BARLEY CROP AND QUALITY AS AFFECTED BY ORGANIC FERTILIZATION AND MICROBIAL INOCULATION

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ABSTRACT

This investigation was carried out at Agricultural Researches Center Al Giza, Egypt, under greenhouse experiments during 2019 and 2020 winter seasons. The study included the effect of three organic fertilization sources: compost, poultry, vermicompost and without organic fertilizer, with mixed inocula (N_2 fixers *Azotobacter chroococcum* (A C), phosphate dissolving bacteria (Bacillus *megatherium var. phosphaticum* (B M), potassium mobilizers (*Bacillus circulans* (B C)) and without microbial inoculation on height, weight of plant and spike weight as well as (N, P and K) uptake of barley plant variety Giza 126. This experiment was conducted in pots 3 kg.

Obtained results showed that the plant height, plant weight and spike weight as well as (N, P and K) uptake of barley plant were increased significantly by adding the poultry or vermicompost compared to without organic fertilization addition in both seasons. Generally, in most cases, all parameters were increased significantly by microbial inoculation compared to the control treatment (without microbial inoculation) in both seasons. The parameters were improved significantly by adding poultry or vermicompost with mixed inocula (N_2 fixers (*Azotobacter chroococcum* (A C), phosphate dissolving bacteria (Bacillus *megatherium var. phosphaticum* (B M), potassium mobilizers (*Bacillus circulans* (B C)) in both seasons. While, the

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lowest values were recorded by without organic fertilization and microbial inoculation in the both seasons.
Key words: Barley plant, Vermicompost, Organic Fertilization, Microbial Inoculation, Compost.

INTRODUCTION

Barley is an important grain crop globally and locally and occupies the fourth place in terms of importance after wheat, maize and rice. It has been used as food for humans and animals since more than ten countries. This crop has characteristics that are unique to it from other grain crops, the most important of which are the following: Another grain, used for human and animal nutrition, withstands drought conditions and is suitable for rain-fed agriculture and new lands. (Mahmoud, 2005).

Microbial inoculants are biologic products composed of live beneficial microorganisms that used to improve soil quality and plant nutrition (Pylak *et al.*, 2019). *Pseudomonas, Bacillus, Azospirillum*, and *Azotobacter* are the main genera of beneficial bacteria that impel plant growth (Ferreira *et al.*, 2019). Soil-applied microorganisms can increase plant growth through nitrogen fixation, phosphate solubilization, plant hormones exudation, siderophore production, and the production of plant pathogen-inhibiting substances (Glick, 2012). The reported beneficial effects of bacterial consortia include increases in yield, root biomass, water retention capacity, and nutrient availability. (Agricen, 2020)

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Organic fertilization provide to the soil is one of the most important factors for increasing the productivity in plant production, with organic phosphore as a significant part of the soil phosphorus cycle contributing to phosphorus nutrition of plants (Richardson *et al.,* 2005). Organic fertilization increases the humus content (Hartl and Erhart, 2005) and enhances the microbiological activity in soil. Agricultural methods leading to high soil organic fertilization content can effectively reduce the need for external phosphorus nutrition.

This research aimed to study the effect of 8 treatments represent the combinations of three organic fertilization sources: compost, poultry, vermi-compost and without organic fertilizer, with mixed inocula (N_2 fixers (*Azotobacter chroococcum* (A C), phosphate dissolving bacteria (Bacillus *megatherium var. phosphaticum* (B M), potassium mobilizers (*Bacillus circulans* (B C)) and mixed inocula on barley productivity.

MATERIALS AND METHODS

A greenhouse experiment was carried out at Agricultural Researches Center, Giza, Egypt, during 2019 and 2020 winter seasons using barley variety, Giza 126. The objective of this experiment is to study the effect of organic fertilization sources: compost, poultry, vermicompost and/or mixed microbial inoculation (N_2 fixers (*Azotobacter chroococcum* (A C), phosphate dissolving bacteria (Bacillus *megatherium var. phosphaticum* (B M),

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potassium mobilizers (*Bacillus circulans* (B C)) on plant height, plant weight and spike weight as well as (N, P and K) uptake of barley plant variety Giza 126. The soil used in this study were subjected for chemical and physical analyses after being ground and sieved through 2 mm sieve; such analyses were represented by Tables (1, 2).

Table (1): Some chemical and physical properties of the studied soils

Seasons	Chemical				Physical				Soil texture
	pH	EC dSm^{-1}	OM	$CaCO_3$	C.sand	F.sand	Silt	Clay	
			%						
2019	7.55	1.16	1.30	1.70	0.96	21.12	34.14	43.15	Clay
2020	7.64	1.22	1.24	1.88	0.95	22.04	32.70	45.12	Clay

Table (2): Cations, anions and nutrients concentration in a paste extract of the studied soil samples

Seasons	Ca^{++}	Mg^{++}	Na^{+}	K^{+}	CO_3^{--}	HCO_3^{-}	Cl^{-}	SO_4^{--}	N	P	K
	Soluble cations (meq/I.)				Soluble anions (meq/I.)				Available (ppm)		
2019	3.62	1.2	5.78	1.05	0.00	0.91	6.58	3.25	30	6. 56	368
2020	3.76	2.5	6.3	1.12	0.00	0.89	6.57	4.88	34	7. 52	374

Table (3): Some characteristics of used organic fertilization

Characteristics / organic fertilization	C/N ratio	PH	N	P	K	O.M	O.C
			%				
Compost	13.9	8.3	1.42	0.73	1.13	34.13	19.8
Poultry	8.16	6.51	4.1	2.03	1.52	57.2	33.16
Vermicompost	2.4	8.7	10.2	0.86	2.86	42.1	24.3

The pots used in this experiment were, 15 cm in diameter and 20 cm in height with 3 kg soil capacity. Experimental treatments were divided into two groups. Group (1): with addition organic fertilization (compost, poultry,

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vermicompost, without organic fertilization). Organic compost was added to the soil before planting at rate of 30 g/pot.

Group (2): with addition mixed inocula and without mixed inocula (N_2 fixers (*Azotobacter chroococcum* (A C), phosphate dissolving bacteria (Bacillus *megatherium var. phosphaticum* (B M), potassium mobilizers (*Bacillus circulans* (B C)) was added at the rate 15 g/pot. The microbial inoculum was mixed with the soil and added scattered after scribbling, then covered and irrigated the soil a week after planting. Added of three times during the growing seasons.

