yield, seed protein and oil content was significant. The result showed that there was no significant difference in terms of number of pods per plant, number of seeds per pod, number of seeds per plant and percentage of protein content in the studied varieties.

However, there was a significant difference in seed oil content, grain yield and 100-seed weight in the studied varieties. The foliar application effect on seed yield and yield components and seed oil and protein content was significant. the interaction effect of year × foliar application on number of pods per plant, number of seeds per pod, number of seeds per plant, 100 seed weight and seed yield were significant. The results showed that the interaction effect of spray × cultivars on seed oil and protein content was significant. Also, interaction effect of year × foliar application× cultivar and year × irrigation × foliar application × cultivar on any of the traits was not significant.

Interaction effect of year × irrigation

The results showed that there was no significant difference in plant height between normal moisture condition and drought stress in the first year of experiment (2016). but, the number of seeds per plant and grain yield were significantly different (Table 4). In the first year of experiment (2016), the highest number of seeds per plant and grain yield were 49.55 and 1428.33 (kg ha^{-1}) in normal moisture conditions (Table 4). In the second year of experiment (2017), there was a significant difference in plant height and number of seeds per plant between normal condition and drought stress. The highest plant height (66.57cm) and number of seeds per plant (178.23) was obtained in Normal condition.

Table 4: Mean comparisons of year and irrigation on soybean traits.

Year	Irrigation	Plant Height(cm)		Seed Number Per Plants		Grain Yield Kg. ha^{-1}	
2016	normal	63.92	a	49.55	a	1428.33	a
	drough stress	63.69	a	41.47	b	1013.33	b
2017	normal	66.57	a	178.23	a	3082.69	a
	drough stress	60.14	b	151.02	b	3005.26	a

Note: Any two means sharing a common letter do not differ significantly from each other at 5%.

However, there was no significant difference in grain yield between two moisture conditions (Table 4). Karami et al. (2011) in their study on the effect of Zinc element irrigation on yield and yield components of soybean in water stress conditions reported that Zinc sulfate application increased yield and yield components. They reported application of zinc coatings could reduce the effects of water stress and improve the growth conditions for the plant. Goodarzi et al. (2013), in study of the effect of different concentrations of Iron and Zinc on the *Zea maiz .L*, reported that the interaction effect of Iron 2mg.L^{-1} and Zinc 8mg.L^{-1} was significant and the highest 1000-seed weight, seed number per row, row number per corn, biological yield, grain yield, harvest index and yield of seed oil were obtained in interaction effect of Iron 2 mg.L^{-1} and Zinc 8mg.L^{-1}.

Interaction of foliar application × irrigation

The results of the means comparison in (Table 5) showed that in the normal conditions, the highest plant height was 81.66cm and obtained in the amino acid foliar application treatment. However, there was no significant difference in plant height between Zn and Amino acid treatment. Also, there was no significant difference in treatments of Ca and N.P.K foliar application in plant height and the lowest plant height (46cm) was obtained in control treatment. Also, in normal conditions the number of stem nodes in Ca, Zn, B, N.P.K and amino acids was in a group and the lowest number of stem node was 2.7 and obtained in control treatment (Table 5).

The highest pod number per plant was 77.41 and observed in N.P.K treatment. However, Zn, B, N.P.K and amino acid were grouped into a common statistical group (Table 5). The lowest pod number per plant was 35.58 and obtained in control treatment. In the normal conditions, the highest 100- seed weight was obtained in B foliar application, and other treatments have not significant difference. also, the highest grain yield was 3631.25kg/ha and obtained in and in B spray application. The lowest grain yield was 1115.25kg ha^{-1} and observed in control treatment and no significant difference was observed in water foliar application and control. our results showed, in the normal conditions, the highest seed protein was obtained in water application. And was no significant difference in other treatment in seed protein. The highest oil seed was obtained in the control treatment. However, the water foliar application and control have not significant difference (Table 5) in drought stress conditions Different results were obtained.

The results showed that under drought stress conditions, none of the treatments had significant effect on plant height, number of nodes on main stem and 100 -seed weight. The highest number of pods per plant was 61 and obtained in B foliar application. But there was no significant difference between Ca, Zn, B, N.P.K and Amino acid treatment. The lowest number of pods per plant (40.33) observed in water foliar application and there was no significant difference with control treatment results showed that in drought stress conditions, the highest grain yield was obtained in B application (2753.83kg ha^{-1}). Also, there was no significant difference in Ca, Zn, N.P.K and amino acids treatments. The lowest grain yield was 1295.66kg ha^{-1} and obtained in control treatment (Table 5). Results showed, in drought stress conditions, none of the foliar application treatments had a significant effect on oil seed and protein content (Table 5).

Table 5: Mean comparisons of irrigation and foliar application on soybean traits.

