TÜRK
TARIM ve DOĞA BİLİMLERİ
DERGİSİ

TURKISH
JOURNAL of AGRICULTURAL
and NATURAL SCIENCES

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Effects of Humic Acid on The Emergence and Seedling Growth of Safflower Varieties (*Carthamus tinctorius L.*)

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Received: 18.09.2014 Received in Revised Form: 03.02.2015 Accepted: 07.02.2015

Abstract:

This research was conducted to determine the effects of different humic acid doses [control (water), 60, 120 and 180 g 100 kg seed^{-1}] on seedling development and growth of safflower during 2012, under greenhouse conditions at Ankara University, Faculty of Agriculture, Department of Field Crops. The trial was designed in randomized complete block design with split-split blocks using three replications. The seeds of safflower cultivars Dinçer, Yenice, Remzibey were treated with Delta Plus 15 Humic acid® (150 g l^{-1} HA+30 g l^{-1} potassium oxide). The results showed 100% emergence was obtained in all applications. Root length ranged 5.878 – 7.156 cm depending on humic acid doses and maximum root length was obtained on 60 g 100 kg^{-1}seed application to cv. Dinçer. Significant differences among cultivars in terms of seedling length were determined and the maximum height was measured as 10.085 cm from cv. Dinçer. Applied humic acid doses compared to control seedling increased the seedling height and the maximum value was measured on 60 g humic acid. In the fresh weight of seedlings, cv. Dinçer (7.526 g plant^{-1}) and 120 g humic acid doses resulted in best responses. Maximum dry root weights were obtained from cv. Remzibey (3.450 g plant^{-1}) and Yenice (3.425 g plant^{-1}) safflower cultivars with the application of 60 g humic acid. It is concluded that significant differences were determined among cultivars regarding seedling growth and treatment of seeds using 60 - 120 g humic acid 100 kg^{-1}seed before sowing affected seedling growth positively in safflower.

Key words: Safflower,*Carthamus tinctorius* L., Humic Acid, Seedling Growth

Introduction

Safflower including 2 type linoleic (omega-6) and oleic (omega-9, in olive oil quality), containing 30-50% fat with high edible quality, used in biodiesel production, grown at the summer season for average 110-140 days, showing resistance to drought, having pulp for animal feed is an annual and long day oil crop (Babaoğlu, 2007). Safflower is considered having an important potential such as rapeseed in our country in alternative oil crops (Kolsarıcı et al., 2005).

Turkey is considered as one of the gene centers of safflower (Gilbert, 2008). Safflower yield is not high in other countries, and also, according to 2010 data. Safflower yield was 143 kg da^{-1} in Turkey (Anonim, 2013). The most important reason for low seed yield is climate and soil characteristics. In particular, soil organic matter and moisture occurs less in our country and absence of sufficient rainfall and harsh winters negatively affect the growing of safflower.

Besides suitable culture techniques and improving soil organic matter, many chemicals like humic acid are also used to improve efficiency of the soil fertility and thus to increase plant yield (Yetim, 1999). Importance of the humic acid sold in the markets is increasing progressively. Humic acid has positive impacts on plant nutrition and metabolism and is of great importance especially in terms of modern greenhouse production. As importance of organic matter has increased in recent years, many organic substances are marketed by the name of organic fertilizers.

Organic matter problem in modern agriculture is increasing. One of the most economical and fast solutions for solving this problem is the

application of humic acid directly to the soil or plants. Humic acids play an important role in the development of plant directly and indirectly. It has a direct effect on plants by affecting root development and metabolism of plants to absorb nutrients that help plant growth. The positive effects of humic acid on plant growth, stimulation of seed germination and soil fertility are reported. A humic acid remain in the soil for a long time and is decomposed slowly over time. Soil aeration and water retention, growth and development of soil microorganisms provided increase with humic acid application, resistance to plant stress conditions, disease and pest are also increased. Today humic acids are used by many scientists and agricultural engineers in improving soil fertility for healthy plant growth.

İçel (2005) tried different doses of humic acids on safflower. The longest roots (13.55 cm) maximum seedling fresh weight (0.22 g) and root dry weight (0.09 g) were obtained after 120 and 180 g humic acids applied on each of 100 kg seed.

Sözüdoğru et al., (1996) determined that effect of humic acids on dry weight of bean plants had not a significant impact; however, they increased uptake of N, P, Fe, Mn and Zn.