Finally, plant samples were taken at the end of experiment of 150 days after cultivation and digested according to the procedure of (Ryan *et al.*, 1996), then the digested plant solutions of (NPK) were analysed (A.O.A.C. 1990).

RESULTS AND DISCUSSION

1- Effect of biological treatments on vegetative parameters:

Data in Figure (1,2and 3) show that the highest significant values of height, weight of plant and spike weight were recorded by using the treatment of poultry or vermicompost compared to the control treatment (without the addition of organic fertilizer sources) in two seasons. Meanwhile, the lowest values were recorded through control treatments (without organic fertilizer addition) during both seasons. Such increase may be attributed to the fact that organic fertilizer helped by rising to fill spike weight. The main cause for

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higher barley crop was the higher filled spike weight. Conserving energy, conserving the environment and fighting pollution is now the most critical problem in the world. Minimizing chemical fertilization usage, organic gardens, and bio fertilization are now the new strategies in all agricultural domains around the world. Similar finding was obtained by Hassan, *et al.,* (2017).

Results in Figure (1, 2 and 3) indicate that the treatment of mixed microbial inoculation alone gave the highest significant values of plant height, plant weight and spike weight compared to the control treatment (without addition of mixed microbial inoculation) in both seasons. Whereas, the lowest values were recorded without mixed microbial inoculation in both seasones. The result of the microorganisms involved in P solubilization, which can improve plant growth by increasing the solubilization efficiency, enhancing the availability of micronutrients and the production of plant growth promoting substances. Microbial inoculation would reduce the need of P mineral fertilizers and decrease adverse environmental effects. Consequently, in the development and completion of sustainable agriculture techniques, bio-fertilization is of great importance in alleviating environmental pollution (Elkoca, *et al.*, 2008).

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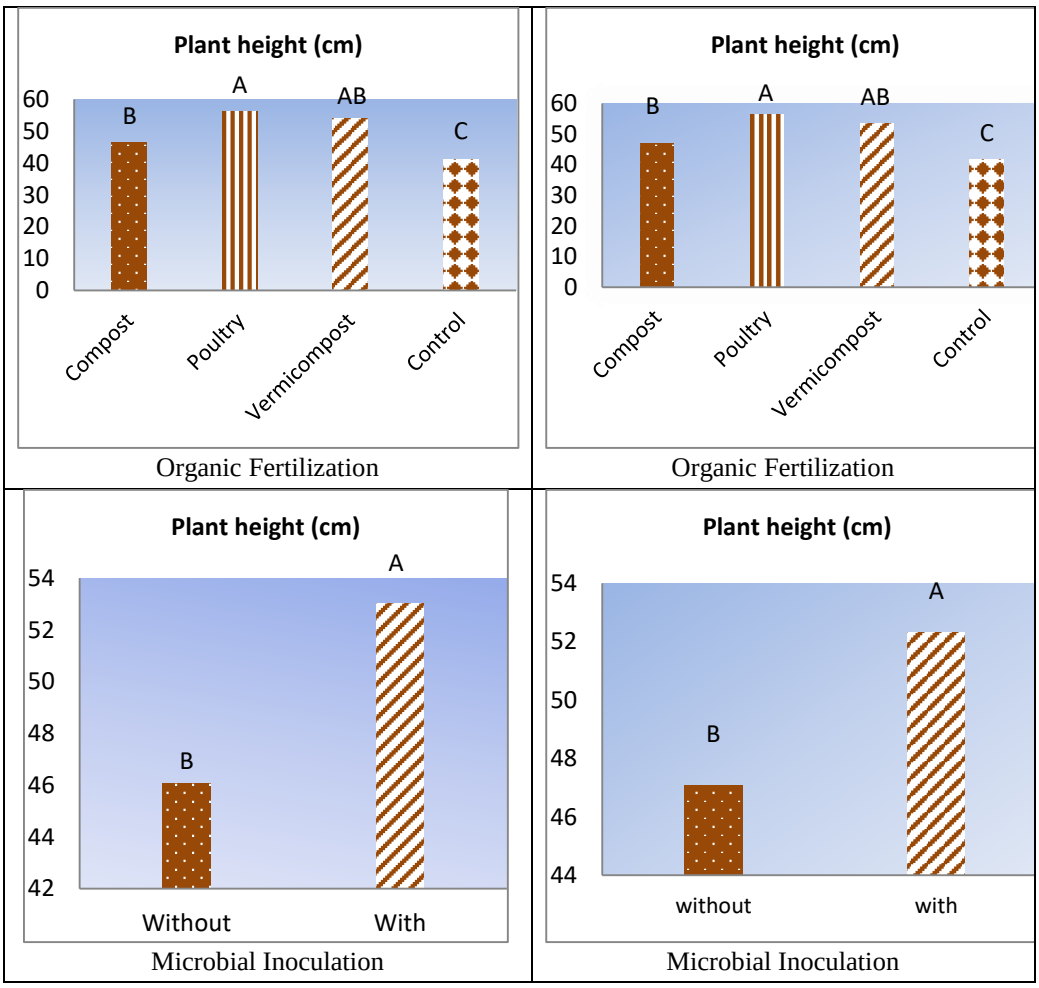

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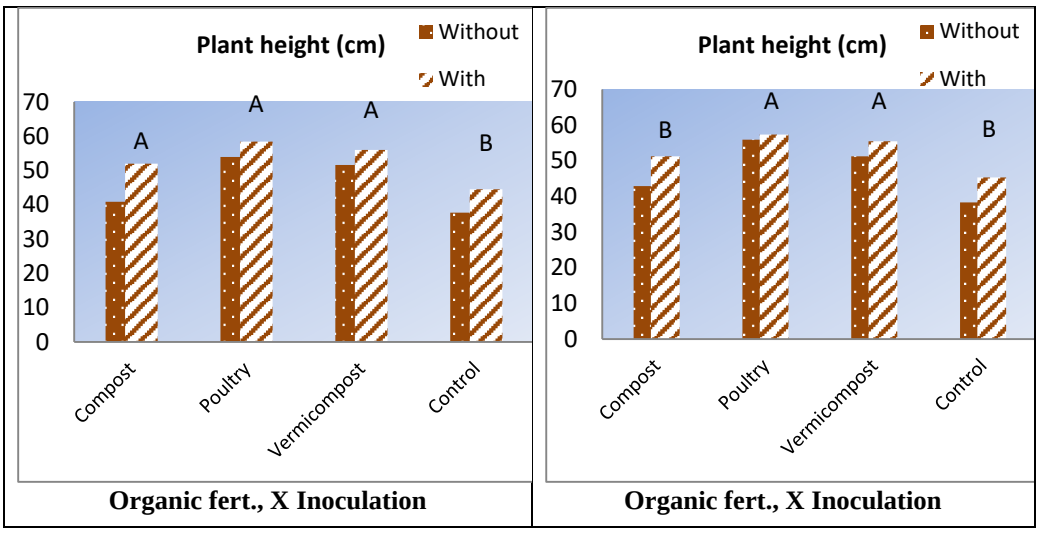

