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Evaluation of mycorrhizal efficiency on growth and productivity of faba bean (*Vicia faba*)

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Abstract:

This study was conducted to evaluate the effectiveness of three isolates of mycorrhiza fungi two of them belonging to Glomus mosseae which are local isolates B1, B2 and the third is imported B3 to investigated impact on the seed germination, growth and yield of faba bean (Vicia faba). Results showed superiority of isolate B2 which significantly increased in all plant growth parameters which studied over other treatments as well as the control treatment, It has been given the highest rate directory germination index, size of roots, fresh weight of roots and vegetative, dry weight of root and vegetative, plant height, number of branches shoot, number of flowers, and content of chlorophyll in leaves (0.91, 32.67 cm^3, 35.12 g $Plant^{-1}$, 88.35 g $Plant^{-1}$, 5.56 g $Plant^{-1}$, 13.86 g $Plant^{-1}$, 43.17 cm, 5.33 branch $Plant^{-1}$, 71.37 flower $Plant^{-1}$, 37.00 mg.g $^{-1}$) respectively as compared B0 treatment which recorded the lowest value (0.65, 4.121 cm^3, 16.50 g $Plant^{-1}$, 55.94 g $Plant^{-1}$, 2.65 g $Plant^{-1}$, 7.93 g $Plant^{-1}$, 21.45 cm, 3.33 branch $Plant^{-1}$, 45.43 flower $Plant^{-1}$, 26.00 mg g $^{-1}$) for each parameter, respectively.

Results also showed superiority of B2 isolate which significantly affected other treatments in number of pods, pods weight, number of seeds in pods in addition to plant production which gave 15.43 pod $Plant^{-1}$, 12.81 g $Plant^{-1}$, 4.35 seed Pod^{-1}, 197.66 g $Plant^{-1}$ for

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each parameter, respectively while the control treatment B0 recorded values 7.18 pod.Plant^{-1}, 9.42 g Plant^{-1}, 3.85 seed.pod^{-1}, 67.64 g Plant^{-1} for each of them, respectively.

Key words: Mycorrhizae, Faba bean, Chlorophyll. Pod

INTRODUCTION

Faba bean plant (*Vicia faba* L.) is one of the most important winter leguminous as a major crops, which have the ability to grow and produce in different types of soils and main source of protein fuether more have a good content of carbohydrates in addition to its main role, being one of the legume family, to atmospheric nitrogen fixation through bacterial root nodules which is important and effective to this element in the agricultural cycle (1).

Microorganisms are vital component of the soil as it play important role whether from bacteria or fungi through its presence in soil they are analyzing organic material to mineral materials which can help plant to take advantage of them as well as increased mineral elements movement, stored and released in addition transfer of water and nitrogen, fixation and release phosphorus from complex compounds and transform it to a form absorbable by the plant, as well as many other metal elements. Microbiology exchange utility between them and plant as preparing the plant for the needs of nutrients and in return you get what you need him of the plant and in limited quantities in addition it play important role as a resistance factor against revive the vitality of the plant pathogenic soil directly either by attacking the pathogen or by increasing the strength of the plant and increase ability to endurance (2). Mycorrhizal fungi are the biggest components of soil (3) where their presence in the soil in the spread of the roots areas or near them facilitate the absorption of mineral elements by the plant, especially the elements that have slow

movement like phosphorus, copper, zinc (4), they also play an important role in nitrogen absorption (5).

The positive effects of mycorrhizal fungi in stimulating plant growth became clear in this time as it provides, upon their presence with the plant, several benefits such improving survival rate for plants that are rooted colony of this type of fungus and improve properties and texture soil through stimulating the plant to secrete certain substances such as glomalin is a glycoprotein produced abundantly on hyphae and spores of arbuscular mycorrhizal (6) as well as they lead to be gaseous exchange process which is an ideal addition to increasing the absorption area for the roots of host plant and extended to distances much further than up to the root hairs of the host plant (7). Furthermore it increased plant ability to revive the soil pathogens through processing plant nutrients that increase the ability to resistant habitation pathogens and resistance to impact it, as well as through the amendments undertaken by external appearance of the root cells (8) and tolerant to some mechanism of environmental conditions non-natural like high temperature, wet lands, salinity and high or low soil pH (9). These fungi play a vital and very important role in reduce reliance on the use of pesticides which have a negative effect on the soil, environment, plants, beneficial soil microorganisms, and public health (10).