Irrigation	Foliar Application	Seed Oil (%)	Protein Seed (%)	Grain Yield (Kg. ha^{-1})	100-Seed Weight (gr)	Pod Per Plant	Plant Height (cm)
Normal	Ca	36.06 b	20.55 b	1951.33 c	21.52 b	46.08 b	66.66 b
	Zn	35.36 b	20.79 b	2199.58 c	21.89 b	61.58 a	77.00 a
	B	35.72 b	21.36 a	3631.25 a	24.21 a	71.91a	68.50 b
	N.P. K	35.70 b	20.92 b	2611.33 b	22.55 b	77.41 a	69.41 b
	Amino acid	35.80 b	20.72 b	2810.41 b	21.47 b	65.58 a	81.66 a
	Water	37.42 a	20.70 b	1469.41 d	19.92 b	48.66 b	47.50 c
	Control	37.85 a	20.43 b	1115.25 d	20.39 b	35.58 c	46.00 d
Water Stress	Ca	37.21 a	20.46 a	1936.25 b	20.49 a	60.00 a	62.08 a
	Zn	36.74 a	20.40 a	2272.25 b	20.91 a	55.66 a	61.58 a
	B	38.85 a	20.61 a	2753.83 a	19.08 a	61.00 a	65.33 a
	N.P. K	36.55 a	20.31 a	2305.25 b	19.80 a	60.66 a	64.00 a
	Amino acid	37.10 a	20.46 a	2183.95 b	19.48 a	59.08 a	54.91 a
	Water	37.86 a	21.10 a	1317.66 c	21.17 a	40.33 b	65.66 a
	Control	37.51 a	20.12 a	1295.66 c	21.78 a	41.58 b	59.83 a

Note: Any two means sharing a common letter do not differ significantly from each other at 5%.

Interaction of Year × cultivar

The results showed that the interaction of year × cultivar on the number of stem node and grain yield was significant. in the first year of the experiment (2016), the highest number of stem nodes was 3.15 and in the Amir cultivar. However, in the second year of experiment, two cultivars did not differ significantly in terms of number of stem node (Table 6). Also, in the first year of experiment, there was no significant difference in cultivar grain yield. But in 2017, the highest grain yield was 3178.52kg/ha and in the Katoul cultivar (Table 6).

Table 6: Mean comparisons of year and cultivar on soybean traits.

Year	Cultivar	Grain Yield (Kg. ha^{-1})	Nod Number in Stem
2016	Katool	1251.45 a	2.56 b
	Amir	1190.21 a	3.15 a
2017	Katool	3178.52 a	4.25 a
	Amir	2909.42 b	4.35 a

Note: Any two means sharing a common letter do not differ significantly from each other at 5%.

Interaction of the year x foliar application

Analysis of variance showed that the interaction of year × foliar application was significant on plant height, number of pods per plant, number of seeds per pod, number of seeds per plant and grain yield (Table 7). In the first year of experiment (2016), the highest plant height was 81.66cm and was obtained in the amino acid foliar application. Also, there was no significant difference between and amino acid and Zn treatments in plant height. Result showed Ca, B and N.P.K treatments were classified in a common statistical group for plant height. The lowest plant height was 46cm and was obtained in control treatment. Also, there was no significant difference between water foliar application and control treatments. In the second year of experiment (2017), there was no significant difference between treatments in plant height (Table 7).

In the first year of experiment, the highest number of pods per plant was 54.16 and obtained in N.P.K application. However, NPK and amino acid foliar application have not significant difference in number of pods per plant. The lowest number of pods per plant was 17.08 and obtained in the control. But in 2017, the highest number of pods per plant was 93 and obtained in B application. Also, Ca, Zn, N.P.K and amino acids have not significant difference. The lowest number of pods per plant was 60.08 and observed in control treatment. However, there was no significant difference between control treatment and water application (Table 7).

In the first year of the experiment, there was no significant difference between Ca, Zn, B, N.P.K and amino acids in seed number per pod. Also, water application and control treatment had lowest number of seed per pod. In the second year of experiment (2017), the highest number of seeds per pod (2.60) was obtained in B application. Also, the lowest number of seeds per pod (1.69) obtained in control treatments that have not significant difference with water application treatments. The number of seeds per plant was also similar to the number of seeds per pod (Table 7). The results showed that in the first year of experiment, the highest grain yield was 2363.16kg. ha^{-1} and was obtained in B treatment. Also, there was no significant difference in Ca, Zn, N.P.K and amino acids in grain yield.

The lowest grain yield was observed in control treatment and was not significant difference between control and water application (Table7). In the second year of experiment (2017), the highest grain yield was 4021.91kg ha^{-1} and observed in B application. Also, the lowest grain yield was 2173.50kg. ha^{-1} and obtained in control treatment. Hosseinpour et al. (2011), showed that Amino acid foliar application increase grain yield, protein and oil content significantly (Table 7).