Figure (1): Effect of organic fertilization sources with microbial inoculation on height of barley plant in two growing seasons

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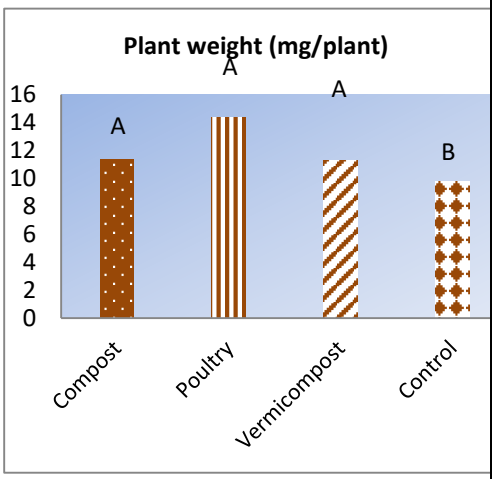
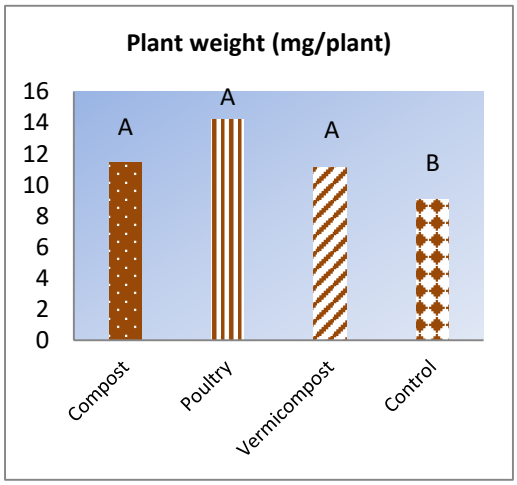
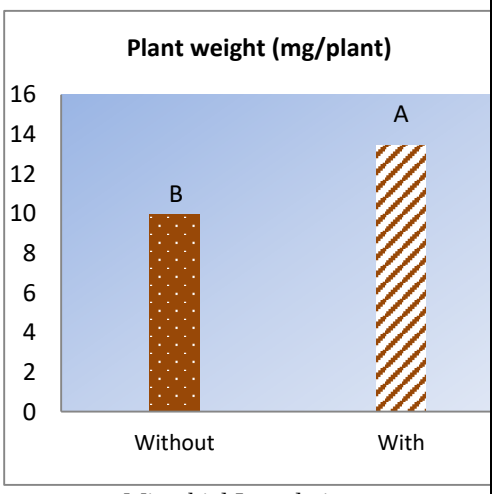


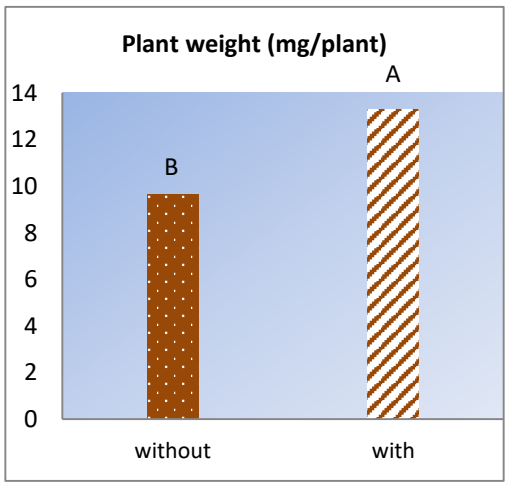
Organic Fertilization



Organic Fertilization



Microbial Inoculation



Microbial Inoculation

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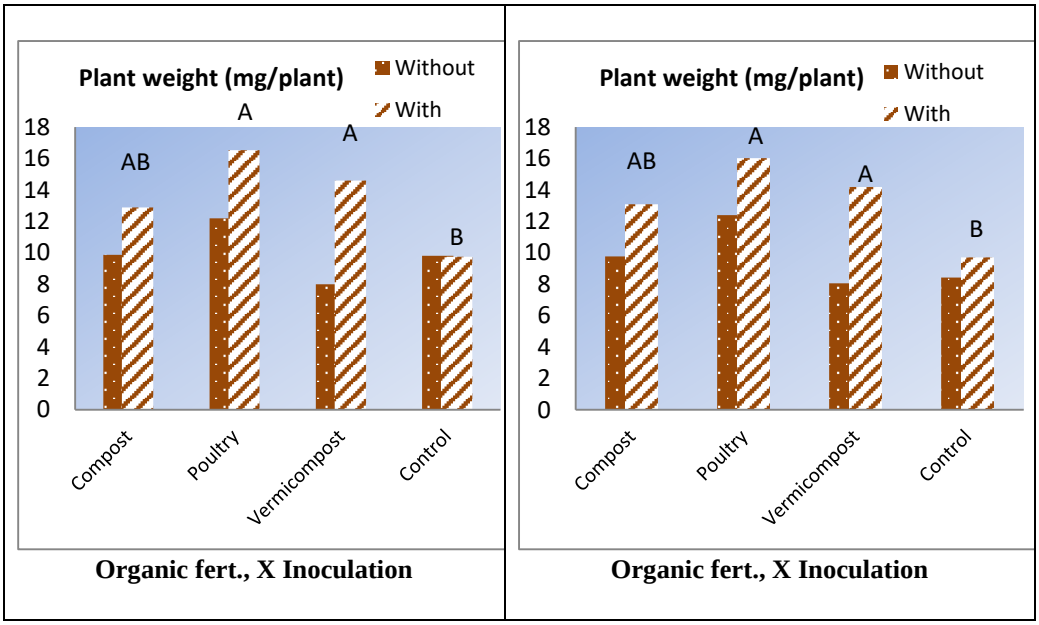