MATERIALS AND METHODS

This experiment was carried out in directorate of agricultural research - ministry of science and technology for the 2014 season using plastic pots (capacity 5 kg) on a silty loam soil (table 1). Using randomized complete block design RCBD, this treatment included control B0 in addition to three treatments of mycorrhizal fungi *Glomus mosseae*. B1 and B2 (local isolates) isolated from barley plants (*Hordeum vulgare*) and Gazania (*Gazania splendens*) they are suitable for product of inoculum

by using wet sieve technique at all stages of isolation (11) while B3 has been produced in laboratories of Dr. Rajan in India, it has been obtained from the organic agriculture centre - ministry of agriculture.

Dried soil aerobically and it has been sterilized by formalin and covered with agricultural nylon by provisions for three days and disclosed at a later time for another three days to get rid of impact of soil and distributed to the pots(5kg pot^{-1}).

Table (1) Some physical properties of the soil field

Character	Soil texture	Clay	Silt	Sandy	ECe	pH
		g kg^{-1}			ds m^{-1}	
Value	silty loam	112	290	598	1.24	7.1

These pots were distributed according to RCBD on five pots per treatment and three replications. Pots were irrigated and left for two days until soil stability and to ensure that Mycorrhizal inoculation used in the experiment didn't leak to the bottom far from the root zone. Inoculum of mycorrhizae by added 50 g (soil + roots) per pot while the comparison treatment has without any addition. Ten seeds of faba bean were planted in each pot and after it has been calculating the germination index and retained it three plants after germination 3 plant/pods until the end of experiment (12).

The germination index (GI) was calculated according this formula:

$$GI = \frac{\text{Number of seeds germinating in the first period}}{\text{number of days from the date of Agriculture}} \div \frac{\text{number of seeds germinating in the middle period}}{\text{number of days from the date of Agriculture}} \div \text{number of seeds germinating in the last period}$$

number of days from the date of Agriculture

After 90 days ended duration of the experiment leaf area, plant height, branches number and content of total chlorophyll was calculated (13) number of flowers and productivity indicators,

then removal of plants carefully was washed by stream moderate water it was calculated fresh weight of root and shoot, volume of roots, dry weight of root and shoot through drying plant on 70 degrees for 48 hours (14). In addition productivity indicators of plants were calculated.

RESULTS AND DISCUSSION

The results showed significant Superiority in all treatments compared with control treatment in indicator of germination index figure (1) terms of B2 treatment gave the highest value amounting 0.91 while the control treatment B0 showed lowest value 0.65.

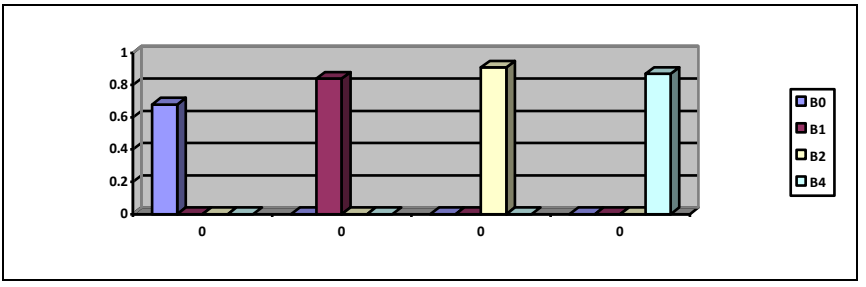

Figure (1) Effect of ecological factors on the germination guide to plant peas.

These results are consistent with what the foundations of many researchers about the use of beneficial microorganism in soil with the seeds of many plants led to a reduction evident in the time required for germination and raise the value of germination guide. The reason is ascribed to the ability of these microorganism on the induction of embryos to emerge by increasing availability of water and nutrient elements as well as working through a series of enzymatic reactions to increase the permeability of the seed, in addition mycorrhizae fungi led to a substantial increase in the percentage of germination and reduction time required for germination (15).

Impact of mycorrhizal isolates on indicators of vegetative growth in faba bean.

In table (2) the results showed superiority of treatment B2 in roots size, fresh weight of roots and shoots and dry weight of roots and shoots, the following values were recorded 32.67 cm^3, 35.12 g $Plant^{-1}$, 88.35 g $Plant^{-1}$, 5.56 g $Plant^{-1}$ and 13.86 g $Plant^{-1}$ for each one respectively while the control treatment B0 gave the values 14.12 cm^3, 16:50 g $Plant^{-1}$, 55.94 g $Plant^{-1}$, 2.65 g $Plant^{-1}$and 7.93 g $Plant^{-1}$for each of one respectively.

Table 2: Effect of mycorrhizal isolates on vegetative growth in faba bean.

