The effect of the bacterial biofertilizer magaterium (Bacillus), phosphorus and vermicompost on some microbiological characteristics and the percentage of organic matter in the soil cultivated with potatoes.

Zeina Kareem Jaber *** Mohammed Sallal Oleiwi**
College of Agriculture / Al-Qasim Green University

Email: mohammed35@agre.uoqasim.edu.iq

Abstract

A field experiment was conducted for potato plants in the field of the Agricultural Research and Experiment Station in Al-Muradiyeh of the Directorate of Agriculture of Babylon _ Babylon Governorate for the agricultural season according to the Factorial experience RCBD design . The addition of bacterial biofertilizer to treatment B1 gave the highest rate of microbial respiration to the soil with a value of 5.88 (mg CO2 g^{-1} dry soil) and the highest percentage of total organic carbon in the soil, which amounted to 1.61%, as well as the highest percentage of organic matter in the soil after harvest, which amounted to 0.65 %, led to the addition of phosphorus sourcesThe treatment P2 gave the highest rate of microbial respiration for the soil with a value of 6.35 (mg CO2g^{-1} dry soil) and the highest percentage of total organic carbon in the soil as it reached 1.54% and the highest percentage of organic matter gave 0.98%. Also, the addition of vermicompost to treatment F2 gave the highest Soil microbial respiration rate Its value was 5.36 (mg CO2 g^{-1} dry soil), the highest percentage of total organic carbon in the soil, which reached 1.66%, and the highest percentage of organic matter in the soil after harvest, which reached 0.68%. (mg CO2 g^{-1} dry soil) and higherThe percentage of total organic carbon in the soil reached 2.02% and the highest percentage of organic matter amounted to 0.75, and the binary interaction treatment B1F2 excelled by giving the highest rate of microbial respiration of the soil with a value of 6.73 (mg CO2 g^{-1} dry soil) and the highest percentage of total organic carbon in soil Where it reached 1.83% and the highest percentage For organic matter, it amounted to 0.83%, and the two-overlap treatment P2F2 excelled by giving the highest rate of microbial respiration for soil with a value of 7.10 (mg CO2 g^{-1} dry soil), the highest percentage of total organic carbon in the soil, which amounted to 1.79%, and the highest value for organic matter amounted to 1.50%, as well The B1P2F2 overlap treatment outperformed by giving the highest Soil microbial respiration rate of 6.63 (mg CO2 g^{-1} dry soil) and the highest percentage of total organic carbon in the soil amounted to 2.55% and the highest percentage of organic matter amounted to 0.93%, and thus we recommend the use of biofertilizer, phosphate rock and vermicompost to achieve an improvement in microbiological characteristics and increase inThe percentage of organic matter in the soil after harvest.

Keywords: biofertilizers, phosphorus , magaterium (Bacillus, vermicompost , microbiological

Introduction

Biofertilizers are considered natural preparations that contain one or more types of beneficial and safe microorganisms, because they are not genetically modified and have an effect on increasing soil fertility due to their ability to release nutrients continuously when appropriate conditions are available, as they cover most of the plant's needs The environment and contribute to reducing the added mineral fertilizers . Studies have confirmed that biofertilizers can reduce the use of mineral fertilizers in high quantities, up to 50% of the recommended amount. Among these bacterial species, the most common are Bacillus magaterium (1). The use of biofertilizers increases the yield of pollinated plants by (20-30%) and compensates for the element nitrogen and phosphorus by 25%, thus improving plant growth standards as well as preserving the fertility and composition of the soil and providing protection for plants from pathogens endemic in the soil as well as reducing pollution the soil agricultural

ISSN 2072-3857

chemicals represented by fertilizers and pesticides (2).Bacillus megaterium is characterized by its ability to form internal spores that give it a high degree of stability, drought tolerance, and its ability to produce enzymes, organic solvents, and secondary metabolic compounds. Therefore, these bacteria are of great importance in terms of increasing nutrient processing and resistance to pathogens in plants (3).And one of the reasons for the low productivity of the crop is the lack of its supply of necessary nutrients, especially phosphorus, without which the plant cannot grow and develop normally. Phosphorus is one of the basic elements that plants need in relatively large quantities, and it cannot be replaced by another element because of its important role in many physiological processes. Phosphorus is the key of life because of its direct role in most of the vital processes that take place inside the plant and that would not take place without it(4) . And vermicompost is one of the necessary growth requirements due to its importance in preparing the nutritional needs of the plant and its positive impact in increasing the yield in terms of quantity and quality on the one hand and improving the physical, chemical and biological properties of the soil rich in nutrients such as nitrogen, magnesium, iron and other nutrients and helps It helps plant growth through its good absorption. It also contains many enzymes that enhance the activities of living organisms (5) . The potato plant grows in hot, tropical and subtropical regions. Moreover, it is one of the most important tuber crops and one of the most widely used vegetable crops. Humans consume it in relatively large quantities, as it constitutes an important source of many foodstuffs, as it contains a high percentage of starch, protein, amino and organic acids, vitamins and mineral elements(6) .