2019 **2020**

Figure (2): Effect of organic fertilization sources with microbial inoculation on weight of barley plant in two growing seasons

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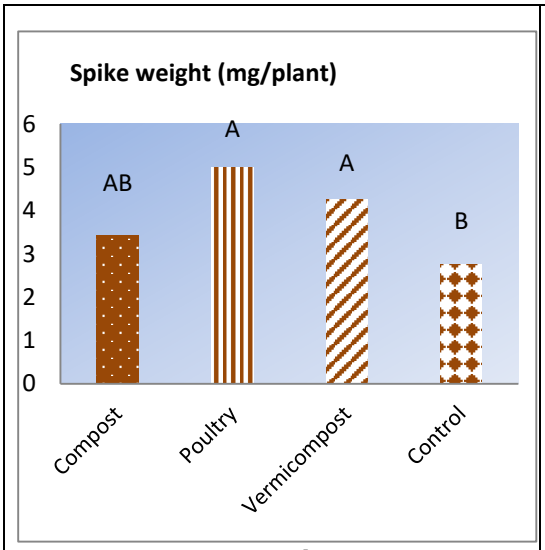

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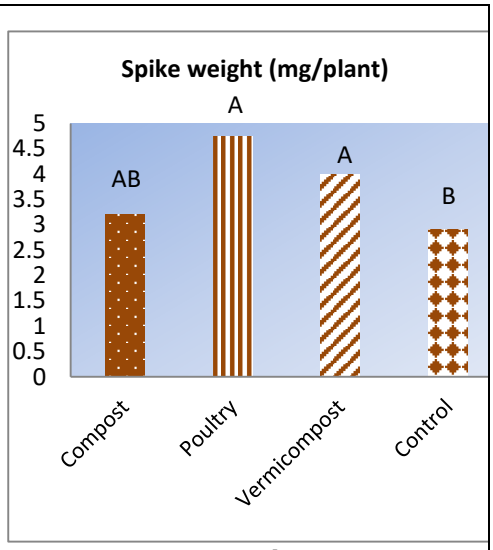

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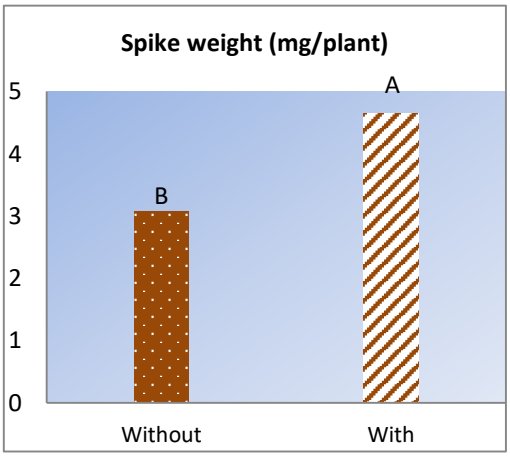
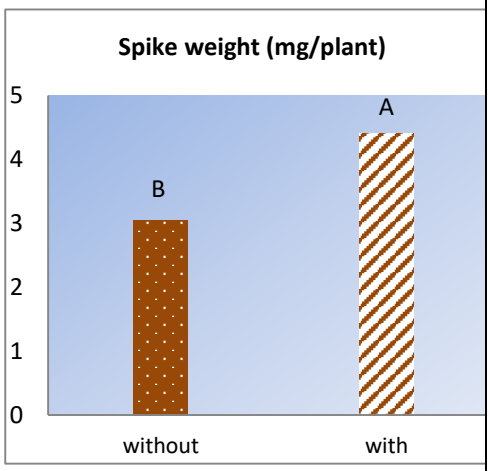


Microbial Inoculation



Microbial Inoculation

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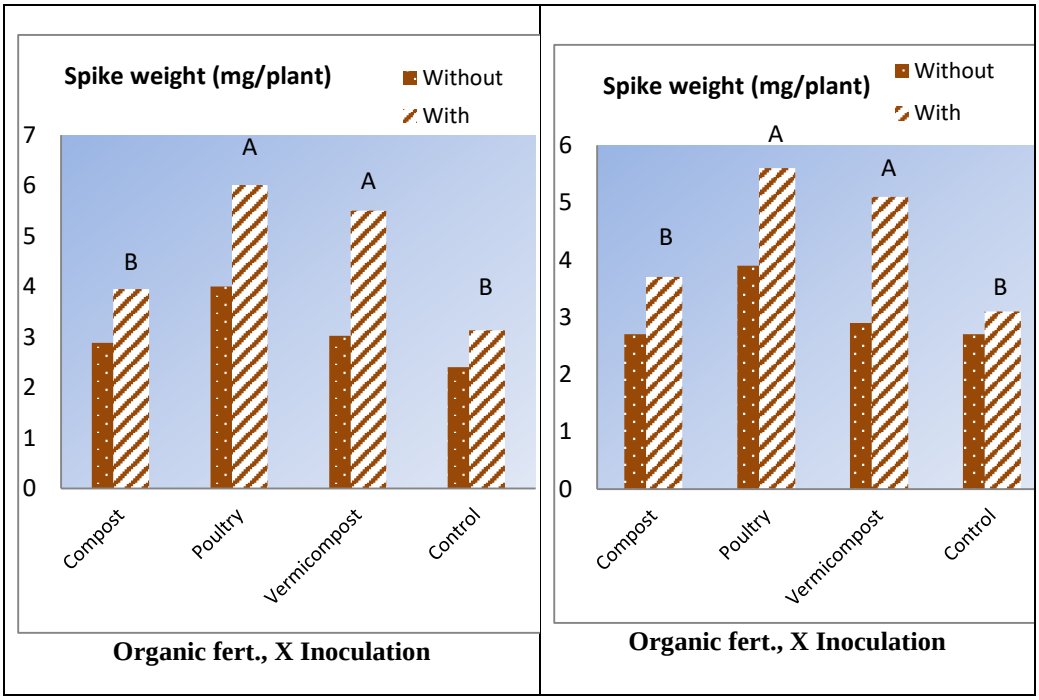

