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Effects of inoculation with azospirillum and phosphorus fertilizer on number of seeds per head, dry weight and thousand grain weight of safflower in Lavaryab region in Iran

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Abstract

Safflower is an oilseed crop native to Iran. There are various kinds of its wild types throughout Iran proving its well adaptability to the climatic conditions of this country. It is characterized by its relative tolerance to soil salinity and drought as well as its high-quality oil content. Phosphorus is a major component in ATP, the molecule that provides "energy" to that plant for such processes as photosynthesis, protein synthesis, nutrient translocation, nutrient uptake and respiration. Azotobacter and azospirillum are free-living N2- fixing bacteria that in the rhizospheric zone have the ability to synthesize and secret some biologically active substances that enhance root growth. The experiment was conducted at the lavaryab zahedan (in iran) which is situated between 29° North latitude and 60° East longitude and at an altitude of 1391m above Mean Sea Level. The field experiment was laid out in randomized complete block design with factorial design with three replications. Analysis of variance showed that the effect of azospirllum on number of seeds per head, dry weight and thousand grain weight was significant.

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Introduction

The oil derived from safflower and sunflower represents a share of 0.07% and 7.3% of the annual global production, respectively, while corresponding figures for Europe are 0 and 75% (FAO 2007a, b). As possibilities to expand planted acreage are limited on a global scale, appropriate production intensities are required to meet the increasing global demand for vegetable oil. In developing countries, where the proportion of less fertile soils is particularly high, it may be difficult to fulfill the nutritional requirements of high-yielding crops (Sauerbeck and Helal 1990,; Marschner 1995). Safflower is an oilseed crop native to Iran. There are various kinds of its wild types throughout Iran proving its well adaptability to the climatic conditions of this country. It is characterized by its relative tolerance to soil salinity and drought as well as its high-quality oil content (Ahmadi and Omidi, 1996,; Jahanbakhsh Godakahriz *et al.*, 2012). Given that it is a plant native to Iran, safflower possesses invaluable characteristics such as adaptability to arid and semi-arid climate, high quality of oil, and resistance to abiotic stresses particularly drought stress (Weiss, 2000). It has strong, outspread root system allowing it to uptake moisture and nutrients from relatively high depths of soil. Therefore, safflower is regarded as a low-expected, drought resistant crop (Abdollahi and Zarrinjoub, 2001). Safflower (*Carthamus tinctorius*) is cultivated for a long time in many countries as a consistent and useful herb with multiple applications. Today, the importance of the unsaturated fatty acids is highly regarded in the nutritional quality of their oil, with over 80% unsaturated fatty acid (Zhu *et al.*, 2003; Isah *et al.*, 2007; Sato *et al.*, 2005). Safflower is native to Iran; it adapts to the hot and dry regions and has resistance against low water stress, salinity and heat (Dajo and Mondel, 1996). The crop is known as a medicinal plant in traditional medicine to treat heart disease, arthritis and diabetes (Ibrahim *et al.*, 2005,; Zhu *et al.*, 2003 ;). Nitrogen and phosphorus fertilizer is a major essential plant nutrient and key input for in increasing crop yield (Dastan *et al*, 2012- Alinajoati sisie & Mirshekari, 2011-Alam *et al*, 2009). Phosphorus deficit is a most important restrictive factor in plant growth and recognition of mechanisms that increase plant phosphorus use efficiency is important (Alinajoati sisie & Mirshekari, 2011). Phosphorus is a major component in ATP, the molecule that provides "energy" to that plant for such processes as photosynthesis, protein synthesis, nutrient translocation, nutrient uptake and respiration. Phosphorus is also a component of other compounds necessary for protein synthesis and transfer of genetic material DNA, RNA (Wilson *et al.*, 2006). Phosphorus application to rice increased P accumulation but did not consistently increase rice yields because flooding decreased soil P sorption and increased P diffusion. Resulting in higher P supply to rice relative to wheat (Delong *et al*, 2002). Phosphorus (P) is among the most needed elements for crop production in most tropical soils, which tend to be P deficient (Adetunji, 1995). The deficiency can be acute in some soils of the Savanna zone of Western Africa to the extent that plant growth ceases as soon as the P stored in the seed is exhausted (Mokwunye *et al.*, 1986). Applying of organic manures and biofertilizers such as cattle manure and nitrogen fixing bacteria has led to a decrease in the use of chemical fertilizers and has provided high quality products free of harmful agrochemicals for human safety (Salem and Awad, 2005; Mahfouz and Sharaf Eldin, 2007). Chemical fertilizers have contributed significantly toward the pollution of water, air and soil. So the current trend is to explore the possibility of supplementing chemical fertilizers with organic ones that are eco-friendly and cost-effective. The use of biological nitrogen fixation by living nitrogen fixers will help minimize use of chemical nitrogen fertilizer and to improve plant growth to decrease the production cost and environmental risk (El-Hawary *et al.*, 2002). Azotobacter and Azospirillum are free-living N2- fixing bacteria that in the rhizospheric zone have the ability to synthesize and secret some biologically active substances that enhance root growth (Chen, 2006). Inoculation of seeds with Azotobacter and Azospirillum promoted the growth and increased the sepal yield of rosette plants compared to the chemical fertilization alone and decreased the production cost and obtaining high quality products (Abobaker and Mostafa, 2011). A positive effect of Azotobacter on yield and yield components has been reported in Apium graveolense (Migahed *et al.*, 2004). Motivation and aims of the study were effects of inoculation with azospirillum and phosphorus fertilizer on number of seeds per head, dry weight and thousand grain weight of safflower in lavaryab region.