Materials and Methods

A field experiment was carried out at the Muradia Research Station of the Directorate of Agriculture of Babylon on 1/20/2022 to the Factorial experience

RCBD design to know the effect of bacterial biofertilizer, sources of phosphorus and vermicompost on the preparation of bacterial and fungal cells for the two phases of vegetative growth and flowering of potato plants addition) and is symbolized by (B0, B1).The second factor is phosphorus sources at three levels (0, 100 kg ha^{-1} of superphosphate, 200 kg hectare-1 of phosphate rock) and is symbolized by (P0, P1, P2). The third factor is vermicompost with three levels (0, 8, 12) ton ha^{-1} and symbolizes it (F0, F1, F2). Soil samples were randomly taken before planting from a depth of 0 - 30 cm, dried, ground and sieved with a sieve with holes of 2 mm to estimate Soil chemical, physical and biological characteristics Table (1) shows the results of the analysis The field was divided into three replications, and in each replicate there were 18 experimental units, the area of the experimental unit was 12 m2, with dimensions of 3 x 4 m, with three paths, the length of the path was 3.5 m, and the distance between one path and another was 0.75 m. The biological fertilizer, Bacillus megaterium, and sources of phosphorus (triple superphosphate and rock) were added. Phosphate) and vermocompost and mix withThe soil was good, and potato tubers of the Burin variety were planted in a hollow, and the field was irrigated after planting, according to the plant's need, and service operations were carried out as needed. The plant was harvested at the stage of full maturity, and the microbiological characteristics and the percentage of organic matter in the soil after harvest were calculated, and the statistical analysis of the data was conducted using the least significant difference (LSD) at the level of probability 0.05. B. megaterium was obtained from the Graduate Research Laboratory of the Department of Soil Sciences and Water Resources and were activated before conducting the study.

ISSN 2072-3857

Table No. (1) The chemical, physical and biological properties of the soil before the agriculture.

Property	unit	The value
(EC)	dSm^{-1}	2.9
Soil pH	-	7.8
Gypsum	$g\ kg^{-1}$	2.2
Carbonate minerals		18.46
Soil organic matter (SOM)	%	0.54
CEC	$Cmolc\ kg^{-1}$	10.67
Positive and negative dissolved ions		
Ca^{+2}	$mmol\ L^{-1}$	9.1
Mg^{+2}		4.33
Na^{+1}		9.21
K^{+}		0.095
SO_4^{-2}		6.33
CL^{-1}		13.31
HCO_3^{-1}		2.41
CO_3^{-1}		Nil
Available nutrients		
Nitrogen	$mg\ kg^{-1}$ soil	24.3
Phosphorous		7.21
Potassium		112.6
Soil Particals		
Sand	$g\ kg^{-1}$	320
Silt		600
Clay		80
Texture class	-	Silt Loam
Bulk density	$mg\ m^{-3}$	1.35
Total number of fungi	C.F. U gm^{-1} soil	10^3*1.6
Total number of bacteria		10^6 * 2.4
The number of *magaterium Bacillus* bacteria		10^6 * 0.87

ISSN 2072-3857

Table No. 2 the characteristics of vermicompost

unit of measure	value	adjective
-	7.66	pH
dS m^{-1}	1.1	EC
%	32.77	O.M
%	20	O.C
%	1.69	Total nitrogen
%	0.0103	Phosphorus
%	0.394	potassium
%	25	Humidity
Ppm	36-50	Fe
Ppm	27-40	Zn
Ppm	15-25	Mn
Ppm	5-9	Cu
-	11.83	C/N Ratio

Results and discussion

1- **The effect of biofertilization, sources of phosphorus and vermicompost and their interactions on some microbiological properties**

1-1 -Microbial respiration in the soil (CO2 mg^{-1} g dry soil)