2019 **2020**

Figure (3): Effect of organic fertilization sources with microbial inoculation on spike weight of barley plant in two growing seasons

Concerning the interaction effect between organic fertilizer sources and microbial inoculation on the studied parameters, obtained data in Figure (1, 2 and 3) show that the highest significant values of plant height, plant weight and spike weight crop were observed by applying the treatment of both organic fertilizer sources i.e., poultry or vermicompost with microbial inoculation ((*Azotobacter chroococcum* (A C), phosphate dissolving bacteria (Bacillus *megatherium var. phosphaticum* (B M), potassium mobilizers

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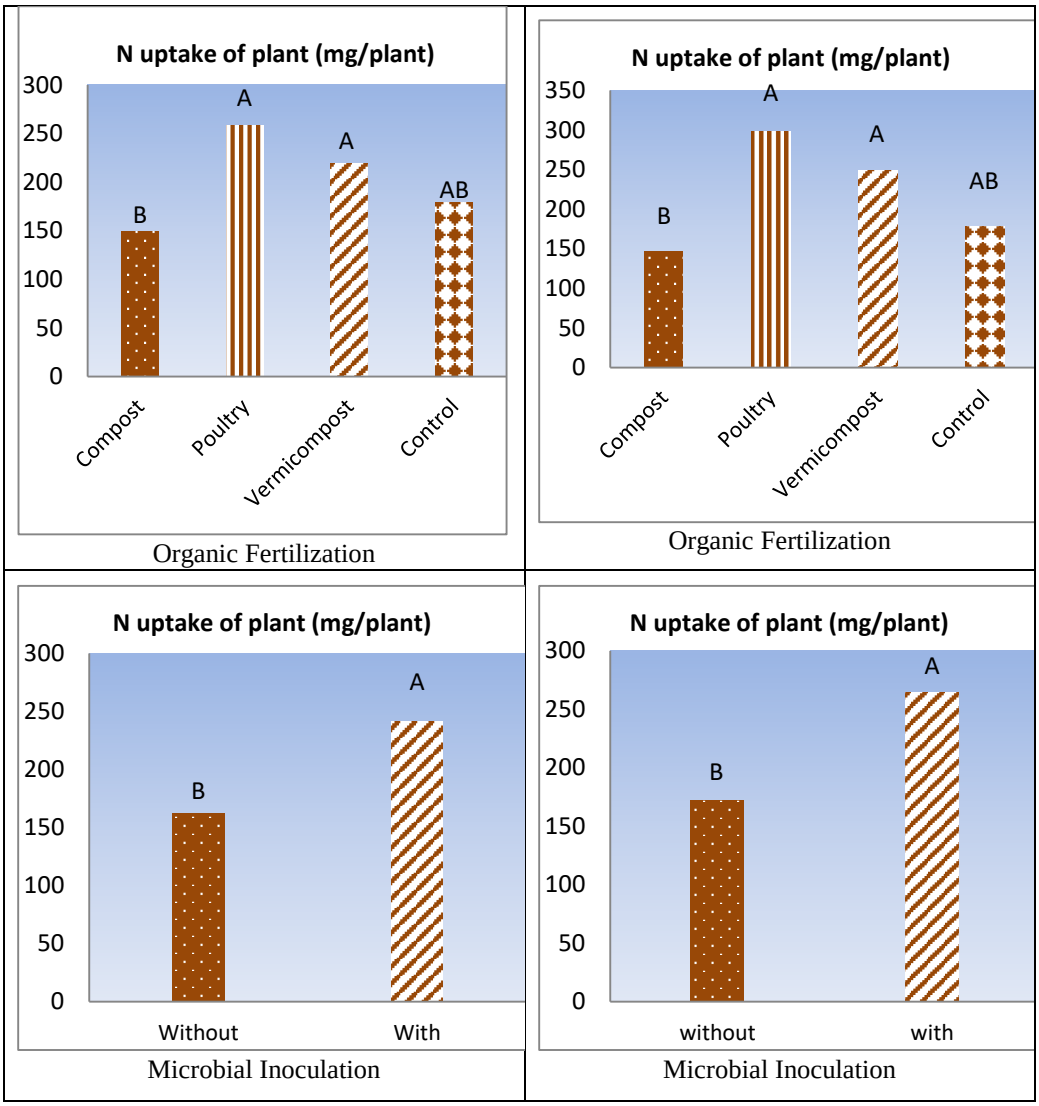
(*Bacillus circulans* (B C)) in both seasons. While, the lowest ones were obtained without organic fertilizer sources and without microbial inoculation, in the both seasons. Recycling of agricultural and industrial wastes and utilization in agriculture as an alternative to fertilizer is promising. Integrated use of chemical fertilizers with organics has been found to be quite promising in maintaining high productivity and greater stability for crop production. Vermicompost improves microbial load in soil and increases microbial availability of phosphorus and nitrogen. This led to increase the barley crop, (Senthilkumar, *et al.,* 2018).

2- N, P and K uptake of plant:

Available data in Figure (4 and 5) show that the N and P uptake of plant were increased significantly by vermicompost followed by poultry compared to without organic fertilizer in both seasons. By using this source as an organic fertilizer, it is possible to reduce the use of the chemical fertilizers up to 50%, which will reduce the production costs as well as increase the soil fertility for high crop productivity (Gao, *et al.*, 2020). On the other hand, N and P uptake of plant improved significantly by adding mixture of microbial inoculation compared to without inoculation in both seasons. Plant Growth-Promoting Rhizobacteria (PGPR) are able to exert a beneficial effect upon plant growth, so they are used as biofertilizers for agriculture (Canbolat, *et al.*,2006) the natural role of the PGPR in maintaining soil fertility is more

important than in conventional agriculture where higher use of agrochemicals mini mizes their significance.