Traits Treatments	Volume of roots(cm^3)	Fresh weight of roots(g)	Fresh weight of vegetative(g)	Dry weight of roots(g)	dry weight of vegetative (g)
B0	14.12	16.50	55.94	2.65	7.93
B1	25.16	28.73	76.14	4.72	11.48
B2	32.67	35.12	88.35	5.56	13.86
B3	8.282	31.58	81.21	5.02	12.73
L. S. D	1.04	3. 29	6.46	0.41	1.51

The measuring indicators to each of plant such as plant height, number of branch, leaf area, leaf content of chlorophyll and number of flowers table (3) results showed a clear divergence between the various treatments but all outperformed on control treatment in all indicators that was measured and excelled treatment B2 mycorrhizae in all treatments which recorded (43.17 cm , 5.33 pranch $Plant^{-1}$, 251.51cm^2, 37.00 mg g^{-1} and 71.37 flower $Plant^{-1}$) for each them respectively compared with control treatments B0 which given values (21.45 cm, 3.33 pranch $Plant^{-1}$, 188.87 cm^2, 26.00 mg g^{-1} and 45.43 flower $Plant^{-1}$) for the same indicators sequentially.

Table (3) Effect of mycorrhizal isolates on vegetative growth in faba bean.

Treatment	Plant height (cm)	Number of branches	Leaf area(cm^2)	Content of chlorophyll ($mg.g^{-1}$)	Number of flowers
B0	21.45	3.33	188.87	26.00	45.43
B1	31.52	4.13	216.23	31.70	58.79
B2	43.17	5.33	251.51	37.00	71.37
B3	35.61	4.87	233.58	32.50	62.42
L.S.D	5.52	0.45	16.14	4.31	6.35

The results of productivity indicators (table 4) reveal that B2 mycorrhizal treatment was superior over all treatments as well as a control treatment in each tested indicator, pods number , pod weight , number of seeds and product of plant which recorded 15.43 pod $Plant^{-1}$, 12.81 g $Plant^{-1}$, 4.35 seed Pod^{-1} and 197.66 g $Plant^{-1}$ for each of them respectively, while the control treatment B0 gave values 7.18 pod $Plant^{-1}$, 9.42 $g.plant^{-1}$, 3.85 seed Pod^{-1}, 67.64 g $Plant^{-1}$ for each of them respectively.

Table (4) Effect of mycorrhizal isolates on productivity in faba bean .

Treatments	N. of pods	pod weight(g)	N. of seeds	Product of plant(g)
B0	7.18	9.42	3.85	67.64
B1	12.65	10.03	4.02	126.88
B2	*1*5.43	12.81	4.35	197.66
B3	14.06	10.84	4.13	152.41
L.S.D	1.31	1.44	0.18	3.52

These results as a whole are consistent with what had been referred to by many researchers, who used mycorrhizae as bio-fertilizers where they noticed that the presence of these useful microorganisms which leads to solubility and availability of phosphorus which in turn plays a major role in growth and development of plant and this is what had been observed at the time of infection of roots by mycorrhizae which led to a significant increase in absorption of elements this is consistent with what was found by Safir, et al (16) who observed that Mycorrhizae fungi encourages the plant to take nutrients and water. These results are also consistent with Ramirez (17)

found, when he pointed to an increase in the height of the papaya plant by 133% after treated with *Glomus mosseae* compared with the control treatment. While Allen et al (18) founds that the chlorophyll content in leaves of plants *Bouteloua gracils* inoculated with Mycorrhizal fungi was higher than existing plants in control.

These results are consistent with what found where they explained that the addition of Mycorrhizal fungi to several seeds of different families of vegetables including Beans, Peas, alfalfa, lentils, chickpeas during cultivation led to a significant increase for the dry weight of root and vegetative parts as well as early flowering and stronger growth, in addition it contributed effectively to the improvement of the capacity of these plants on the maximum of mineral elements present in the soil(19) these results also agree with the view of Neumann and George (20). When he found that treating two types of cowpea with mycorrhizae led to a significant increase in fresh weight and increase the number of branches as well as early flowering in addition to a significant increase in plant content of mineral nutrients, which refer to them reason superiority the plants treatment with mycorrhizae as well as consistent with foundation of Kumar et al (21) when treated of chickpea seeds with mycorrhizae led to a significant increase In all growth indicators as well as increase biomass, especially size and weight roots in addition to presence of these fungi in soil led to positive effects on several growth indicators and productivity in plants. This beneficial effect is due to effect of these fungi which stimulate plant to produce several compounds including phytohormones, organic acids, siderophors, and fixation atmospheric nitrogen, phosphorus availability and stimulate production of antibiotics in plant tissues and the other mechanisms are not interpreted.

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