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Effects of Water Stress and Application of Bio-fertilizer Phosphorus on Agronomic Traits of Safflower Varieties *(Carthamus tinctrius L)*

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ABSTRACT

Crop plants are usually affected by environmental stresses. Among different possible stresses, irrigation and available nitrogen supply are two of most important stresses for the plants. Surveys of the effects of draught and phosphorous bio-fertilizer on yield and element of yield of safflower were conducted through a farm test in form of split plot and in block frame. The experiment was conducted randomly with four replications in 2012. The surveys were on three levels of draught stresses (control, no irrigation during stem development, and no irrigation during flowering) and four level of phosphorous bio-fertilizer (control, Phosphor 25%, Phosphor 50%, Bio-Phosphate). The traits under consideration were yield, weight 1000 grains, total number of seeds in tray, total number of heads, and length of plant. The results showed significant differences of traits between draught stress samples and nitrogen bio-fertilizer stress samples. However, no significant difference was found regarding reciprocal effects. Results concerning agricultural traits showed that no irrigation after stem development negatively affected the sample. The best grain yield was obtained for ordinary irrigation sample (control group) and phosphorous bio-fertilizer of 25% and 50% with yield of 4949 and 5029kg/ha.

Keywords: safflower, draught stress, phosphorous, yield, agricultural traits

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INTRODUCTION

Safflower (*Carthamus tinctrius L*), Compositae family, is mainly used as oil gains in Iran. Following recent researches on nutrition value of the grains, the species is one of the promising options for development of oil grain. Deep roots, Waxy leaves, grains with thick crust make the safflower an ideal option for arid regions. (Carvalho et al; 2006) With 600000MT production of oil grains (Anonymous, 2007), Iran supplies major portion of its needs for edible oil from other countries. Safflower is resistive to draught and salt stresses and can be cultivated in lands susceptible to abiotic stresses (Bassiland Kaffka, 2002; Esendel 1992, Napy et al 2004). In addition, spring and fall types make safflower suitable choice for production of edible oil (Pasban Eslam 2001). For sake of shorter period of cultivation, sprig type is preferred to fall type. (KaffkaKearney, 1998)

As resistive species to low winter and spring precipitation and draught during flowering and grain formation, deep roots and ability to soak water from lower layers, safflower is cultivated as a source of oil grain in arid regions. Moreover, previous researches showed that number of heads and weight of 1000 grains are more important factors on yield of spring cultivars of safflower. (Koutroubas et a., 2004)

Sing et al. (1995) studied effect of irrigation and phosphor fertilizer on safflower yield and reported maximum yield of 1520kg/ha for irrigation in rosette and gain formation stages treatments. Further experiments showed that maximum yield of water consumption (WUE) was 4.37kg/m3.

Marita & Muldoon (1995) and Patel (1993) reported that different irrigation regimes during stem development, flowering and grain formation resulted in considerable increase in grain yield. Moreover, they found that flowering and grain formation are the most important stages. In addition, maximum yield was obtained for 1 turn watering during flowering.

MATERIAL AND METHODS

The experiment was conducted in research farm, Islamic Azad University, Ghale Sien Village, Pishva, Varamin, at longitude 51º,31' east, latitude 35º,20', and 1050m height from sea level with an area of 1280m2. The experiment was conducted through split plot in block frame selected randomly for 4 replications. The safflower cultivar was Isfehani. The main factor under consideration was draught stress at three levels (control, no irrigation during stem development, no irrigation during germination) and secondary factor was amount of phosphorus bio-fertilizer at four levels (control, 50% phosphor, 25% phosphor, and bio-super phosphor). Each experiment unit (block) constituted 5 stacks each for 7m; the stacks were prepared at 60cm interval; and seeds were planted at 20cm intervals. Samples were planted in 19 May 2012 – 3 seeds aggregated in depth 3-5cm. Samples were watered at 7 days periods until inducing stress.

RESULTS AND DISCUSSION

Grain yield

Table (2) represents results of variance analysis regarding grain yield. Draught stress treatments show significant difference (1% level) on grain yield. Table 2 represent comparison of grain yields for different draught stress treatments.

Duncan's Multiple Range test showed significant differences between draught stress treatments. Based on table 3, maximum yield was obtained from control group and no irrigation after stem development with 4214 and 3862 kg/ha respectively. Minimum yield was obtained from flowering stress treatment (3077kg/ha). (Table 3)

Phosphorous bio-fertilizer treatment showed significant effect of stress (1% level) on grain performance (table 2). Comparison between average yields obtained for different level of phosphorous bio-fertilizer (table 3) showed that 25% phosphorous bio-fertilizer treatment and mere bio-super-phosphate had maximum grain yield.

Retrospective result concerning irrigation and phosphorous fertilizer was not significant (table 2). In spite of insignificant retrospective effect, maximum yield was obtained from control and phosphorous bio-fertilizer treatments. In a survey on effect of phosphate soil, tio-bacillus bacteria and microorganisms capable of solving phosphate on qualitative and quantitative yield of maize, Koliai (2012) reported significant increase in yield in comparison with control group after using super-phosphate triple.

Weight of 1000 grains

In general, weight of 1000 grain is an element of yield which is affected by environmental and genetic factors. Except for causes subject to shortage or late plantation or when majority of yield is a factor of vegetable growth (resulted in small grains), there is an insignificant relation between the yield and weight of 1000 grains. (Koliai, 2012)

Table 1 tabulates results of variance analyses on weight of 1000 grains. According to the results, there is a significant difference between changes of weight of 1000 grains among draught stress treatment and phosphorous bio-fertilizer at 1%, while reciprocal effect of the treatment is insignificant.

