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Original article

Effect of biological phosphate and chemical phosphorus fertilizer on yield quality and quantity of Ajowan (*Carum Copticum*) medicinal plant

H. Habibi[a], G.H. Talaei[b,*]

[a]*Agronomy Department, Faculty of Agriculture Sciences and Medicinal Plant Research Center, Shahed University of Tehran, Tehran, Iran.*

[b]*Young Researchers and Elite Club, Khorramabad Branch, Islamic Azad University, Khorramabad, Iran.*

*Corresponding author; Young Researchers and Elite Club, Khorramabad Branch, Islamic Azad University, Khorramabad, Iran.

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ABSTRACT

In order to study the effect of biological phosphate and chemical phosphorus fertilizer on yield quality and quantity of Ajowan (Carum copticum) medicinal plant, an experiment was conducted as factorial experiment in the base of randomized complete blocks design and three replications at research farm of Khorramabad in Lorestan of Iran in 2013. Treatments included biological phosphate (Pseudomonas putida) at two levels inoculated and non-inoculated and chemical phosphorus (P2O5) at three levels (Zero, 50 and 100 kg.ha-1). Results showed that effect of treatments on grain yield, biological yield, harvest index (HI) and essential oil yield were statically meaningful, however, there were no significant differences between treatments in about essential oil percentage. The means showed that the greatest plant highest (70 cm), biological yield (1798 kg.ha-1), grain yield (475 kg.ha^{-1}) and essential oil yield (17.25 kg.ha^{-1}) were obtained by a treatment of biological phosphate + chemical phosphorus (50 kg.ha-1 P2O5). In general, results of the present study revealed that application of biological fertilizers plays a remarkable role in improving quantity and quality of Ajowan and they can be viewed as a suitable replacement for chemical fertilizers.

1. Introduction

Medicinal and aromatic plants have the economic importance because of the continuous and increasing demand for their products by local and international markets (Yuonis, 2004). Ajowan (Carum copticum) belonging to the Apiaceae family is a grassy, annual plant with a white flower and small, brownish seeds which commonly growsin Iran, India, Egypt and Europe. The seeds have been used for their flavour and spice in food industry. Also, the Ajowan seeds have essential oil as an active substance, which is used in pharmaceutical industry as a diuretic, anti-vomiting, analgesic, antiasthma, antispasmodic and a carminative (Nagalakshm and Shankaracharya, 2000; Khajeh et al., 2004). Since, application of these fertilizers increase the soil and water pollution and accumulation of some heavy metals such as cadmium, they can threat the human health. Moreover, the long-term use of chemical fertilizers tends to the soil structure degradation (Singh et al., 2008). Nowadays, attention to biological fertilizer has been increased due to price of chemical fertilizers and attention to sustainable agricultural systems (Ehteshami et al., 2007). Biological fertilizers containing beneficial bacteria and fungi improve soil chemical and biological characteristics, phosphorus solutions and agricultural production (El-Habbasha et al., 2007; Yosefi et al., 2011). Some bacteria provide plants with growth promoting substances and play major role in phosphorus solubilizing (Abou-Aly et al., 2006). Biological fertilizers have improved quantity and quality features of some plants (Ratti et al., 2001). Biological fertilizers comprised of nitrogen fixers, phosphorus dissolvers and available potassium (Ezz et al., 2011). It is necessary to use phosphorus solubilizing microorganisms to change insoluble phosphorus into soluble form. An advantageous of phosphorus solubilizing microorganisms is related to their propagation rate that can relatively remove the plant requirements to phosphorus at the root region (Sharma, 2002). Belimov et al. (1995) demonstrated that, inoculation of soil with bacterial mixtures caused a more balance nutrition for plants and improvement in root uptake of nitrogen and phosphorus in a main mechanism of interaction between phosphorus solubilizing and bacteria nitrogen fixing. Ratti et al. (2001) investigated effect of some varieties of phosphorus solubilizing bacteria on the yield of Lemon Grass (Cymbopogon) and concluded that the plant height and biomass increased compared to the control condition. Hazarika et al. (2000) reported that the use of phosphorus solubilizing bacteria significantly increased the height of tea plant. In another research, Kapoor et al. (2004) showed that fennel root symbiosis with pseudomonas significantly increased the flowering, 1000 seeds weight, dry matter and seed yield. Kapoor et al. (2007) reported that the inoculation of root with a kind of phosphorus solubilizing bacteria enhanced the shoot dry matter. The study showed significant improvement in seed yield of medical plant as Phyllanthus amarus under using of solving phosphorus bacteria in compare to the control (Annamalai et al., 2004). Inoculation the medical plants by pseudomonas causes to increase the root growth and plant growth ability in soil with fewer amounts of phosphorous (Mubassara et al., 2008). The present investigation was done in order to evaluate the effect of different treatments methods of biological phosphate and chemical phosphorus fertilizer on yield quality and quantity of Ajowan (Carum copticum) medicinal plant.