Table 7: Mean comparisons of year and foliar application on soybean traits.

Year	Foliar Application	Grain Yield	Seed Number Per Plant	Seed Number Per Pod	Pod Number Per Plant	Plant Height (cm)
2016	Ca	1182.66 b	42.58 a	1.40 a	30.00 c	66.66 b
	Zn	1339.08 b	53.66 a	1.37 a	38.25 b	77.00 a
	B	2363.16 a	64.66 a	1.62 a	39.91 b	68.50 b
	N.P. K	1543.08 b	79.66 a	1.48 a	54.16 a	69.41 b
	Amino acid	1469.41 b	58.06 a	1.20 a	47.41 a	81.41 a
	water	411.00 c	14.00 b	0.55 b	24.33 c	47.50 c
	control	237.41 c	5.91 b	0.35 b	17.08 d	46.00 c

2017	Ca	2704.91 d	147 c	1.93 d	76.08 b	62.08 a
	Zn	3133 c	172 b	2.17 c	79 b	61.55 a
	B	4021.91 a	246 a	2.60 a	93 a	65.33 a
	N.P. K	3373.50 b	192 b	2.28 b	83.91 b	64.00 a
	Amino acid	3524.91 b	171 b	2.21 c	77.25 b	54.91 a
	water	2376.08 e	120 d	1.86 d	64.66 c	65.66 a
	control	2173.50 e	102 d	1.69 d	60.08 c	59.83 a

Note: Any two means sharing a common letter do not differ significantly from each other at 5%.

Interaction of the cultivar × foliar application

Our results showed that interaction of cultivar × foliar application on plant height, seed oil and protein content was significant. According to the results in Katol cultivar, there was no difference between treatments in plant height and seed oil. the lowest protein content was 20.17% and observed in Ca foliar application, but there was no significant difference in treatment and control (Table 8). But in the Amir cultivar, Ca, Zn, B, N, P, K and amino acids have not significant difference in plant height. Also, control and water application treatment have the lowest plant height. The results showed, in Amir cultivar, there was no significant difference in protein percentage between treatments. But the highest percentage of seed oil was observed in control treatment, there was no significant difference in water application and control. Also, Ca, Zn, B, N, P, K and amino acids have not significant difference seed oil (Table 8).

Table 8: Mean comparisons of cultivar and foliar application on soybean traits.

Cultivar	Foliar Application	Seed Oil (%)	Seed Protein (%)	Plant Height (cm)
Katool (DPX)	Ca	37.52 a	20.17 b	69.41 a
	Zn	36.83 a	20.51 a	76.16 a
	B	37.34 a	21.20 a	75.50 a
	N.P. K	36.58 a	20.73 a	76.91 a
	Amino acid	37.60 a	20.48 a	76.25 a
	water	37.86 a	20.95 a	65.50 a
	control	37.23 a	20.29 b	63.08 a
Amir	Ca	35.76 b	20.85 a	59.33 a
	Zn	35.27 b	20.68 a	62.41 a
	B	37.23 a	20.77 a	58.33 a
	N.P. K	35.66 b	20.51 a	56.50 a
	Amino acid	35.30 b	20.69 a	60.33 a
	water	37.62 a	20.84 a	47.66 b
	control	38.13 a	20.24 a	42.75 b

Note: Any two means sharing a common letter do not differ significantly from each other at 5%.

Most plants can usually tolerate mild stresses and their growth is not reduced. But when the drought stress is severe Due to the decrease in cellular inflammation, cell growth and division, and eventually plant growth, are greatly reduced. Rahimizadeh et al. (2012) reported that drought stress had a significant effect on plant height in sunflower, lowest plant height was observed in severe drought stress treatment (25% less than non-stress treatment). Imam and Rabbani (2011) also found that drought stress in vegetative stage reduced plant height significantly (10.2%) in Maize. Soy (*glycine max l*) The most important oily plants and has the highest cultivation area in the world among oily plants [2]. In About 1/3 of the world's cultivated lands, drought stress is major factor in reducing crop yield [3]. Under drought stress due to osmotic potential loss, nutrient availability is one of the most influential factors in plant growth and development.

On the other hand, most of the agricultural soils of Iran are facing low pH, leading to low nutrients solubility. Under such a condition, application of fertilizers may result in increased nutrients solubility [4]. Drought stress reduces biomass, grain yield, plant height and number of branches in soybeans [5]. Drought stress during plant growth period reduced plant height, number of nodes, branch number, plant weight, seed number, seed weight, pod number, pod weight and soybean harvest index [6]. the study of the effect of two levels of irrigation on two soybean cultivars (one narrow growth and unlimited growth) showed that drought stress at the seed filling stage reduced grain weight. The effective grain filling period was not affected by the stress in the non- determinate cultivar, but this period was reduced in determinate cultivar.