It is noted from the results of Table (3) that bacterial biofertilization, phosphorus sources, vermicompost and their interactions had a significant effect on the microbial respiration rate of the soil, as the bacterial fertilization of the inoculated treatment B1 reached the highest value of 5.88 mg CO2 g^{-1} dry soil , compared to treatment B0 that was given A value of 5.22 mg CO2 g^{-1} dry soil , Also, the effect of adding phosphate rock had a significant effect on the microbial respiration rate, and its highest value was in treatment P2, which had a value of 6.35 mg CO2 g^{-1} dry soil, compared to treatments P1 and P0, which had a value of 6.18 and 5.66 mg CO2 g^{-1} dry soil , as well as the addition of vermicompostThere was a significant increase in the microbial respiration rate, and its highest value was in the F2 treatment, which amounted to 5.36 mg CO2 g^{-1} dry soil , compared to the F0 treatment, which had a value of 4.14 mg CO2 g^{-1} dry soil. To a significant increase in the rate of microbial respiration and the highest valueIt was when the treatment of the binary interaction of phosphorus sources with biofertilization for the treatment B1P2, which amounted to 5.88 compared to the treatment of B0P0, which amounted to 4.03 mg CO2 g^{-1} dry soil. Binary overlap treatmentB1F2 with a value of 6.73 mg CO2 g^{-1} dry soil , compared to the binary interaction treatment B0F0 with a value of 4.25 mg CO2 g^{-1} dry soil. It was at the P2F2 binary overlap treatment that amounted toIts value is 7.10 mg CO2 g^{-1} dry soil , compared to the lowest value for the binary interference treatment P0F0, which amounted to 4.52 mg CO2 g^{-1} dry soil .It is also noted from the same table that the effect of the triple interaction of the study factors all had a significant effect on increasing the microbial respiration rate mg CO2 g^{-1} dry soil, and that

ISSN 2072-3857

its highest value was when the triple interaction treatment B1P2F2 had a value of 6.63 mg CO2 g^{-1} dry soil, as measured by the lowest value of the microbial respiration rateIt is represented by the triple overlap treatment B0P0F0, which amounted to 3.75 mg CO2 g^{-1} dry soil, with an increase of 76.8%.

Table 3: Effect of biofertilization, sources of phosphorus and vermicompost and their interactions on microbial respiration in the soil (mg CO2 g^{-1} dry soil)

Average B	B*P	vermicompost F			Sources of phosphorous P	Biofertilization B
		F2	F1	F0		
5.22	4.03	4.25	4.10	3.75	P0	Without: B0
	4.15	4.85	4.63	3.82	P1	
	4.68	5.10	4.93	4.00	P2	
5.88	4.88	5.53	5.25	4.13	P0	With: B1
	5.29	5.90	5.73	4.25	P1	
	5.88	6.63	6.10	4.93	P2	
LSD: B=	LSD:B*P	LSD: B*P*F = 1.20			value LSD	
0.24		0.73			B x F	
LSD: B*F = 1.13		6.10	5.33	4.25	B0	
		6.73	6.20	4.71	B1	
Average P					P x F	
5.66		6.73	5.75	4.52	P0	
6.18		6.93	6.81	4.80	P1	
6.35		7.10	6.97	5.00	P2	
LSD: P =0.40		LSD: P*F =0.13			value LSD	
---		5.36	5.12	4.14	---	Average F
		LSD: F = 0.10			value LSD	

1-2- The effect of biofertilization, sources of phosphorus and vermicompost and their interactions on the percentage of total organic carbon in the soil.

The results of the statistical analysis Table (4) indicated that the effect of bacterial fertilization had a significant effect on the percentage of organic carbon, as the effect of biological fertilization had a significant effect on increasing the percentage of total organic carbon in the soil. The inoculated treatment reached a value of 1.61% for treatment B1 compared to treatment B0, which amounted to Its value is 1.47%, and the addition of phosphorus sources, including phosphate rock, increased the percentage of total organic carbon in the soil, and its highest value was in treatment P2, which amounted to 1.54%, compared to the treatment of adding triple superphosphate to treatment P1 and P0, whose values were 1.37 and 1.30. % each sequentially, as ledThe addition of vermicompost to a significant increase in the total organic carbon in the soil, and its highest value was in treatment F2, which amounted to 1.66%, compared to treatments F1 and F0, which amounted to 1.48 and 1.25% each, respectively. The binary interactions of the study factors also led to a significant increase in the percentage of total organic carbon in the soil, and the effect of the bilateral interaction of bacterial fertilization and phosphorous sources resulted in a significant increase in the percentage of organic carbon, and its highest