Dursun et al., (1997) studied the effect of humic acids in greenhouse cultivation of tomatoes and eggplant seedlings. For number of leaves, width, stem and root dry wet weight and stem length, the best results were obtained on 50 and 100 ml L^{-1} humic acids application. Peyamlı et al., (1997) treated seeds of corn with 0, 0.5, 1.0, 1.5, 2.0 g kg^{-1}humic acids. Humic acids applied to the soil increased intake of Cl, Na and Fe by plants, but had no significant impact on fresh and dry weight of plant. Akıncı et al. (2009) treated seeds was to determine of the influence of humic acids on broad bean (*Vicia faba* L.) cultivar 'Eresen 87' on root growth and development as well as nutrient uptake, during investigation in a pot experiment. Treatment with leonardite, as humic acids source positively affected both germination and harvesting, enhancing root length and biomass. Humic acids (HA) caused significant increase of fresh (RFW) and dry (RDW) weights by 30.1% and 56.6% of broad bean roots, respectively.

This research was conducted to determine the effects of different humic acids (HA) doses on seedling development of safflower.

Materials and Methods

Cultivars Dinçer, Yenice, Remzibey safflower registered by Eskişehir Anatolian Agricultural Research Institute were used in the study. Delta Agricultural Chemical Industry, Ltd. 'had active ingredient of 150 g L^{-1} humic acids + 30 g L^{-1} of potassium oxide' Delta Plus 15 Commercial View humic acids was used in liquid form. Humic acids 100 kg of seed in doses of 60 g (400 ml), 120 g (800 ml) and 180 g (1200 ml) was prepared. As a control, 2.2 L of water was applied to 100 kg of seed. For this purpose, 60 g of 1.8 L water + 400 ml of humic acids= 2.2 L of humic acids, 120 g of 1.4 L water + 800 ml of humic acids to 2.2 L and 180 g of humic acids = 0.8 L water + 1200 ml humic acids solutions= 2.2 L were prepared. The solution was sprayed onto the seeds with a small hand sprayer. In control applications, the seeds were just sprayed with water. After application of humic acids the seeds were dried for 24 hours at room temperature.

The seeds were sown to 16 cm diameter plastic pots containing, field soil + sand + burned manure (2:1:1). Each pot contained 10 seeds sown 2 cm deep. After emergence of the seeds completed, five plants were selected per pot. During the experiment, all pots were irrigated with sufficient quantity. 10 days after the emergence of the seeds on the soil surface rooted seedlings are removed, the roots were washed carefully with tap water using sieves (Gençtan et al., 1994). Thereafter, seedling length, root length were measured and the seedlings were divided into roots and above-ground parts and they were placed in Petri dishes. Thereafter, fresh weights of the seedlings were determined. The seedlings were dried at 105° C for 3 hours and root seedling dry weight was also determined (Böhm, 1979).

The trial was designed in split plots in randomized block design with 3 replications. Cultivars were sown as main plots, Humic acids applications were placed as sub plots. Analysis of variance of the data was performed using MSTAT-C statistical program and differences between means were determined by LSD test (Düzgüneş et al., 1987).

Results

Cv. Dinçer, Yenice and Remzibey were treated with four levels of humic acids (0, 60, 120 and 180 g). Root length, shoot length, root & shoot fresh weight and root and seedling dry weight were examined. Analysis of variance results are given in Table 1.

As seen in Table 1, in terms of features of seedling and root of cultivars statistical difference was found at 5% level in humic acids doses. LSD test results are given in Table 2.

Table 1. Analysis of variance results pertaining to the effects of different humic acid doses on safflower seedling characteristics.*

Source of variance	DF	*Root length*	*Seedling length*	*Root fresh weight*	*Seedling fresh weight*	*Root dry weight*	*Seedling dry weight*
General	35	34.543	72.767	0.065	0.464	0.970	0.183
Replication	2	0.003	0.152	0.001	0.022	0.016	0.003
Cultivars (A)	2	11.223*	13.844*	0.018	0.100*	0.091*	0.099*
$Error_1$	4	1.673	1.370	0.011	0.039	0.066	0.004
Humic acids (B)	3	8.936*	9.686*	0.009	0.116*	0.096	0.002*
A x B	6	6.813	31.443	0.004	0.077	0.463	0.051
$Error_2$	18	5.894	16.272	0.022	0.111	0.238	0.024

*p<0.05

Humic acids doses had statistically different effect on root length, at 5 % level among cultivars. Dinçer with maximum root length (7.013 cm) and 6.283 cm and 5.646 cm were respectively on cv. Remzibey and Yenice. The maximum root length (7.156 cm) was obtained from 60 g application of humic acids, while the minimum value was noted on control (5.878 cm). Similar to the results of this research, Malik and Azam (1985) reported that application to humic acids to wheat (54 mg l^{-1}) that increased root length.

