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Effects of inoculation with azospirillum on some characteristics of safflower

Mohsen Heidari*, **Hamid Reza Ganjali, Atefeh Shahri**

Department of Agronomy, Zahedan Branch, Islamic Azad University, Zahedan, Iran

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Abstract

Bio fertilizer based on microbial application is an effort to minimize dependency on chemical fertilizer purposes. The use of microbial simbiont within the plants intended to trim down chemical fertilizers supply even the possible' dose can be reduced to zero. Safflower (*Carthamus tinctorius*) is an herbaceous annual broad-leaved plant and a member of the asteraceae family. It is native to parts of Asia, the Middle East and Africa. It was grown mainly for its flowers, which were used in making dyes for clothing and food, but today, it is grown mainly for its oil. It grows well in both dry land and irrigated areas and is a drought-tolerant plant. The experiment was conducted at the lavaryab zahedan (in iran). 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 and phosphorus fertilizer on oil yield, Percent of oil, biological yield and grain yield was significant.

* **Corresponding Author:** Mohsen Heidari ✉ m.heidari22110@gmail.com

Introduction

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 (Marscher, 1990; Saurbeck, 1990) Fertilizer application represents an important measure to correct nutrient deficiencies and to replace elements removed in the products harvested, and N fertilisation has been shown to be particularly effective with respect to yield formation (Connar, 1991). The results of different studies represent the importance of chemical fertilizer's consumption in the safflower. Hence, it is very important to use the accurate amount of fertilizers to compensate the deficiency of nutrients removed by the previous products in order to prepare sufficient and necessary nutrients demand of new plants to meet acceptable harvest. In addition, the following studies represent the importance of nitrogen fertilization (Connar, 1992). Cassato *et al*., 1997 and Corleto, 2006 reported that the number of capitols per plant is one of the important yield components which generally showed the positive and significant relationship with seed yield. Tuncturk and Yildirim 2004 and Ahmadzadeh *et al*., 2008 reported that safflower's plant height had significant correlations with seed yield and number of seeds per a capitol. They concluded that increase of seed yield would immensely be efficient via plant height and 100-seed weight. Bio fertilizer based on microbial application is an effort to minimize dependency on chemical fertilizer purposes. The use of microbial simbiont within the plants intended to trim down chemical fertilizers supply even the possible' dose can be reduced to zero. Through microbial enzymatic processes, organic substance could be mineralized and turn into inorganic substances to provide phosphate, nitrogen, potassium and other nutrient that can be absorbed by maize. Transformation processes of macro and micro elements can occur from soil to plants when it was determined by the existence of phosphate solubilizing bacteria and nitrogen-fixing bacteria as well as root exudates supporting which are lead the way to symbiotic progression (Bais *et al*., 2006) Safflower (*Carthamus tinctorius* L.) is an herbaceous annual broad-leaved plant and a member of the Asteraceae family. It is native to parts of Asia, the Middle East and Africa. It was grown mainly for its flowers, which were used in making dyes for clothing and food, but today, it is grown mainly for its oil. It grows well in both dry land and irrigated areas and is a drought-tolerant plant (Armah *et al*., 2002). The importance of safflower as oilseed crop has increased in recent years, especially with the increasing interest in the production of biofuels (Doordas, 2008). Nutrient management is one of the critical inputs in achieving high productivity of safflower (Moudel *et al*., 2004). One of the most important methods for increasing agricultural production in crop management practices is to increase the efficiency of fertilizer dose. With this aim in view, optimum fertilizer application ratios, fertilizer content, nutritional requirements of the plant during the growth season, and the amounts of nutrients present in the soil should be ascertained (Alivelu *et al*., 2006; Dong *et al*., 2005). Safflower (*Carthamus tinctorius* L.) is an annual plant, which is classified as Composite. It is one of the most important oil seed crops because the seeds contain 25 - 40 percent high quality oil (rich in Oleic and Linoleic acids). Safflower's dried petals are used to produce oily paints for Fabric painting and manufacturing medicine due to major component and properties of petals (Caravalho *et al*., 2006; Nabipour *et al*., 2007). Generally, the oil derived from safflower possesses 0.07 percent of the annual global production (FAO, 2007). Worldwide, the planted area and yield of safflower are 611436 hectare and 615214 ton, respectively. While the area allocated to plant this product and the yield are 10000 ha and 500 tons, respectively (FAO, 2010). Beneficial rhizobacteria have tremendous potential to facilitate plant growth and productivity, in a number of ways. Another remarkable eminence on the credit of these marvelous creatures is their capability to support plants under stressed environments. When established in soils exposed to abiotic stresses, the populations of rhizobacteria become adapted to such stressed conditions thereby developing tolerance and further they can be isolated to be used as inoculum to support crops grown in correspondingly stressed environments (Khan *et al.*, 2012; Sandhya *et al.*, 2010). They can protect plants against deleterious effects of different environmental stresses to which crop plants are intermittently exposed, like heavy metals, flooding, salt and drought (Mayak *et al.*, 2004). Among such abiotic stresses, drought is becoming more prevalent especially in arid and semi-arid regions of the world, where it sternly influences the crop yields (Hamayken *et al.*, 2010). A number of different bacteria promote plant growth, including Azotobacter sp, Azospirillum sp, Pseudomonas sp, Bacillus sp and Acetobacter sp (turan *et al.*, 2006). PGPR are a group of growth promoting bacteria that actively colonize plant root and increase plant yield and growth by production of phytohormones, asymbiotic N2 fixation, fight against phytopathogenic microorganisms by production of siderophores, synthesis of antibiotics, enzymes and fungicidal compounds and also solubilization of mineral phosphates and other nutrients (Golami *et al.*, 2006). Behl *et al.*, 2003 indicated that Azotobacter and Micorhiza increased seed yield, seed number, 1000 seed weight and biological yield of wheat. Zahir *et al.*, 1998 reported 19.8% increase in seed yield of maize due to dual inoculation of seeds with Azotobacter and Pseudomonas. Titlak *et al.*, 1982 reported improving seed yield due to dual inoculation of Azotobacter and Azospirillum. Bio fertilizer, Phosphate Barvar-2 contains a group of phosphate solubilizing bacteria like Pseudomonas and Bacillus which can produce different organic and mineral acids like 2-Ketogluconic, citric, oxalic, Salic, succinic acids and they also secret phosphatase enzyme. Alkan bio fertilizer is amixture of compost and sterile manure in powder form and contains sulfur microelements and Thiobacillus. Its formulation consist of 70% organic matter with PH=6.5. This bio fertilizer contains other microelements like Fe, Cu, Mn and Zn (Ahmad *et al.*, 2006). The aims of the study were effects of inoculation with azospirillum on some characteristics of safflower.

