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The effect of different levels of auxin hormone and phosphate fertilizer on morpho-physiological characteristics of fababean root and its qualitative yield in ahvaz climate

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Key words: auxin hormone, phosphorus fertilizer, faba bean, nitrogen biological fixation, yield.

Abstract

Statistics indicate increasing importance and development of legumes as an important source of food in most countries and sowing faba bean has a long history in Khuzestan. The use of plant hormones to produce herbal products with higher quality and quantity has been investigated since many years ago. In order to investigate the effect of different levels of Auxin hormone and phosphate fertilizer on morpho-physiological characteristics of broad been root and its yield components an experiment was carried out in Ahvaz in 2011-2012 as a split plot in the form of randomized complete block design. The main plots included different levels of phosphate fertilizer (P1=0Kg/h, P2 = 100Kg/h, P3 = 150kg/h) and the sub plot included different doses of Auxin hormone (H1 = 0_{ppm}, H2 = 10_{ppm}, H3 = 15_{ppm}). The results showed that foliar spray of auxin increased lateral roots, root dry weight, nitrogen percentage of nodes and the number of nodes per plant. Moreover, the application of 100 kg/ha phosphorus fertilizer increased lateral roots and root dry weight. Since the land was salty in plots where auxin was not used, the nodes were not formed in broad been roots and thus biological fixation did not occur. The results also showed that the highest yield among productive components belonged to treatments with 15 ppm auxin and 100 kg/ha phosphate fertilizer.

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Introduction

Statistics indicate increasing importance and development of legumes as an important source of food in most countries and sowing faba bean has a long history in Khuzestan (Golabi and Lak, 2005).

Legumes with high rate of energy, protein, different kinds of vitamins, minerals, and medicinal properties are among the most Iranian crops. The rate of protein found in the seeds of legumes is twice or three times as much as the rate of protein in grain cereals and 10 to 20 times as much as protein found in glandular plants (starch). Legumes forage has high nutritional value due to owning high percentage of protein. Like other legumes, fababean has high nutritional value as well by having 23-25% protein, and by having nitrogen fixation capability it has a good periodic effect and improves chemical and biological fertility of soil (Noori *et al*., 2005; Sadravi, 2005).

Nearly, 78% of the Earth's atmosphere is composed of N_2. Plants, animals, and microorganisms are all surrounded by nitrogen and in fact all live in N_2 world. Hence, this large source of nitrogen is usable for all living things except bacteria (Abbassi *et al*., 2005). The entrance of molecular nitrogen to the surface of biosphere is called nitrogen fixation. Fixation and change of this form of nitrogen to usable forms by plants is mainly possible through industrial or biological ways (by a group of bacteria) (Sprent, 1991).

Nitrogen biological fixation by bacteria is mainly done through symbiosis with legumes (Abbassi *et al*., 2005). Nitrogen fixation through symbiosis is done in different ways including symbiosis between rhizobium bacteria and legume crops. In symbiosis between legumes and rhizobium bacteria not only the main part of fixated nitrogen is used by crops, the soil is also enhanced in terms of nitrogen (Bhattacharaya and Sengupta, 1994). The amount of fixated nitrogen in one-year-old grain legumes is reported to be 56 to 112 kg/ha (MajnoonHosseini, 1993) and according to Lindeman *et al.* (1998) it has been reported to be more than 280.2 kg/ha (Parsa and Bagheri, 2008).

For achieving maximum productivity, the amount and balance of nutrients distribution in Faba bean root is essential. The absence of highly consumed elements in growth of plant has a negative effect on growth of plant and energy fixation. (Jalilian, 2008).

Studying nitrogen biological fixation to be replaced by nitrogen chemical fertilizers in Iran farming soils, quantitative and qualitative study of local rhizobium for maximum efficiency of rhizobium-leguminous symbiotic systems is widely considered around the world. Broader use of nitrogen fixation as vital biological necessities for realization of sustainable agricultural systems is more and more emphasized (Saki Nejad *et al*., 2009).

The importance of phosphorus application in faba bean plant

For achieving maximum productivity, the amount and balance of nutrients distribution in Faba bean root is essential. Phosphorus is an essential and important element that plants need during their growth and reproduction stages.

Phosphorus causes development and production of more foliage and roots in shorter time (Malakooti and Sepehr, 2003).

Phosphorus often exists in soil as poorly soluble or dissolved inorganic phosphates or as organic phosphorus which are not easily usable for plants. Agricultural soils within the country have caused phosphorus to be added to the soil as phosphorus chemical fertilizer in order to remove its deficiency (Pant and Reddy, 2003).