In terms of seedling length, the varieties and humic acids doses were statistically different at the 5% level. The highest (10,085 cm) seedling length was taken from cv. Remzibey, with 9.718 cm and 8.625 cm on cv. Yenice and Dinçer respectively. At 60 g dose of humic acids and the highest seedling length (10.018 cm) was obtained, 9.963 cm, 9.051 cm, 8.872 cm values were found on the control, 180 g and 120 g of humic acids treatments respectively. The results obtained were similar to Lulakis and Petsas (1995)'s results which humic substances (humic acids, fulvic acids, sodium humate) had a positive effect on tomato seedlings development.

Safflower varieties and humic acids levels were not significant statistically in terms of fresh root weight. Among the varieties, as well as humic acids doses, the highest root weight was achieved 5.189 g and 5.179 g respectively, from cv. Dinçer and 180 g of humic acids treatment.

There were statistically important differences among humic acids doses and the varieties at 5% level in terms of seedling fresh weight. The highest seedling fresh weight values (7.526 g and 7.511 g) were achieved in cv. Dinçer and using dose of 120 g of humic acids treatment while the lowest values (7.400 g and 7.368 g) were observed in cv. Remzibey and control treatment respectively.

There were statistically significant differences among cultivars at 5% level and were different in terms of root dry weights, and the highest values were achieved on cv. Remzibey (3.450 g) on 60 g of humic acids treatment (3.467 g), while the lowest values were 3.333 g on cv. Dinçer and 3.332 g on control applications.

Differences among the varieties and the humic acids doses in terms of seedling dry weight were found at the level of 5%. The highest seedling dry weights (5.303 g $plant^{-1}$ and 5.248 g $plant^{-1}$) were obtained from respectively, cv. Remzibey and 60 g of humic acids application. Cv. Yenice and control application gave minimum values of 5.175 g and 5.231 g respectively.

Conclusion

Safflower is an oilseed crop that grows under arid conditions. Because of that it can be grown in alternative areas, rotated with other crops, importance of this crop should be emphasized or Turkey's vegetable oil and mixed feed industry.

To ensure sufficient emergence after sowing and strong seedling growth after emergence is prerequisite for high seed yield of safflower in Central Anatolian conditions at Ankara; that receive irregular and insufficient precipitation.

Result of this research indicated that seedlings of cv. Dinçer had the best response to humic acids applications compared to other cultivars. Additionally, application of 60 and 120 g per 100 kg seed humic acids dose has positive effects on seedling growth and safflower seed germination when applied before sowing.

Table 2. Effects of various doses of humic acid on seedling characteristics of some safflower cultivars.

	HUMIC ACID DOSES				
	Control	60 g	120 g	180 g	
CULTIVARS		Root length (cm)			Means
Remzibey	6.217	7.567	5.667	5.683	6.283 AB
Yenice	4.967	5.967	6.200	5.450	5.646 B
Dinçer	6.450	7.933	6.233	7.433	7.013 A
Means	5.878 B	7.156 A	6.033 B	6.189 B	
LSD(A): 0.7328		LSD (B): 0.8462		LSD (AxB): 4.165	
		Seedling length (cm)			
Remzibey	9.560	10.917	11.217	8.646	10.085 A
Yenice	9.940	8.007	7.450	9.130	8.625 B
Dinçer	10.390	11.130	7.950	9.403	9.718 A
Means	9.963 A	10.018 A	8.872 B	9.051 B	
LSD(A): 0.6629		LSD (B): 0.7654		LSD (AxB): 6.920	
		Root fresh weight (g/plant)			
Remzibey	5.143	5.153	5.123	5.150	5.142
Yenice	5.133	5.127	5.123	5.177	5.140
Dinçer	5.213	5.173	5.160	5.210	5.189
Means	5.163	5.151	5.136	5.179	
		Seedling fresh weight (g/plant)			
Remzibey	7.262	7.333	7.535	7.468	7.400 B
Yenice	7.368	7.452	7.422	7.520	7.440 AB
Dinçer	7.473	7.543	7.575	7.512	7.526 A
Means	7.368 B	7.443 AB	7.511 A	7.500 A	
LSD(A): 0.1133		LSD (B): 0.1309		LSD (AxB): 0.5715	
		Root dry weight (g/plant)			
Remzibey	3.300	3.367	3.633	3.500	3.450 A
Yenice	3.533	3.533	3.300	3.333	3.425 A
Dinçer	3.133	3.500	3.300	3.400	3.333 B
Means	3.322	3.467	3.411	3.411	
LSD(A): 0.03884		LSD (B): 0.04139		LSD (AxB): 0.8369	
		Seedling dry weight (g/plant)			
Remzibey	5.323	5.267	5.303	5.320	5.303 A
Yenice	5.217	5.187	5.157	5.140	5.175 C
Dinçer	5.153	5.290	5.280	5.267	5.248 B
Means	5.231 B	5.248 A	5.247 A	5.242 A	
LSD(A): 0.0358		LSD (B): 0.04139		LSD (AxB): 0.2657	

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