Material and methods

Location of experiment

The experiment was conducted at the lavaryab zahedan (in iran) which is situated between 29° North latitude and 60° East longitude and at an altitude of 1391m above Mean Sea Level. The average annual rainfall is 55 mm and the annual evaporation rate of 4500 to 5000.

Composite soil sampling

The soil of the experimental site belonging clay loam. Composite soil sampling was made in the experimental area before the imposition of treatments and was analyzed for physical and chemical characteristics.

Field experiment

The field experiment was laid out in randomized complete block design with factorial design with three replications.

Treatments

Treatments consisted of Azospirllum in 2 levels: no inoculation (A1), inoculation with azospirllum and azotobacter (A2) and phosphorus fertilizer in 4 levels: no phosphorus (P1), 100kg/ha (p2), 150kg/ha (p3), 200kg/ha (p4).

Data collect

Data collected were subjected to statistical analysis by using a computer program MSTATC. Least Significant Difference test (LSD) at 5 % probability level was applied to compare the differences among treatments` means.

Results and discussion

Thousand grain weight

Analysis of variance showed that the effect of azospirllum on thousand grain weight was significant (Table 2). The maximum thousand grain weight (37.79) of treatments inoculation of azospirllum was obtained (Table 3).

Table 1. Soil characteristics of the experiment during 2011 area growing season.

Year	Depth of soil (cm)	pH	Ec(ds /m)	N (%)	Ca(ppm)	K(ppm)	Sand	Silt	Clay
2012	0-30	7.98	6.5	0.036	11.4	97.36	74	4	22

Table 2. Analysis of variance for safflower affected by azospirllum and phosphorus fertilizer.

		MS		
S.O.V	df	Thousand grain weight	Plant dry weight	Number of seeds per head
R	2	2.37^{ns}	0.9^{ns}	0.875^{ns}
Azospirllum (A)	1	37.5^{**}	2047.3^{**}	651.04^{**}
phosphorus fertilizer (P)	3	60.27^{**}	1079.3^{*}	86.37^{**}
A*P	3	10.77^{**}	265.7^{**}	70.37^{**}
Error	14	1.37	1.24	0.97
C.V	-	14	28	25

*, **, ns: significant at p<0.05 and p<0.01 and non-significant, respectively.

C.V: Coefficient of Variation.

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The minimum thousand grain weight (35) of treatments no inoculation was obtained (Table 3). Analysis of variance showed that the effect of phosphorus fertilizer on thousand grain weight was significant (Table 2). The maximum thousand grain weight (38.83) of treatments p4 was obtained (Table 3). The minimum thousand grain weight (22) of treatments p1was obtained (Table 3). Analysis of variance showed that the Interaction of A*P was significant (Table 2). The maximum thousand grain weight (42) of treatments A2p4 was obtained (Table 3). The minimum thousand grain weight (31.66) of treatments A1p1was obtained (Table 3).

Table 3. Means comparison of safflower affected by azospirllum and phosphorus fertilizer.

Treatment	Thousand grain weight	Plant dry weight	Number of seeds per head
A1	35b	87.5b	34.91b
A2	37.79a	106a	45.33a
P1	22c	58.9d	28c
P2	35.66c	108.6a	44.66a
P3	38.8a	94.1c	36.16b
P4	38.83a	105.3b	41.66b
A1p1	31.66d	64.11c	33.33d
A1p2	35.33c	108.77ab	35d
A1p3	37.33b	84.88b	31e
A1p4	35.66bc	92.3b	40.33c
A2p1	32.33d	93.7b	42.66b
A2p2	36bc	108.5ab	54.33a
A2p3	40.8a	103.3ab	41.33bc
A2p4	42a	118.3a	43b

Any two means not sharing a common letter differ significantly from each other at 5% probability A1: no inoculation, A2: inoculation of azospirllum, P1: no phosphorus, P2: 100kg/ha phosphorus, P3: 150kg/ha phosphorus, A4: 200kg/ha phosphorus.

Plant dry weight

Analysis of variance showed that the effect of azospirllum on plant dry weight was significant (Table 2). The maximum plant dry weight (106) of treatments inoculation of azospirllum was obtained (Table 3). The minimum plant dry weight (87.5) of treatments no inoculation was obtained (Table 3). Analysis of variance showed that the effect of phosphorus fertilizer on plant dry weight was significant (Table 2). The maximum plant dry weight (108.6) of treatments p2 was obtained (Table 3). The minimum plant dry weight (22) of treatments p1was obtained (Table 3). Analysis of variance showed that the Interaction of A*P was significant (Table 2). The maximum plant dry weight (118.3) of treatments A2p4 was obtained (Table 3). The minimum plant dry weight (64.11) of treatments A1p1was obtained (Table 3).

Number of seeds per head

Analysis of variance showed that the effect of azospirllum on number of seeds per head was significant (Table 2). The maximum number of seeds per head (45.33) of treatments inoculation of azospirllum was obtained (Table 3). The minimum number of seeds per head (34.91) of treatments no inoculation was obtained (Table 3). Analysis of variance showed that the effect of phosphorus fertilizer on number of seeds per head was significant (Table 2). The maximum number of seeds per head (44.66) of treatments p2 was obtained (Table 3). The minimum number of seeds per head (28) of treatments p1was obtained (Table 3). Analysis of variance showed that the Interaction of A*P was significant (Table 2). The maximum number of seeds per head (54.33) of treatments A2p2 was obtained (Table 3). The minimum number of seeds per head (31) of treatments A1p3was obtained (Table 3).

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