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Effects of Biofertilizer Application on Phenology and Growth of Sunflower (*Helianthus annuus* L.) Cultivars

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ABSTRACT

In order to evaluate the effects of a biofertilizer containing *Azospirillum* and *Azotobacter* inoculants on phenology and growth of sunflower cultivars in the region of Sanandaj in Kurdistan province (west of Iran) an experiment was conducted using a split-plot layout with randomized complete block design in three replications. Two levels of application and non-application of biofertilizer were compared in main plots. Four cultivars (Azargol, Euroflor, Lacomka & Feverit) were applied as sub-plots. The results indicated that inoculants application significantly affected growth stage intervals. Number of days to star shape stage, vegetative stage duration, number of days to flowering end, reproductive stage duration, grain filling duration and the total duration of plant growth were significantly increased by using biolfertilizer as compared with non-application of biofertilizer. There were significant differences between cultivars with respect to duration of growth stages. Growth stage intervals of Azargol hybrid were longer than which in other cultivars and the shortest period of growth stages was recorded by Lacomka cultivar. Morphological traits such as plant height, head weight, stem diameter, stem weight, hollow diameter and head diameter were not affected by biofertilizer and cultivar. However the crop growth was promoted as the result of biofertilizer application.
KEY WORDS: *Azospirillum. Azotobacter*. Biofertilizer. Sunflower.

INTRODUCTION

Considering the environmental and health problems arising from chemical fertilizers usage, many attention has been drawn to the application of biological fertilizers in agriculture. Biological fertilizers or biofertilizers contain useful microorganisms which could colonize the rhizosphere and promote plant growth through increasing the supply or availability of essential nutrients to the plants [1]. A wide range of bacteria such as *Rhizobium, Azospirillum*, *Azotobacter, Pseudomonas, Bacillus*, and *Enterobacter* have been used as biofertilizer because of their positive effects on growth and productivity of plants via several mechanisms including plant hormones production, N_2 fixation, antagonism against phytopathogenic microorganisms and solubilization of nutrients [2-10].

Sunflower (*Helianthus annuus* L.) is one of the most important oilseed crops containing high quality edible oil. It is easy cultivated and grown in different conditions and soils [11,12]. Sunflower oil has excellent nutritional properties and has a relatively high concentration of linoleic acid [13]. In Iran sunflower is also one of the main crops producing the oil requirements of the country. It has an important position in crop rotation system of many Iranian farmlands so achieving a sustainable system for sunflower cultivation would be of great value in agricultural management in the region. Therefore this study was designed to evaluate the influence of a biofertilizer containing *Azospirillum* and *Azotobacter* inoculants on growth and phenology of sunflower cultivars in the region of Sanandaj, west of Iran.

MATERIALS AND METHODS

This experiment was conducted at the research farm of agriculture faculty, Islamic Azad University, Sanandaj Branch in the growing season of 2008-2009. The experimental site is located at latitude of 35˚ 10′ N and longitude of 46˚ 59′ E with an altitude of 1393 m above sea level. The long-term values of mean temperature and annual rainfall in this location are 13.35 ˚C and 471 mm respectively. Soil texture of experimental site was clay loam and the electrical conductivity and pH were 0.6 dS/m and 7.7 respectively. The experiment was laid out in a split-plot arrangement with randomized complete block design in three replications. Main plots were two levels of application and non-application of biofertilizer (*Azospirillum+Azotobacter*). Subplots were four cultivars of Azargol, Euroflor, Lacomka and Feverit. Each sub-plot was 5 m long and consisted of 4 rows, 50 cm apart with intrarow spacings of 25 cm to achieve the plant density of 8 plants/m^2. The inoculation of sunflower

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seeds was carried out by mixing the seeds with 20% sugar solution and liquid form of biofertilizer (at the recommended rate) under shed to avoid deleterious effects of sunshine on bacterial inoculant. After drying the inoculated seeds the operations of sowing and immediate irrigation were performed.