2. Materials and methods

The experiment was carried out in 2013 at the research farm Nourabad, Lorestan Iran, located in the longitude 48o and 21’ and the latitude 320 and 30’ with a height of 1117 m above sea level, with annual precipitation of 524 mm and average annual temperature of 17oC. The physical and chemical properties of the experimental soil where shown in table 1. The field was prepared in autumn and in March the crop was planted. The experiment was a factorial with two factors arranged in a randomized complete block design with three replications. The first factor was biological phosphate (bacterial strain Pseudomonas putida) (for preparation of biological phosphate solution, 100 g Pseudomonas putida was added to 2000 ml water and was sprayed on seeds) at two levels; inoculated (+) and non-inoculated (-) and second factor was three levels of chemical phosphorus fertilizer (P2O5) P1= Zero, P2= 50 and P3= 100 $kg.ha^{-1}$. Each experimental plot was three meters long and two meters wide with the spacing of 50 cm between the rows and a distance of 20 cm between plants in the rows. There was a space of one meter between the plots and two meters between replications. The Ajowan seeds were planted distance were two cm apart, covered with wet sand and about a centimeter thick and after emerging from the soil, thinning operation to set the desired density was performed. Three-quarters of fertilizer was applied at planting seeds and the rest was applied to plant at shooting. Ajowan seeds were directly sown by hand. There was no incidence of pest or disease on Ajowan during the experiment. Basin irrigation until harvest was done depending on weather conditions and weeds were controlled. In order to measurement of characteristics of

effective on yield components and substance effective, after removing the marginal effects of each plot, 10 plants from each plot were harvested randomly. All necessary cultural practices and plant protection measures were followed uniformly for all the plots during the entire period of experimentation. Dried seeds (50 g) of each plot were separated and powdered. The powder subjected to hydro distillation (400 ml distilled water), using a Clevenger-type apparatus for 2.5 hours and its essential oil was separated. Collected essential oil value was expressed regarding seed weight as essential oil yield. Data analysis was done by using software SPSS and MSTAT-C. The ANOVA test was used to determine significant ($p \leq 0.01$ or $p \leq 0.05$) treatment effect and Duncan Multiple Range Test to determine significant difference between individual means. In this experiment biological yield, grain yield, harvest index (HI), essential oil percentage and essential oil yield were studied. Fifteen plants were randomly selected from each plot and the observations were recorded.

Table 1
Several physical and chemical properties of the experimental soil.