ISSN 2072-3857

value was in the treatment B1P2, which amounted to 2.02%, compared to the treatment B0P0, which It amounted to 1.17%, and the bilateral interaction of vermicompost with biofertilization led to a significant increase in the percentage of total organic carbon in the soil, and the highest value was in the binary interaction treatment B1F2, which amounted to 1.83%, compared to the comparison treatment B0F0, which amounted to 1.43%. Also to overlap The combination between phosphorus sources and vermicompost had a significant effect on increasing the percentage of total organic carbon in the soil, and its highest value was when the binary interaction treatment P2F2, whose value amounted to 1.79%, compared to the binary interaction treatment P0F0, whose value amounted to 1.25%.

as it is noted from the same table that to the interference effect The three factors of the study had a significant effect on increasing the percentage of total organic carbon in the soil, and its highest value was in the triple interaction treatment B1P2F2, which amounted to 2.55%, compared to the lowest value of the percentage of total organic carbon in the soil, represented by the comparison treatment B0P0F0, which amounted to 1.10%

It is noted from Tables (3) and (4) that the effect of bacterial biofertilization, phosphorus sources, vermicompost and their interactions all had a significant effect on increasing the microbial respiration rate in the soil (CO_2 mg^{-1} g dry soil) and the percentage of total organic carbon in the soil, as Inoculation with bacterial biofertilizer leads This result is consistent with what they found (7) of an increase in the rate of microbial respiration in the soil and the liberation of CO_2 by 9%. The microorganisms are different nutrition in the soil as well as chemical fertilization represented by phosphorus sources, including phosphate rock and triple superphosphate, to increase the rate of microbial respiration in the soil and its reflection on the percentage of total organic carbon in the soil because chemical fertilization with phosphate fertilizer leads to a decrease in the percentage of infected roots This leads to a decrease in the percentage of fixed aggregates in the soil with the levels of phosphate chemical fertilization sources. Bacterial fertilization also led to the ability of this bacteria to decompose vermicompost, secrete organic acids, and liberate CO_2, which contributes to increasing the activity of microorganisms. Also, the treatment of vermicompost to the soil and its interaction with other factors led to the availability of organic carbon, which is an energy source and contributes significantly to increasing the respiration rate.

ISSN 2072-3857

Table 4: The effect of biofertilization, sources of phosphorus and vermicompost and their interactions on the percentage of total organic carbon in the soil.

Average B	B*P	vermicompost F			Sources of phosphorous P	Biofertilization B
		F2	F1	F0		
1.47	1.17	1.25	1.17	1.10	P0	Without: B0
	1.24	1.30	1.28	1.15	P1	
	1.32	1.39	1.35	1.22	P2	
1.61	1.37	1.45	1.41	1.26	P0	With: B1
	1.63	2.00	1.59	1.31	P1	
	2.02	2.55	2.10	1.43	P2	
B= LSD	LSD:B*P	LSD: B*P*F = 0.86			value LSD	
0.08	0.35				B x F	
LSD: B*F = 0.25		1.52	1.47	1.43	B0	
		1.83	1.61	1.47	B1	
Average P					P x F	
1.30		1.35	1.31	1.25	P0	
1.37		1.43	1.39	1.29	P1	
1.54		1.79	1.50	1.34	P2	
LSD: P =0.06		LSD: P*F =0.20			value LSD	
---		1.66	1.48	1.25	---	Average F
		LSD: F = 0.07			value LSD	

Microbial and increase the percentage of total organic carbon in the soil. These results are consistent with what they found (8) .Biofertilization also has a major role in the decomposition of phosphate rock and in increasing the availability of nutrients, including phosphorous, as vermicompost has the ability to secrete clomaline, proteins and sugars, and thus make the soil mediumSuitable for the growth of other microorganisms (9).The increase in the rate of microbial respiration and the percentage of total organic carbon in the soil (Tables 2) and (3) is attributed to the settlement of bacteria in the rhizosphere, where it works to stimulate the physiological response, which is clearly reflected in the increase in root branches, which increases the mass of the vital roots and its secretions that affect on activityBiological, as well as the bilateral interactions between bacterial fertilization and sources of phosphorus and vermicompost works to encourage plant growth through several mechanisms, as it works to fix atmospheric nitrogen and dissolve phosphorus and decompose organic matter and the production of chelating compounds and reduction of ethylene and used in biological control because the interaction of factorsThe studies together lead to an increase in the rate of microbial respiration (CO_2 mg^{-1} g dry soil) and its reflection on the increase in the percentage of total organic carbon in the soil (10).