Phenological traits including number of days from sowing to star shape stage, vegetative stage duration, number of days from sowing to flowering end, reproductive stage duration, grain filling duration and the total duration of crop growth were recorded. Plant height, head weight, stem diameter, stem weight, hollow diameter and head diameter were measured at maturity stage.

All data were subjected to analysis of variance (ANOVA) and differences among treatments were tested by Duncan's multiple range test (at $P \leq 0.05$) using MSTAT-C software.

RESULTS AND DISCUSSION

Growth stages of sunflower were significantly affected by biofertilizer application. Number of days to star shape stage, vegetative growth stage duration, days number to flowering end stage, reproductive stage duration, grain filling duration and the whole duration of crop growth significantly were increased as the result of seed inoculation with *Azospirillum* and *Azotobacter* in comparison with non-inoculation treatment (Table 1). Similar results were reported by Hamidi et al. [14]. They showed that duration of pollination, silking ,coincidence of flowering and grain filling period of maize hybrids were prolonged as the result of PGPR application. Prolonged phenological stages due to biofertilizer application in present study was an indication of suitable conditions and time available for plant growth and development. *Azotobacter* and *Azospirillum* are among plant growth promoting rhizobacteria (PGPR) that enhance crop growth conditions through several mechanisms especially growth hormones production and improving the efficiency of roots [1,15]. The effect of cultivar on growth stages was significant. The longest and the shortest periods of developmental stages were recorded by Azargol and Lacomka cultivars respectively (Table 1). The phenological differences among cultivars can be ascribed to diverse genotypic reactions of cultivars.

Table 1: Mean values of different phenological stages duration as influenced by biofertilizer and cultivar factors*

Factors	Days to star shape stage	Vegetative stage duration (days)	Days to flowering end stage	Reproductive stage duration (days)	Grain filling Duration (days)	Total growth duration (days)
Biofertilizer						
application	52.5 a	66.3 a	93.6 a	41.8 a	16.8 a	**131.9 a**
non-application	44.6 b	57.3 b	84.2 b	38.2 b	14.4 b	**124.5 b**
Cultivar						
Azargol	60.5 a	73.0 a	101.0 a	48.2 a	18.3 a	**142.5 a**
Euroflor	46.8 b	63.8 b	93.0 b	43.3 b	16.0 b	**132.3 b**
Lakomca	42.8 d	52.5 d	79.0 d	32.7 d	13.0 d	**114.7 d**
Feverit	44.0 c	57.7 c	82.5 c	35.7 c	15.0 c	**123.3 c**

* Different letters within each group of a column indicate significant differences at $P \leq 0.05$ according to Duncan's multiple range test.

Data analysis showed that the morphological and growth traits including plant height, head weight, stem diameter, stem weight, hollow diameter and head diameter were not affected by biofertilizer application and cultivar factor, even though inoculation treatment led to growth promotion as compared with non-inoculation treatment (Table 2).

Table 2: Mean values of growth traits as influenced by biofertilizer and cultivar factors*

Factors	Plant height (cm)	Head weight (g)	Stem diameter (cm)	Stem weight (g)	Hollow diameter (cm)	Head diameter (cm)
Biofertilizer						
application	144.9	119.7	3.4	100.0	0.6	**16.9**
non-application	133.2	104.7	3.1	93.0	0.9	**15.0**
Cultivar						
Azargol	133.6	107.8	3.1	96.1	0.8	**15.8**
Euroflor	133.1	120.5	3.2	87.2	0.8	**17.4**
Lakomca	144.2	113.9	3.4	96.8	0.7	**16.0**
Feverit	145.3	106.7	3.3	106.1	0.7	**14.7**

* Treatment differences were not significant

CONCLUSION

According to the results of this study biofertilization of sunflower cultivars with *Azotobacter* and *Azospirillum* inoculants may be useful under field conditions but it is recommended that further works

should be done to evaluate single and mixed inoculations of various plant growth promoting rhizobacteria in comparison with different treatments of chemical fertilizers in order to demonstrate the potential of bacterial biofertilizers as a crucial component of crop nutrition in sustainable agriculture.

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