Ec mmos/cm	pH	Cu ppm	Zn ppm	Mn ppm	Fe ppm	N ppm	K ppm	P ppm	O.C (%)	Deep (cm)
0.61	7.7	0.68	0.8	6.6	7.6	80	230	8	0.79	0-30

3. Results and discussion

3.1. Biological yield

Effect of by all treatments on Ajowan biological yield was significant at 1% probability level (Table 2). The mean comparison of data in different treatments showed that the highest biological yield (1798 kg.ha-1) was achieved by biological phosphate + chemical phosphorus (50 kg.ha^{-1} P2O5). The lowest biological yield (1425 kg.ha-1) was obtained in control (non fertilizer application) (Fig. 1). Plants treated by phosphorous because of positive effects of microorganisms at better availability of plant to phosphorous had an increasing trend in plant growth. Results of Migahed et al. (2004) who investigate effects of both individualy or in combination inoculation of the lipoferum, Azospirillum, Azotobacter, chroococcum and megaterium Bacillus on wild celery reported that inoculation treatment let to production of plant growth promoting components and this increased plant growth, yield and essential oil compared to non-inoculated plants. In Vallisneria spiralis application of biological fertilizer including Bacillus spp. and Pseudomonas rubiacearum with combination of compost organic fertilizer caused to 34% increasing of plant dry weight compared to treatments which treated only by organic fertilizers. More this increased phosphorous solublzing bacteria and nitrogen fixation bacteria in root rhizospher of treated plants (Lewis, 1995).

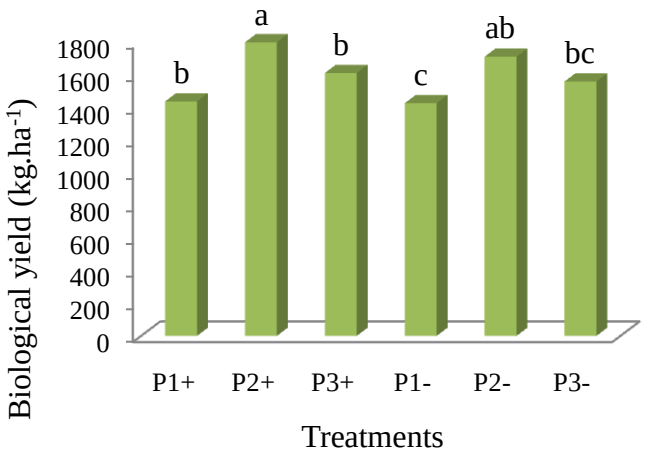

Fig. 1. Effect of fertilizer treatments on biological yield.

3.2. Grain yield

The results presented in Table 2 have revealed that different levels of treatments had significant effects on the grain yield (P≤0.01). Mean comparison table showed that the maximum (475 kg.ha^{-1}) and minimum (377 kg.ha-1) grain yield were obtained by a treatment of biological phosphate + chemical phosphorus (50 kg.ha-1 P2O5) and control (non fertilizer application), respectively (Fig. 2). Increase of grain yield under the influence of phosphorus fertilizers, can be attributed to the ability of phosphorus solution bacteria in fertilizer in increasing phosphorus liberalization of insoluble phosphorus sources. In another study Rokhzadi et al., (2004) reported that grain yield of chickpea increased by utilization of biological fertilizer.

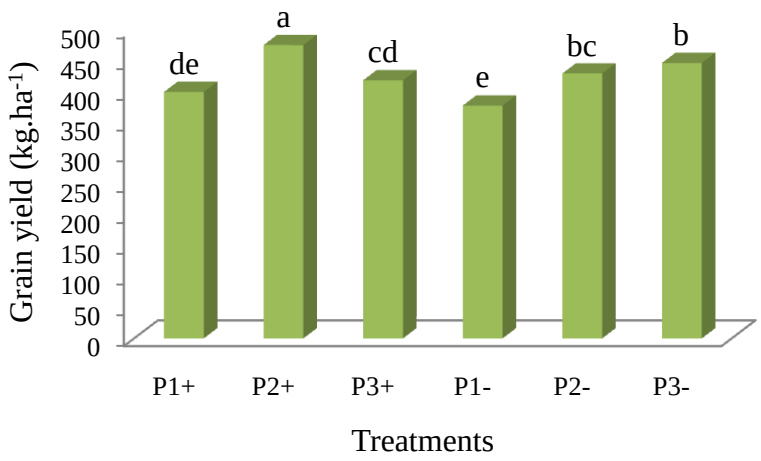

Fig. 2. Effect of fertilizer treatments on grain yield.