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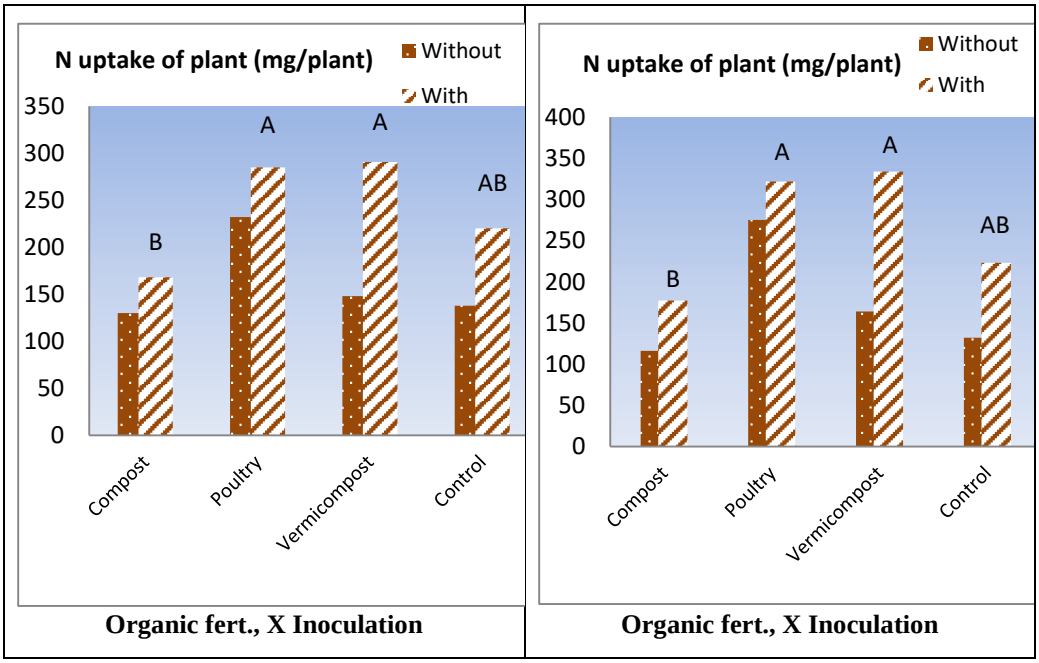

Figure (4): Effect of organic fertilization sources with microbial inoculation on N uptake of barley plant in two growing seasons

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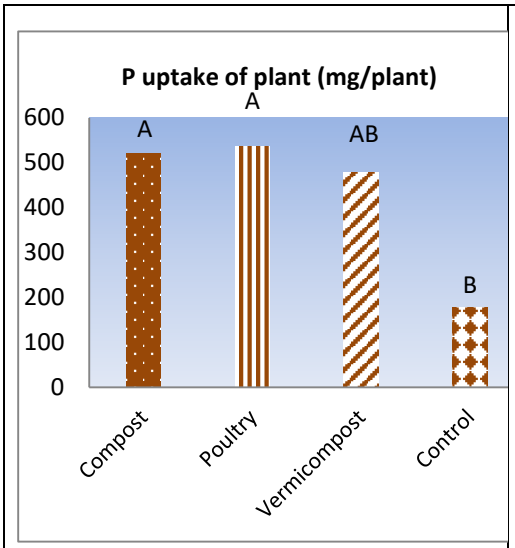
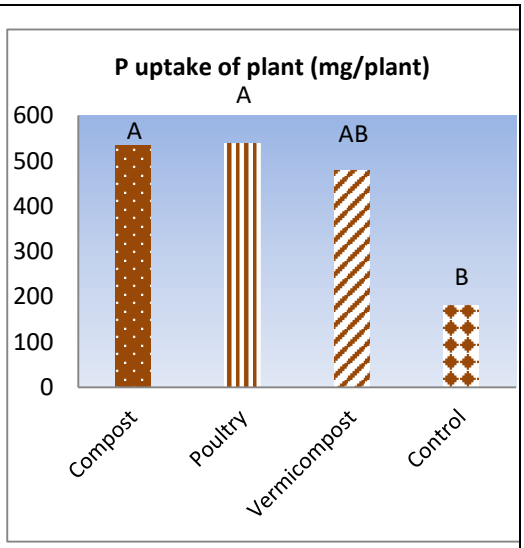
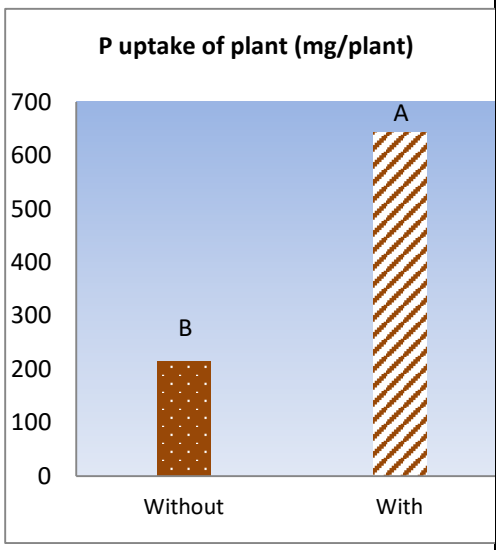