2- The effect of biofertilization, sources of phosphorus and vermicompost and their interactions on the percentage of organic matter in the soil.

It is noted through the results of Table (5) that the effect of bacterial biofertilization, sources of phosphorus and vermicompost and their interactions all had a significant effect on increasing the percentage of organic matter in

ISSN 2072-3857

the soil after harvest, as the inoculation with bacterial fertilizer led to a significant increase in the percentage of organic matter in the soil after harvest and gave treatment B1 had the highest value of 0.65% compared to treatment B0, in which the percentage of organic matter in the soil reached 0.51%, which amounted to 0.98%, compared to treatment P1, which is a source of triple superphosphate, and control treatment P0, which amounted to 0.68 and 0.57% for each of them, respectively. percentage of organic matter inSoil after harvest and the highest amount of it was in treatment F2, which amounted to 0.68%, compared to treatments F1 and F0, which amounted to 0.64 and 0.44%, with an increase of 6.25 and 54.5% for each of them, respectively.

The effect of vermicompost through its decomposition, as most of the organic acids that work to increase the percentage of organic matter in the soil after harvesting (%) are released from it. Membership in soil after harvest, and its highest value was when the binary overlap treatment B1P2, which amounted to 0.75%, compared to the lowest value for the binary overlap treatment B0P0, which amounted to 0.48%, with an increase of 56.3%. in increasing the ratioThe percentage of organic matter and its highest value was in the treatment of binary interference B1F2, which amounted to 0.83%, compared to the lowest value of the percentage of organic matter represented by treatment B0F0, whose value amounted to 0.35%And the highest value was in the treatment of binary interference P2F2, which amounted to 1.50% compared to the lowest value of the percentage of organic matter in the soil after harvest, and was in the control treatment P0F0, which amounted to 0.45%.

It is also noted from the same table that the influence of the study factors represented by their triple interactions led to a significant increase in the percentage of organic matter in the soil after harvest, and that the highest value was in the treatment of the triple interaction B1P2F2, which amounted to 0.93%, which did not differ significantly from the treatment of the triple interaction B1P1F2, which reachedIts value was 0.73%, while the lowest percentage of organic matter in the soil after harvesting was represented by the triple overlap and comparison treatment, which amounted to 0.35% . as biofertilization may be attributed to its role in improving plant growth because it contains many organic acids and nutrients, which increased the secretions of roots and increased the number of bacterial cells than increased organic carbon and its reflection on the increase in the percentage of organic matter in the soil after harvest. These results are consistent with what they found (11), and bio-fertilization produces organic acids and releases CO2 during the mineralization process and its union with water (soil moisture), which leads to the formation of acid carbonic, which in turn leads to reduce the degree of interaction of the soil pH with an increase in the readiness of macronutrients and its reflection on the increase in the percentage of organic matter in the soil after harvesting, and this was confirmed by (12) and that the effect of adding phosphorus sources had a significant effect on increasing the percentage of organic matter in the soil after harvesting. Since the vermicompost and its decomposition release most of the nutrients and increase the organic acids that work to increase the percentage of organic matter in the soil (8). The effect of phosphorus sources had a significant effect on the percentage of organic matter in the soil after harvest, and its highest value was in the treatment of P2, whose source is phosphate rock, which when dissolved releases most of the nutrients, including phosphorus and some organic acids, which have a major role in increasing the percentage of matter. Membership in soil, and its highest value was in treatment P2.

ISSN 2072-3857

Table 5: Effect of biofertilization, sources of phosphorus and vermicompost and their interactions on the percentage of organic matter in the soil after harvest.

Average B	B*P	vermicompost F			Sources of phosphorous P	Biofertilization B
		F2	F1	F0		
0.51	0.48	0.56	0.53	0.35	P0	Without: B0
	0.52	0.59	0.58	0.39	P1	
	0.54	0.62	0.60	0.41	P2	
0.65	0.92	0.67	0.64	0.45	P0	With: B1
	0.64	0.73	0.70	0.50	P1	
	0.75	0.93	0.79	0.52	P2	
LSD: B=	LSD:B*P	LSD: B*P*F = 0.28			value LSD	
0.09		0.15			B x F	
LSD: B*F = 0.40		0.63	0.55	0.35	B0	
		0.83	0.72	0.41	B1	
Average P					P x F	
0.57		0.69	0.59	0.45	P0	
0.68		0.85	0.73	0.48	P1	
0.98		1.50	0.93	0.51	P2	
LSD: P =0.21		LSD: P*F =0.55			value LSD	
---		0.68	0.64	0.44	---	Average F
		LSD: F = 0.02			value LSD	