3.3. Harvest index (HI)

Analysis of variance (ANOVA) showed that the effect of all treatments on the harvest index (HI) was significant at 1% probability level (Table 2). The mean comparison of data in different treatments showed that the highest harvest index (33 %) was determined by application of biological phosphate + chemical phosphorus (50 kg.ha^{-1} P_2O_5). The lowest highest harvest (21 %) was obtained in control (without application of fertilizer) (Fig. 3). Biological fertilizer increased harvest index due to increasing economic performance. Results were in agreement with finding most of the workers like (Aslam-khan et al., 2005).

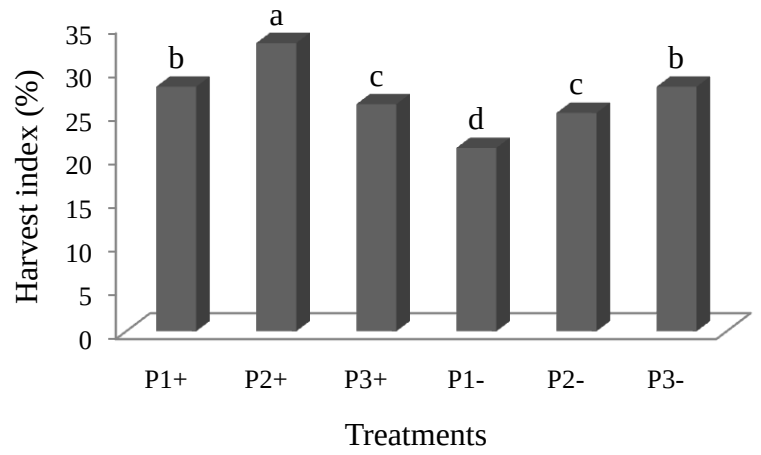

Fig. 3. Effect of fertilizer treatments on harvest index.

3.4. Essential oil percentage

The results of ANOVA showed that the effect of all treatments on essential oil percentage was not significant (Table 2).

3.5. Essential oil yield

The results of the analysis variance showed that the essential oil yield was significantly affected by all treatments (P≤0.01) in this experiment (Table 2). Mean comparison table showed that the highest (17.25 kg.ha^{-1}) and lowest (11.68 kg.ha^{-1}) essential oil yield were obtained by a treatment of biological phosphate + chemical phosphorus (50 kg.ha-1 P_2O_5) and control (non-fertilizer application), respectively (Fig. 4). Although the effective elements of plants are produced by genetic processes but their production is affected by different factors such as, yield loss, wrong management and particularly nutrients deficit (Malakouti, 2009). The results of the present study confirm with the results of Azizi (2000) reporting the effect of biological fertilizer on the essence yield in anis plant. Shalaby and Razin (1992) reported that application of 105 kg/ha-1 of phosphorus increased essence and thymul in Thymus plant.

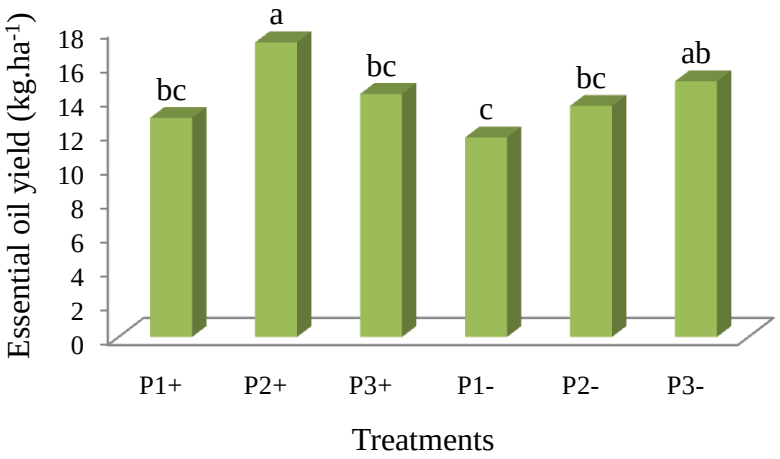

Fig. 4. Effect of fertilizer treatments on essential oil yield.