Apart from the effect of phosphorus in root expansion and branch generation, it is also very effective on reproductive and grain filling stages. Phosphorus overuse not only does not increase the products, but also it is gradually fixated in soil. Its deficiency not only decreases the formation of new branches and destroys the flowers it also causes general weakness of reproductive parts of plant and other deficiencies within the plant (Madani *et al*., 2008).

Studies show that faba bean has a positive reaction to phosphorus (KazemiPoshtMasari, 2006).

In greenhouse and field experiments and in order to calibrate the critical concentration of P and Zn in faba bean plant through the use of soil phosphorus, Lewis and Hawthorne (1996) reported an increasing yield of 500 to 800 kg/ha (20-25%).

Availability of phosphate ions causes plant's resistance to lodging, early maturity of product, higher quality, increase of plant growth from emergence to the beginning of flowering and pollination and consequently the crop yield will increase (Tarek and Tawaha, 2002; Hosseinzadeh, 2005).

The results of studies conducted by Lewis and Hawthorne (1996), Boland *et al.* (2001), Liben *et al.* (2001), Adams *et al* (2001) all showed that as the phosphorus in soil increased the yield of faba bean increased too. Carter (2002) has pointed out that phosphorus is the most important element for faba bean.

The importance of auxin hormone application in faba bean plant

The application of auxin hormone increases biological fixation (Takanashi *et al.*, 2011).

The purpose of this study was to evaluate the effect of auxin hormone and phosphate fertilizers on FabaBean root Morpho-physiological characteristics and their effect on the production component is a FabaBean.

Materials and methods

The experiment was carried out in ShahidSalemi field 3 km away from southern Ahvaz in 2011-12. It was a split plot experiment in the form of randomized complete block design with three replications including two factors of auxin hormone and phosphate fertilizer. Auxin hormone in three levels of 0, 10, 15 ppm and phosphate fertilizer in three levels of 0, 100, 150 kg/ha were investigated.

In order to investigate nitrogen biological fixation during the growth of faba bean sampling was done five times in such a way that from each plot three plants were selected quite randomly and the roots were pulled out as cylinder. After separating the roots from the plants, they were washed and then the number of root nodes, color and dry weight of nodes, number of lateral roots, dry weight and volume of roots were measured. Afterward, the roots and nodes were placed in an oven in temperature of 75 $^{\circ}C$ for 48 hours and then their dry weight was calculated.

A) volume roots

The volume of the roots was calculated after counting the number of bilateral roots and dry weight of roots and through Archimedes Law and the difference of the volume of water in cylinder.

B) nitrogen biological fixation

Some nodes of each plot which were intact were taken to the laboratory in order to estimate the amount of nitrogen and nitrogen percentage was calculated through Micro Kjeldahl method.

C) Qualitative Yield

Yield as a qualitative trait in faba bean results from the number of plants per area unit and the number of pods per plant, the number of seeds per pod and the average weight of grain. At the end of growth season lines 3 and 4 were harvested as the final region in an area of 1 m^2 and the grain yield and yield components were investigated and measured. In order to calculate qualitative yield the following formula was used:

$$U = K.L.Z.A/10^5$$

K: number of plants per square meter
L: the average number of pods per plant
Z: the average number of grains per pod
A: 100-grain weight (g)
Its unit is kg/ha (Saki Nejad, 2009).

Statistical measurements were done by means of Excel and Minitab software.

Results

A. The effect of auxin hormone and phosphate fertilizer on rood nodulation and nitrogen biological fixation

The ANOVA results showed that the effect of auxin hormone and the interactive effect of auxin and phosphate on nitrogen percentage of node were significant at 1% level but phosphate fertilizer had no significant effect on this trait (Figs. 1, 2).

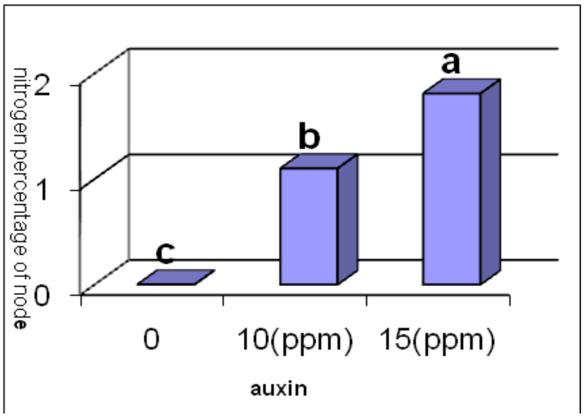

Fig. 1. Mean comparison of the effect of auxin hormone on nitrogen percentage of node

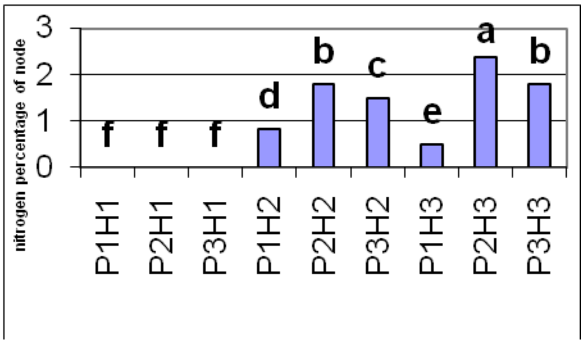

Fig. 2. Mean comparison of the interactive effect of auxin and phosphate on nitrogen percentage of node

As it is observed in above Fig.s, the highest biological fixation belonged to the treatment with 15 ppm auxin and 100 kg/ha phosphate fertilizer.