CONCLUSIONS

we recommend the use of biofertilizer, phosphate rock and vermicompost to achieve an improvement in microbiological characteristics and increase inThe percentage of organic matter in the soil after harvest and The use of various biological fertilizers because of their great role in improving soil characteristics and increasing its fertility. We recommend the use of bacterial biofertilizer, phosphate rock and vermicompost at higher levels for other crops to reach results that can be used in achieving sustainable development, clean agriculture and pollution reduction.

Reference:

1- **Al-Musawi**, Ali Abadi Manea and Khalid Abdul-Amir Abbas Al-Birmani. (2017). The effect of adding organic fertilizers on the growth and yield of two cultivars of broccoli (*Brassica oleracea* var. Italica). Al-Furat Journal of Agricultural Sciences.9(4).1016-1023 .

2- **Yazdani**, M.; M. K. Bahmanyar; H. Pirdashti and M.A. Esmaile. (2009). Effect of phosphate solubilization microorganism (PSM) and plant growth promotion rhizobacteria (PGPR) on yield componenets of corn (*Zea mays* L.): World Academy of Science,Engineering and Technology . 37: 90-92.

3- **Devi**, A. R.; R. Kotoky; P.Pandey and G. D. Sharma.(2016). Application of Bacillus spp. for Sustainable Cultivation of Potato (*Solanum tuberosum L.*) and the Benefits. In Bacilli and Agrobiotechnology (pp. 185-211). Springer, Cham.

ISSN 2072-3857

4- **Bamagoos** , A,A., Alharby , H.F., Belal , E.E., Khalaf , A. E. A., Abdelfattah , M.A., Rady, M.M., Ali , E.F., Mersal , G.A.M .(2021). Phosphate – solubilizing becteria as a panacea to alleviate stress effects of high soil CaCO3 content in phaseolus vulgaris with special reference to P-releasing enzymes. sustainability 13 (13) , 7063. https ://doi.org/10.3390/su13137063.

5- **Haider** Makki Jahil , Jawad Abdl-Kadhim Kama. (2021). Effect of Bacillus megaterium, Vermicompost, and Phosphate pock on Growth and yield of sunflower (Helianthus annuus L.) . Earth and Environmental science 735 (012087) .

6- **Bártová, V.; J. Bárta; A. Brabcová; Z. Zdráhal and Horáčková, V.(2015**). Amino acid composition and nutritional value of four cultivated South American potato species. Journal of Food Composition and Analysis, 40:78-85.

7- **Zhang** , B.,Li,S.,Chen ,S., Ren T.,Yang Z.,Zhao,H., …and Han , X. (2016). Arbuscular mycorrhizal fungi regulate soil respiration and its response to precipitation change in a semiarid steppe . Scientific Reports , 6 (January),1-10 .

8- **Oehl** , F.,E. Sieverding , K . Ineichen , P .Mader , T. Boller and A.Wiemken . 2003. Impact of land use intensity on the species diversity of arbuscular mycorrhizal fungi in agroecosystem of Central Europe . Applied Environ . Miceobial ., 69:2816-2824.

9- **Havlin** , J .L .,Beaton , J.D., Tisdale , S .L ., and Nelson , W.L. (2005). Soil fertility and fertilizers :An introduction to nutrient management (No. 631.422/H388).New Jersey : Pearson prentice hall.

10- **Saharan**, B and Nehra, V. (2011). Plant growth promoting rhizobacteria: A critical review, Life Sciences and Medicine Research, Volume 2011 -21 , http://astonjournals. com/lsmr.

11- **Van** Der Heijden , M . G., Martian , F.M., Selosse , M. A., and Sanders , I.R.(2015). Mycorrhizal ecology and evolution ; the past , the present , and the future . New Phytologist , 205(4) , 1406-1423.

12- **Ganiger**, V.M.,J.C. Mathad.,M.B.Madalageri., H.B.Babalad,. N.S.Hebsur and B.Y. Nirmala.(2012). Effect of organics on the Physico-Chemical properties of soil after bell pepper cropping under open field condition. Karnataka J.Agric. Sci.,(4):479-484.

ISSN 2072-3857