Table 2
Analysis of variance for Effect of biological phosphate and chemical phosphorus fertilizer on yield quality and quantity of Ajowan (Carum copticum) medicinal plant

Resource changes	df	biological yield	grain yield	harvest index (HI)	essential oil percentage	essential oil yield
Repetition	2	8480.056 ns	4526.222 ns	30.500 ns	0.245 ns	19.369 ns
Nitroxin	1	177012.500 **	747.556 ns	72.000 **	0.180 ns	8.515 **
Nitrogen	2	2299.389 **	6504.222 **	33.167 **	0.101 ns	16.006 **
Nitroxin × Nitrogen	2	74388.167 **	2146.889 **	50.167 **	0.071 ns	7.518 **
Error	10	6421.122	172.089	0.633	0.059	2.057
CV (%)	-	5.04	3.09	2.95	7.36	10.18

**, Significant at = 1%, ns, Not significant.

4. Conclusions

Biological fertilize are widely applied in crop production and they are proper substitutions for chemical fertilizers. Application of biological fertilizes significantly improved quality and quantity in Ajowan. Maximum of biological yield, grain yield, and harvest index (HI) and essential oil yield was obtained in treatment of biological phosphate + chemical phosphorus (50 $kg.ha^{-1}$ P_2O_5). Totally, the obtained results revealed that using biological fertilizes combined with chemical fertilizer significantly improved the quantity and quality yield compared to control.

References

Abou-Aly, H.E., Mady, M.A., Moussa, S.A.M., 2006. Interaction effect between phosphate dissolving microorganisms and boron on growth, endogenous phytohormones and yield of squash (Cucurbita pepo L.). First Sci. Conf. Agr. Chem. Env. Soc., Cairo, Egypt.

Annamalai, A., Lakshmi, P.T.V., Lalithakumari, D., Murugesan, K., 2004. Optimization of biofertilizers on growth, biomass and seed yield of Phyllanthus amarus (Bhumyamalaki) in sandy loam soil. J. Med. Aromat. Plants Sci., 26(4).

Aslam-khan, M., Abid, M., Hussain, N., Usman-masood, M., 2005. Effect of phosphorous levels on growth and yield of maize (zea mays l.) cultivars under saline Conditions. Int. J. Agr. Biol., 7 (3), 511-514.

Azizi, S.J., 2000. Agr. Sci., 3 (123), 88- 79. 6. Balasubramanian P.,Palaniappan, S.P., 2001. Principles and practices of agronomy; Tata McGraw-Hill Publishing Co. Ltd., New Delhi, India.

Belimov, A.A., Kojemiakov, A.P., Chuvarliyeva, C.V., 1995. Interaction between barley and mixed cultures of nitrogen fixing and phosphate-solubilizing bacteria. Plant Soil., 173, 29-37.

Ehteshami, S.M.R., Aghaalikhani, M., Khavazi, K., Chaichi, M.R., 2007. Effect of phosphate solubilizing microorganisms on quantitative and qualitative characteristics of maize (Zea mays L.) under water deficit stress. Pak. J. Biol. Sci., 10 (20), 3585-3591.

El-Habbasha, S.F., Hozayn, M., Khalafallah, M.A., 2007. Integration effect between phosphorus levels and biofertilizers on quality and quantity yield of faba bean (Vicia faba L.) in newly cultivated sandy soils. Res. J. Agric. Biol. Sci., 3 (6), 966-971.

Ezz, T.M., Aly, M.A., Saad, M.M., El-Shaieb, F., 2011. Comparative study between bio- and phosphorus fertilization on growth, yield, and fruit quality of banana (Musa spp.) grown on sandy soil. J. Saudi. Soc Agric. Sci., (In Press).