Regarding the number of nodes and dry weight of root nodes, the highest number and weight of node belonged to the treatment with 15 ppm auxin and 100 kg/ha phosphate fertilizer. Moreover, in plots where auxin hormone was not applied nodulation did not happen in the root of faba bean.

B. The effect of auxin hormone and phosphate fertilizer on volume and dry weight of root

The ANOVA results showed that the effect of auxin hormone, phosphate fertilizer, and the interactive effect of auxin and phosphate on the root volume were significant at 1% level (Fig.s 3, 4, 5).

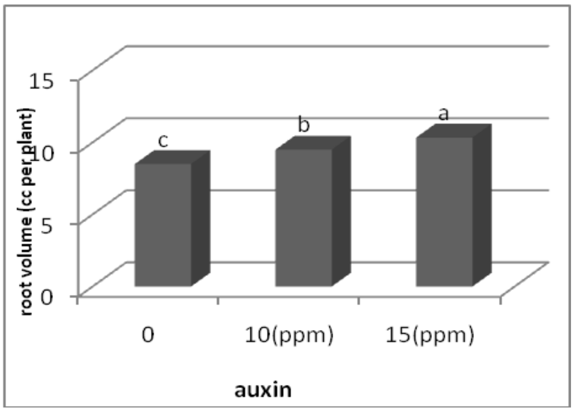

Fig. 3. mean comparison of the effect of auxin on root volume

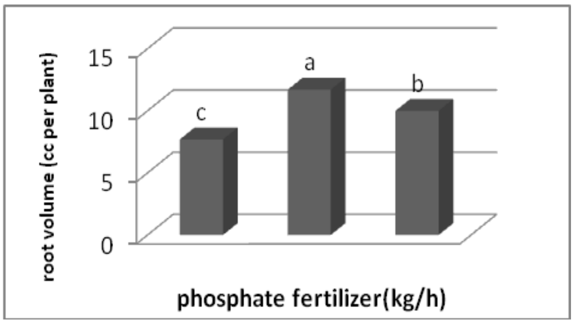

Fig. 4. mean comparison of the effect of phosphate fertilizer on root volume

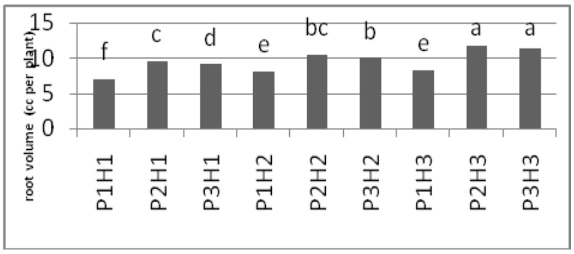

Fig. 5. mean comparison of the interactive effect of auxin and phosphate on root volume

The ANOVA results of dry weight are similar to root volume and they are quite consistent.

The effect of auxin hormone and phosphate fertilizer on yield components of faba bean

The measured yield components in this experiment include:

1. number of pods per plant
2. number of grains per pod
3. 100-grain weight
4. Grain yield

In all measured yield components, treatments with 15 ppm auxin and 100 kg/ha phosphate fertilizer had the highest yield and there was not any significant difference between 100 and 150 kg/ha phosphate fertilizer and even in some cases the increase of phosphate application decreases some yield components (Fig.s 6, 7, 8).