The stress is one of the main factors affecting seed composition, protein content, grain yield and finally the quality of crops decrease the rate of carbon dioxide metabolism, reduce stomatal conductance and decrease water use efficiency, the factors involved in the reducing crop yields under drough stress conditions [7]. Hemmati et al. (2018) reported that Under drought stress, reactive oxygen species (ROS) are produced due to an imbalance between light interception and its use and ROS, causing damage to a plant. Bilaloy et al. (2013) also reported seed oil content of soybean under drought stress showed a significant decrease. The reason is the high sensitivity of lipid accumulation to drought stress at the seed filling stage. Kandogan et al. (2013) in their research on soybeans, reported that different levels of drought stress increased seed protein content and the lowest percentage of protein was obtained in control treatment (complete irrigation).

Drought stress in flowering stage delayed flowers formation, also increase percentage of infertile flowers, falling flowers and pods Therefore, these problems can reduce the number of pods in drought stress conditions [8]. Usually in soils where pH, chemical composition of food and root growth conditions and intake of nutrient element is unsuitable, crop is encountered with a nutritional disorder. Under drought stress conditions, due to lower soil soluble content, the crop faces nutrient element deficiency. Therefore, in this condition, nutrient foliar application is the best way to crop nutrition [9]. The nutrients can be applied to crop in a variety of ways like seed treatment, soil and foliar application [10].

Foliar application of micronutrients improves the nutrition [11]. Zhang et al. [12,13] reported foliar Zn application, foliar N, P, and K fertilization has been used to increase crop production, especially in dryland areas. The limited translocation of Zn in woody species can result in highly non-uniform Zn distribution and the occurrences of the characteristic symptoms of Zn deficiency in fruit/nut trees which includes poor apical meristem development, resetting and tufting of newly emerged leaves [14]. The use of macro- and micro- nutrients is one of the strategies for coping with environmental stresses [15]. Kumar-Pal et al. [16] observed that application of B, Se, and Fe, which may be attributed to increased levels of photosynthetic pigments (2013).

In fact, spraying causes the nutrients reach the crop during critical stages of growth, and when the plant needs nutrient more [17]. Oilseed crop such as soybeans are more susceptible to micronutrient deficiency, especially B, Zn and iron in comparison with cereals. However, the effects of foliar applications of Zn and Fe on rice growth could be related to the initial Zn and Fe supply [12,18]. It has recently been reported that the foliar application of Zn-amino acids chelates (ZnAACs) can improve the nutritional quality of wheat and is more effective than $ZnSO_4$ in increasing grain Zn, Fe, and protein concentrations and Zn bioavailability [19]. The Zn concentrations of grain milling fractions are also improved by foliar Zn applications. Additionally, the increase in the Zn concentrations of grain and grain milling fractions due to foliar fertilization is enhanced by increased soil N levels in both fields and green-houses (Cakmak et al., 2010; Kunman et al., 2011) improvements in rice yield after lime or foliar application of Zn or Fe have also been reported [18,20].

Salama et al. [21] reported Zn is a cofactor of carbonic anhydrase that increases the content of CO_2 in the chloroplast, and thus also increases the carboxylation capability of the Rubisco enzyme. Kader et al. [22] reported that Zn has an important role in biological activity, such as enzymatic activity, chlorophyll synthesis and nutrient absorption from root. also, Researchers have shown that Zn and Ca foliar application have a positive effect on crop growth under environmental stress conditions [23]. Brand & Heinickle [24] obtained the $ZnSO_4$ had a positive effect on total carbohydrate content that may be due to its important role in carbohydrate metabolism enzymes. also, Zn is a vital nutrient for the plants and its role as a structural constituent or regulatory co-factor in wide range of different enzymes [1]. This support late season foliar application of macro and micronutrients (N, B and Zn) can enhance concentration of carbohydrates and mineral nutrients reserves [25-30].

Conclusion

The results showed that drought stress reduce soybean yield and yield components, which depends on the severity of the stress. The weather conditions can also be effective. in the year with less rainfall, the effect of drought stress was higher. In these conditions, the nutrient foliar application played a more effective role in preventing the loss of soybean yield. Also, results showed that spray application of nutrients, especially B, improves the yielding traits (number of capsules, number of seed, 100-seed weight, grain yield and biological yield) and protein content of the seed under drought stress conditions in each two years of experiment. But the foliar application of nutrient did not have a significant effect on the seed oil content. Between the genotype examined, DPX genotype showed a significant difference in yield and yield component in compared to Amir genotype in normal and drought.

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