Hazarika, D.K., Taluk Dar, N.C., Phookan, A.K., Saikia, U.N., Das, B.C., Deka, P.C., 2000. Influence of vesicular arbascular mycorrhizal fungi and phosphate solubilizng bacteria on nursery establishment and growth of tea seedlings in Assam. Symposium No. 12. Assam Agr. Univ., Jorhat-Assam, India.

Kapoor, R., Chaudhary, V., Bhatnagar, A.K., 2007. Effect of arbuscular mycorrhiza and phosphorus application on artemisinin concentration in Artemisia annua L. Mycorrh., 17, 581-587.

Kapoor, R., Giri, B., Mukerji, K.G., 2004. Improved growth and essential oil yield and quality in Foeniculum vulgare Mill. on mycorrhizal inoculation supplemented with P-fertilizer. Bioresource Technol 93, 307-311.

Khajeh, M., Yamini, Y., Sefidkon, F., Bahramifar, N., 2004. Comparison of essential oil composition of Carum copticum obtained by supercritical carbon dioxide extraction and hydrodistillation methods. Food Chem., 86, 587–591.

Lewis, A.L, Domingues, L.O., Munoz, O.S., 1995. Effect of time and method of azotobacter chooccum application on the cultivation of garlic (Allium sativa L.) cv. Vietnamita. Int. Am. Soc. Trop. Hort., 39, 27-32.

Malakouti, M., Motasharihzaeh, J., 2009. Role in increasing the quantitative and qualitative improvement of agr. publ. Agr. Educat., Karaj, pp 113.

Migahed, H.A., Ahmed, A.E., Abd El-Ghany, B.F., 2004. Effect of different bacterial strains as biofertilizer agents on growth, production and oil of Apium graveolense under Calcareous soil. J. Agr. Sci., 12, 511-525.

Mubassara, S., Zahed, U.M., Motiur, R.M., Patwary, F.K., Akond, M.A., 2008. Seed inoculation effect of Azospirillum spp. On growth, biomass and yield parameter of wheat. Acad. J. Plant. Sci., 1 (4), 56-61.

Nagalakshm S, Shankaracharya N B. 2000. Studies on chemical and technological aspects of ajowan. Food sci. technological Mysore., 37 _3), 277- 81.

Ratti, N., Kumar, S., Verma, H.N., Gautam, S.P., 2001. Improvement in bioavailability of tricalcium phosphate to Cymbopogon martinii var. Motia by rhizobacteria, AMF and Azospirillum inoculation. Microbiol. Res., 156, 145-149. Saharan BS, Nehra V (2011) Plant growth promoting rhizobacteria, a critical review. Life. Sci. Med. Res., 60, 613- 635.

Rokhzadi, A., Asgharzadeh, A., Darvish, F., Nour-Mohammadi, G., Majidi, E., 2004. Influence of plant growth, promoting rhizobacteria on dry matter accumulation and yield of chickpea. American-Eurasian J. Agr. Env. Sci., 3(2), 253-257.

Shalaby, A.S., Razin, A.M., 1992. J. Ag. Cro. Sci., 168, 243-248.

Sharma, A.K., 2002. Bio-fertilizers for sustainable agriculture. Agrobios Indian Pub, 407 p.

Singh, Y.P., Dwivedi, R., Dwivedi, S.V., 2008. Effect of biofertilizers and graded dose of nitrogen on growth and flower yield of calendula (Callendula officinalis). Plant Arch., 8 (2), 957-958.

Yosefi, K., Galavi, M., Ramrodi, M., Mousavi, S.R., 2011. Effect of bio-phosphate and chemical phosphorus fertilizer accompanied with micronutrient foliar application on growth, yield and yield components of maize (Single Cross 704). Aust. J. Crop. Sci., 5 (2), 175-180.

Yuonis, S.I., Ghaly, N.G., Ahmed, S.K., 2004. Effect of FYM and planting space on the vegetative growth, active ingredient and chemical composition of Ammi visnaga L. J. Agr. Sci. Mansoura Univ., 29, 1985-1993.