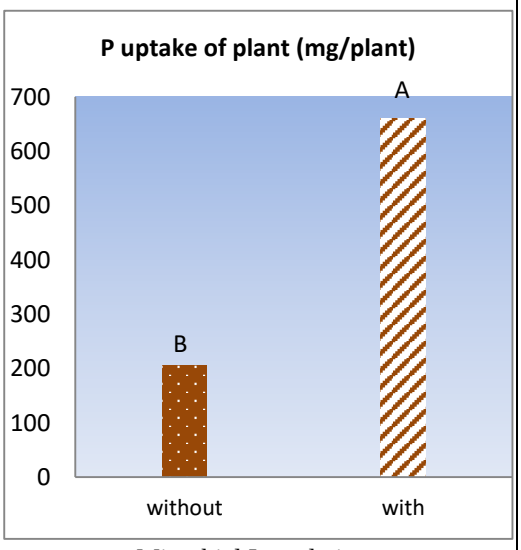
Organic Fertilization



Organic Fertilization



Microbial Inoculation



Microbial Inoculation

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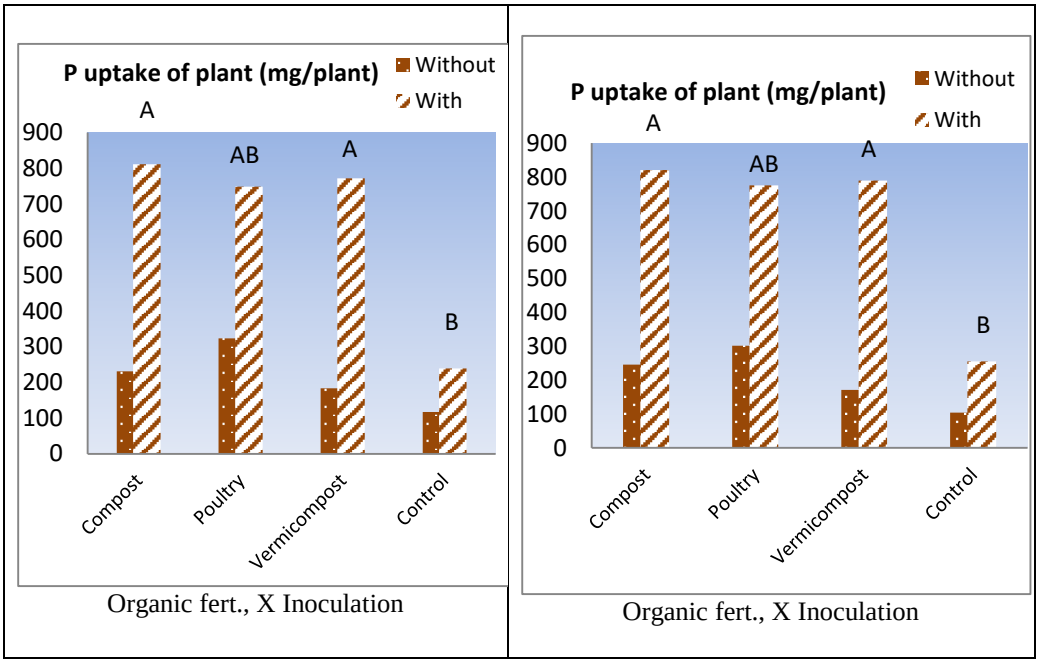

Figure (5): Effect of organic fertilization sources with microbial inoculation on P uptake of barley plant in two growing seasons

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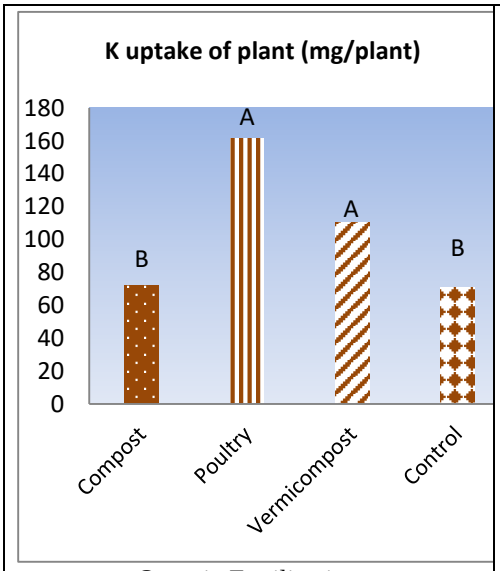
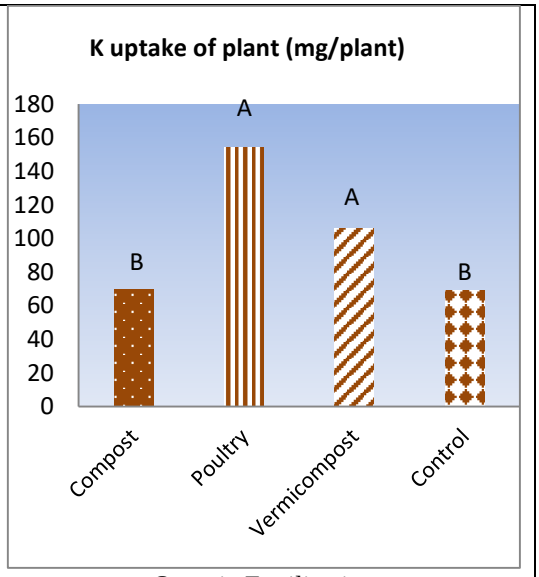
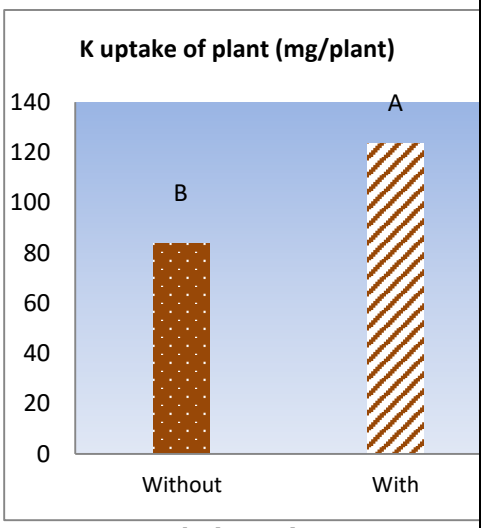