According to table 3, maximum weight of 1000 grains (42.72gr) was obtained for control group and the minimum figure was for no irrigation during flowering (30.71gr). Moreover, regarding phosphorous bio-fertilizer treatments maximum yield was for 25% phosphorous bio-fertilizers with 43.27gr. About reciprocal effect of nitrogen bio-fertilizer we also found that maximum weight of 1000 grain was for control group with 25% phosphorous fertilizer and mere bio-super-phosphate with 46.83gr and 46.80gr respectively. The results are consistent with Koliai et al. (2012).

Table 1: soil properties

Soil samples were collected from 30cm depth and different parts of the farm

B p.p.m	Mn p.p.m	Cu p.p.m	Zn p.p.m	Fe p.p.m	Sand %	Silt %	Clay %	K p.p.m	P p.p.m	N %	OC %	TNV %	PH	EC ds/m	Type of experiment
2	10	2	3	12	40-50	30-40	20-30	350	15	>0/2	>1.5	<`10	6.5-7.5	2>	**Standard**
0.576	11.58	1.22	1.2	6.28	16	54	30	469.8	10.6	0.08	0.88	16.91	8.11	4.01	**Results**

Table 1: mean square variance analyses for some of agricultural traits

Source of changes SOV	df	Grain yield	Weight of 1000 grains	Number of head	Total number of grain in head	Height
Replication	3	19891.866 ^{ns}	27.189 ^{ns}	1.722 ^{ns}	754.410 ^{ns}	64.087 ^{ns}
Drought stress (factor A)	2	5422651.521 **	144.563 **	7.646 *	4071.698 ^{ns}	60.863 ^{ns}
error A	6	448779.153	10.809	0.951	1448.368	95.554
Phosphor bio-fertilizer (factor B)	3	4845548.491 **	97.784 **	6.333 **	4198.910 *	29.584 ^{ns}
AB (Drought stress * bio-fertilizer)	6	487595.135 ^{ns}	18.844 ^{ns}	0.813 ^{ns}	282.618 ^{ns}	18.400 ^{ns}
Experiment error	27	474870.252	12.404	1.319	1137.879	31.977
CV%	-	15.54	8.84	10.88	15.18	12.60

*ns , *, **: insignificant, significant at 5% and 1% respectively*.

Table 2: comparison of mean main and secondary effects level (Duncan's method)

Treatment	Grain yield	Weight of 1000 grains	Number of head	Total number of grain in head	Height
S_1	4214 a	42.72 a	6.813 a	196.7 a	46.02 a
S_2	3862 a	40.04 a	6.00 ab	192.6 a	44.01 a
S_3	3077 b	36.72 b	5.438 b	167.3 a	42.46 a
P_1	3006 b	36.78 c	5.500 b	163/3 b	42.58 a
P_2	3410 b	38.35 bc	6.333 ab	178 ab	45.63 a
P_3	4441 a	43.27 a	7.000 a	205.8 a	46.03 a
P_4	4012 a	40.91 ab	5.500 b	194.9 a	45.33 a

S1, S2, S3: control, no irrigation during stem development, and flowering respectively

P1, P2, P3, P4: Phosphor bio-fertilizer, no fertilizer (use of Phosphor based on soil tests results), bio-fertilizer + 50% Phosphor recommended, bio-fertilizer + 25% Phosphor recommended, only bio-fertilizer (Phosphor + bio super phosphor)

Number of heads

According to variance analyses on number of heads (table 2) it is clear that there is a significant relation between draught stress and phosphorus bio-fertilizer treatments at 1% and 5% levels. However, no significant relation was found between reciprocal effects of bio-fertilizer and the stresses. Based on table 3, maximum number of head was observed for control group (no stress) with 6.813 heads and for bio-fertilizer 25% with 7 heads. Regarding reciprocal effect of draught stress and bio-fertilizer, no significant relation was found and maximum number of head was found for control group with 25% phosphorous bio-fertilizer.

Total number of grain in heads

Variance analyses on total number of grains in heads (table 2) showed a significant relation between draught stress and phosphorous bio-fertilizer treatment at 5% level. However, no significant relation was found between reciprocal effect of the stress and bio-fertilizer. Results of comparison on average simple effect (table 3) showed that maximum number of grains in heads was found in control group with total number of 196.7 grain per head and this figure for bio-fertilizer treatments 25% and mere bio-phosphate was 205.8 and 194.9.

Regarding reciprocal effect of draught stress and bio-fertilizer, no significant was found. However, comparisons on mean points of reciprocal effects showed that maximum number of heads was for control groups 25% fertilizer supply and mere bio-phosphate fertilizer and for draught stress at flowering treatment with 25% fertilizer supply as well.

Height of samples

There was no significant difference between simple and reciprocal relations of draught stress and phosphorous bio-fertilizer treatment. However, maximum height of sample was observed for control group (46.02cm) and minimum height was 42.46cm for no irrigation during stem development. The results are consistent with Koliai, et al (2012).
As presented in table 3, mean point comparison demonstrate that maximum height was observed in samples received 25% phosphorous bio-fertilizer (46.03%).

Regarding reciprocal effect, increase in phosphorous bio-fertilizer and no stress resulted in increase in height of the samples. Maximum height of 46cm was observed for samples supplied with 25% phosphorous bio-fertilizer per hectare. The results are consistent with Koliai, et al (2012).

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