Materials and methods

Location of experiment

The experiment was conducted at the lawaryab zahedan (in iran) which is situated between 29° North latitude and 60° East longitude and at an altitude of 1391m above Mean Sea Level.

Annual rainfall

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

Oil yield

Analysis of variance showed that the effect of azospirllum on oil yield was significant (Table 2). The maximum oil yield (483.6) of treatments inoculation of azospirllum was obtained (Table 3). The minimum oil yield (322.2) of treatments no inoculation was obtained (Table 3). Analysis of variance showed that the effect of phosphorus fertilizer on oil yield was significant (Table 2). The maximum oil yield (433.5) of treatments p2 was obtained (Table 3). The minimum oil yield (328) of treatments p1was obtained (Table 3). Analysis of variance showed that the Interaction of A*P was significant (Table 2). The maximum oil yield (732.2) of treatments A2p4 was obtained (Table 3). The minimum oil yield (403.8) of treatments A1p1was 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

Percent of oil

Analysis of variance showed that the effect of azospirllum on percent of oil was significant (Table 2). The maximum percent of oil (22.02) of treatments inoculation of azospirllum was obtained (Table 3). The minimum percent of oil (18.58) of treatments no inoculation was obtained (Table 3). Analysis of variance showed that the effect of phosphorus fertilizer on percent of oil was significant (Table 2). The maximum percent of oil (21.65) of treatments p2 was obtained (Table 3). The minimum percent of oil (19.15) of treatments p3was obtained (Table 3). Analysis of variance showed that the Interaction of A*P was significant (Table 2). The maximum percent of oil (34.5) of treatments A2p4 was obtained (Table 3). The minimum percent of oil (26.54) of treatments A1p3was obtained (Table 3).

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

MS					
S.O.V	df	Oil yield	Percent of oil	Biological yield	Grain yield
R	2	557.9^{ns}	0.01^{ns}	27150^{ns}	13229.2^{*}
Azospirllum (A)	1	155650^{**}	71.1^{**}	10480000^{**}	1139704^{**}
phosphorus fertilizer (P)	3	15086.9^{**}	7.46^{**}	4365038^{**}	408648^{**}
A*P	3	24348.4^{**}	23.03^{**}	256816^{**}	162748^{**}
Error	14	15.4	0.049	11054.7	2295
C.V	-	17	7	30	26

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

C.V: Coefficient of Variation.

Biological yield

Analysis of variance showed that the effect of azospirllum on biological yield was significant (Table 2). The maximum biological yield (7643) of treatments inoculation of azospirllum was obtained (Table 3). The minimum oil yield (5317) of treatments no inoculation was obtained (Table 3). Analysis of variance showed that the effect of phosphorus fertilizer on biological yield was significant (Table 2). The maximum biological yield (7833) of treatments p4 was obtained (Table 3). The minimum biological yield (4843) of treatments p1was obtained (Table 3). Analysis of variance showed that the Interaction of A*P was significant (Table 2). The maximum biological yield (8700) of treatments A2p4 was obtained (Table 3). The minimum biological yield (4467) of treatments A1p1was obtained (Table 3).

Grain yield

Analysis of variance showed that the effect of azospirllum on grain yield was significant (Table 2). The maximum grain yield (2281) of treatments inoculation of azospirllum was obtained (Table 3). The minimum grain yield (1745) of treatments no inoculation was obtained (Table 3). Analysis of variance showed that the effect of phosphorus fertilizer on grain yield was significant (Table 2). The maximum grain yield (2145) of treatments p4 was obtained (Table 3). The minimum grain yield (1386.7) of treatments p1was obtained (Table 3). Analysis of variance showed that the Interaction of A*P was significant (Table 2). The maximum grain yield (2450) of treatments A2p3 was obtained (Table 3). The minimum grain yield (1240) of treatments A1p1was obtained (Table 3).

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

Treatment	Oil yield (kg/ha)	Percent of oil (%)	Biological yield (kg/ha)	Grain yield (kg/ha)
A1	322.2b	18.58b	5317b	1745b
A2	483.6a	22.02a	7643a	2281a
P1	328b	20.73b	4843c	1386.7c
P2	433.5a	21.65a	6866b	1986b
P3	412.8ab	19.15d	7366b	2133a
P4	432.3a	19.67c	7833a	2145a
A1p1	403.8c	32.94bc	4467d	1240f
A1p2	507.6b	28.75e	6200c	1873c
A1p3	450.08bc	26.54g	6633b	1817cd
A1p4	450.4bc	27.09f	6972b	1750d
A2p1	477.46b	29.52d	6220c	1530e
A2p2	650.36a	34.5a	7533ab	2100b
A2p3	698.5a	31.76b	8100a	2450a
A2p4	732.2a	32.26b	8700a	2440a

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.

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