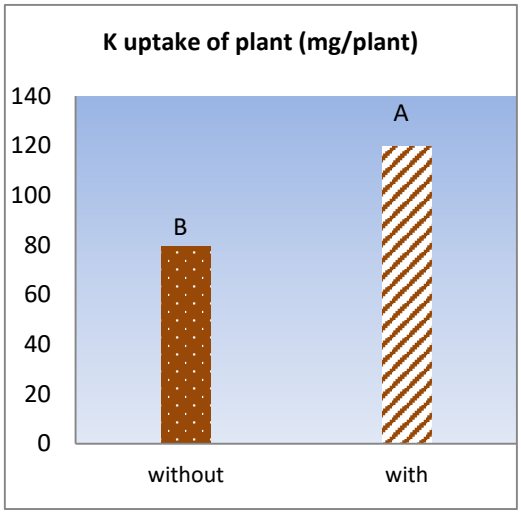
Organic Fertilization



Organic Fertilization



Microbial Inoculation



Microbial Inoculation

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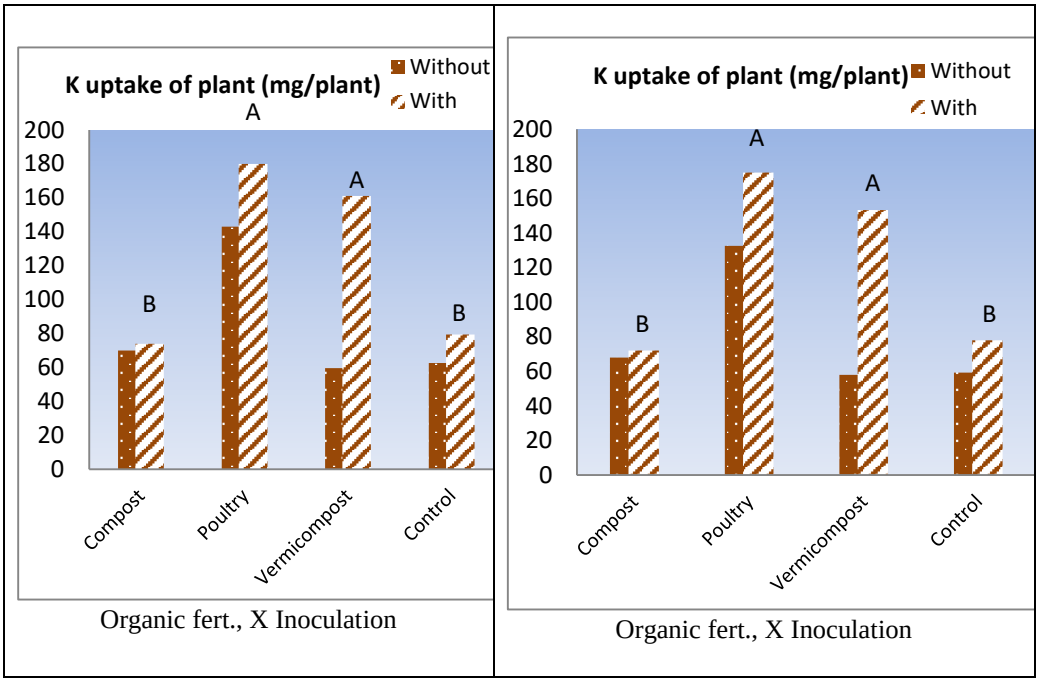

2019 **2020**

Figure (6): Effect of organic fertilization sources with microbial inoculation on K uptake of barley plant in two growing seasons

The obtained results of Figure (4 and 5) indicate that the treatment of mixed microbial inoculation alone gave the highest significant values of N and P uptake of plant compared to the control treatment (without addition of mixed microbial inoculation) in both seasons. Whilst, the lowest ones were recorded without mixed microbial inoculation in both ones.

Regarding the interaction effect between organic fertilizer sources and mixture microbial inoculation on such parameters, data in Figure (4 and 5)

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illustrate that the highest significant value of N and P uptake of plant was obtained by using the vermicompost or poultry or without organic fertilizer addition under mixture microbial inoculation by microorganisms in the both seasons, the lowest one was obtained treatment of without organic fertilizer sources under without mixture microbial inoculation in the both seasons. On the contrary, the lowest ones were observed when sole application of bacteria dissolving phosphorus without organic fertilizer addition was practiced for N and P uptake of plant in the both ones. The plant was treated by mixed culture not individual culture. Similar trends were obtained by Nandini, *et al.,* (2010) who pointed out that phosphate solubilizing bacteria are capable of transforming soil phosphorus to the forms available to plant.

Data illustrated by Figure (6) showed that the K uptake of plant was increased significantly by organic fertilizer sources of poultry followed by compost compared to without organic fertilizer in both seasons.

Also, data presented in Figure (6) indicate that the highest significant values of K uptake of plant were recorded by using the treatment of mixed culture compared to the control treatment (without microbial inoculation) in both seasons. While, the lowest ones were recorded without mixed microbial inoculation in both ones. It also, gave a significant improvement in the interaction between the two treatments, organic fertilizer and mixture microbial inoculation, this agrees with results obtained by Kantikowati, *et al.,* (2019).

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From the abovementioned results, it may be concluded that organic fertilization sources compost, poultry, vermicompost with mixture microbial inoculation, N_2 fixers (*Azotobacter chroococcum* (A C), phosphate dissolving bacteria (Bacillus *megatherium var. phosphaticum* (B M), potassium mobilizers (*Bacillus circulans* (B C)) has a high impact on increasing of vegetative parameters of barley plant in comparison with conventional phosphorus fertilizer, decrease fertilizer costs, and help to release those plant nutrients currently bound is minerals and salts. This practice can conveniently be adopted by the farmers and will be cost effective besides being ecofriendly.

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تأثر محصول الشعير وجودته بالتسميد العضوى والتلقيح الميكروبي

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المستخلص

قد اجريت هذه الدراسة فى مركز البحوث الزراعية (الجيزه , مصر) خلال موسمى الشتاء ٢٠١٩-٢٠٢٠. شملت الدراسة تأثير ثلاثة مصادر للتسميدالعضوى: الكمبوست ، سبلة الدواجن، الفيرمكمبوست و/او بدون التسميد العضوى مع التلقيح الميكروبى المخلوط: مثبت الازوت الجوى *Azotobacter chroococcum* (A C)، بكتيريا مذيبات الفوسفات Bacillus *megatherium var. phosphaticum* (B M) ميسرات البوتاسيوم *Bacillus circulans* (B C) و/او بدون التلقيح الميكروبى المخلوط على طول، وزن النبات و وزن السنبلة وكذلك محتوى النتروجين، الفوسفور والبوتاسيوم لنبات الشعير صنف جيزه ١٢٦. وقد اجريت هذه التجربة فى اصص ٣ كجم.

أظهرت النتائج المتحصل عليها أن طول النبات، وزن النبات ووزن السنبله وكذلك محتوى النيتروجين فى النبات، محتوى الفوسفور فى النبات ومحتوى البوتاسيوم فى النبات من الشعير زادت معنويا باضافة سبلة الدواجن او الفيرمكمبوست مقارنة بدون التسميد العضوى. عموما فى معظم الحالات كل الصفات زادت معنويا مع المعاملة بالتسميد الحيوى مقارنة بدون التلقيح. بشكل عام فى معظم الحالات تم تحسين هذه المعلمات معنوياً بشكل ملحوظ باضافة سبلة الدواجن او الفيرمكمبوست مع التلقيح الميكروبى المخلوط فى كلا الموسمين.

الكلمات المفتاحية: نبات الشعير, الفيرمكمبوست, التسميد العضوى, التلقيح الميكروبى, الكمبوست.

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