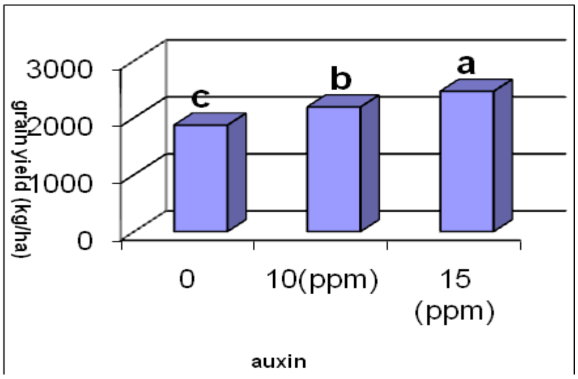

Fig. 6. mean comparison of the effect of auxin on grain yield

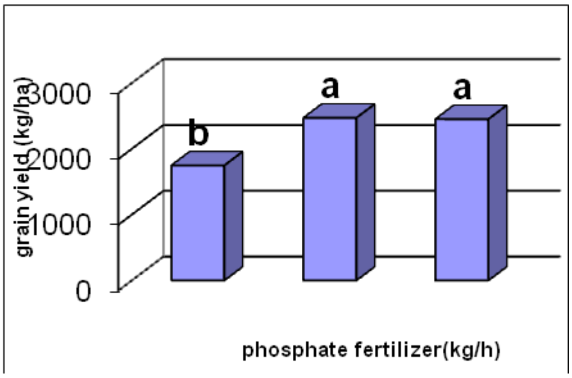

Fig. 7. mean comparison of the effect of phosphate fertilizer on grain yield

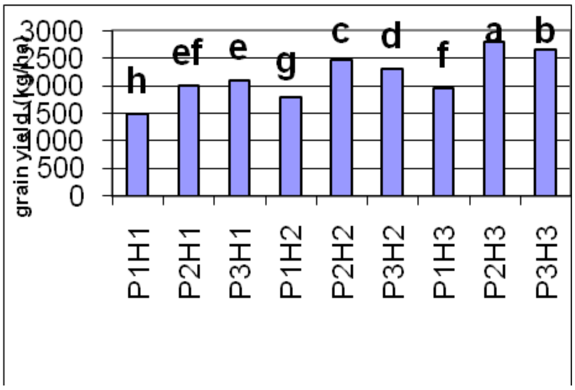

Fig. 8. mean comparison of the interactive effect of auxin and phosphate on grain yield

Discussion

A: lack of nodulation and biological fixation in plots which didn't use auxin hormone

The first and the most important stage of nodulation in root is the transformation of fatal cords which is either in response to indole acetic acid which is produced due to stimulation by bacteria or in response to ethylene which is produced due to stimulation by indole acetic acid (Saki Nejad, 2006). Bacteria in soil are absorbed by materials secreted from the roots especially tryptophan. This material is converted to auxin (indole acetic acid) by bacteria and the auxin alters the shape of fatal cords (distortion or split of fatal cords) (Saki Nejad, 2006).

Therefore, if auxin hormone is not produced in the root of plant, nodulation and consequently biological fixation won't happen. It is probably due to high EC of soil that axuin is not produced in the root. Barazandeh and Asadi (2011) stated that if the EC of soil is high, it prevents soil biological fixation.

B: Volume and dry weight of root

As the abovementioned results showed, the highest volume and dry weight of root belonged to the treatment with 15 ppm auxin and 100 kg/ha phosphate fertilizer. 100 kg/ha is the best amount of phosphate fertilizer recommended for faba bean (Kazemi, Pirdashti, 2007).

Phosphorus causes development and production of more foliage and roots in shorter time (Malakooti and Sepehr, 2003).

Phosphorus overuse not only does not increase the products, but also it is gradually fixated in soil (Madani, NadriBorujerdi, 2008).

C: The effect of auxin hormone and phosphate fertilizer on yield components of faba bean

Availability of phosphate ions causes plant's resistance to lodging, early maturity of product, higher quality, increase of plant growth from emergence to the beginning of flowering and pollination and consequently the crop yield will increase (Tarek and Tawaha, 2002; Hosseinzadeh, 2005).

In greenhouse and field experiments and in order to calibrate the critical concentration of P and Zn in faba bean plant through the use of soil phosphorus, Lewis and Hawthorne (1996) reported an increasing yield of 500 to 800 kg/ha (20-25%).

Studies show that faba bean shows a positive response to phosphorus (KazemiPoshtMosavi, 2006).

Apart from the effect of phosphorus in root expansion and branch generation, it is also very effective on reproductive and grain filling stages. Phosphorus shortage not only decreases the formation of new branches and destroys the flowers it also causes general weakness of reproductive parts of plant and other deficiencies within the plant (Madani. Naderi Borujerdi, 2008).

However, it should be noted that external use of auxine hormone in legumes will increase their tolerance of low temperature (Bakht *et al.*, 2006).

In pea plants treated with auxin, the flowers sustainability significantly increased in low temperature stress (Kumar, 2008).

Under stress conditions, the use of auxin increased the grain yield due to maintaining high levels of chlorophyll and relative water content and thus maintaining photosynthesis (Travaglia, 2007).

Moreover, auxin hormone increases the crops through inhibition of rapid loss of leaves, stem elongation, nodulation and nitrogen biological fixation and also through better distribution of assimilates from the root to the stem and finally to the pods seeds.

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