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EFFECT OF PSEUDOMONAS AND TRICHORDEMA ON THE PROPERTIES AND QUANTITY OF ORGANIC MATTER AND POTATO GROWTH

S. J. Mohammed[1]* H. A. Ali[2] A. A. Khadhum[1]*

[1] College of Agriculture - University of Anbar
[2] The Euphrates Basin Development Center - University of Anbar

***Correspondence to:** Sara Jasim Mohammed, Department of Soil Science and Water Resource, College of Agriculture, University of Anbar, Iraq.
Email: Jassimsalih2@gmail.com

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Abstract

The increase in chemical pesticides in the soil causes great damage to the environment, humans, and animals, leading to the destruction of many beneficial and harmful organisms in the soil. This study aimed to identify the effect of Pseudomonas and Trichoderma with organic matter on the productivity of potatoes and the residue after using the glyphosate pesticide. The soil was analyzed before and after planting, estimating elements that affect soil fertility, including total nitrogen, organic carbon, phosphorus, pH, salinity, carbonates, bicarbonates, calcium carbonate, calcium, sodium, and other essential elements for plants.

The treatments regarding organic matter showed that treatment C5 excelled over the rest of the treatments, with a value of 200.600 ppm, followed by treatment C1 with a value of 200.101 ppm, and treatment C7 with a value of 200.001 ppm. Treatments C3 and C8 had equal values of 199.812 ppm. Regarding the interaction between the concentration of the pesticide and temperature, the relationship was significant at a 0.05 level, indicating that high temperature is an important factor in the decomposition of the pesticide. The results of the study indicated that higher pesticide concentrations require longer periods for decomposition, assisted by bacteria and fungi present in the soil, specifically using Trichoderma fungus and Pseudomonas bacteria to decompose glyphosate.

Keywords: Pseudomonas, Trichordema, Organic matter. Glyphosate pesticide, Potatoes.

تأثير بكتريا السيدوموناس وفطر الترايكودرما في خصائص ومقدار المادة العضوية ونمو البطاطا

سارة جاسم محمد[1]* هالة أرشد علي[2] علي عبدالله كاظم[1]

[1] كلية الزراعة – جامعة الانبار

[2] مركز تنمية حوض اعالي الفرات – جامعة الانبار

***المراسلة الى:** سارة جاسم محمد، قسم علوم التربة والموارد المائية، كلية الزراعة، جامعة الانبار، العراق.

البريد الالكتروني: Jassimsalih2@gmail.com

الخلاصة

إن زيادة المبيدات الكيماوية في التربة لها أضرار كبيرة على البيئة والإنسان والحيوان، وتتلخص في تدمير العديد من الكائنات الحية المفيدة والضارة في التربة. هدفت الدراسة إلى التعرف على تأثير بكتيريا Pseudomona و Trachoderma مع المادة العضوية وتأثيرها على إنتاجية البطاطس ومعرفة المتبقي منها بعد استخدام مبيد الجليفوسات. تم تحليل التربة قبل الزراعة وبعد الزراعة وتقدير بعض العناصر التي تؤثر على خصوبة التربة للعناصر (النيتروجين الكلي، الكربون العضوي، الفوسفور، الرقم الهيدروجيني، الملوحة، الكربونات، البيكربونات، كربونات الكالسيوم، الكالسيوم، الصوديوم، وباقي العناصر) العناصر الأساسية للنباتات). وأظهرت المعاملات الخاصة بالمواد العضوية تفوق المعاملة C5 على بقية المعاملات بقيمة 200.600 جزء في المليون، تلتها المعاملة C1 بقيمة 200.101 جزء في المليون، تليها المعاملة C7 بقيمة 200.001 جزء في المليون، بينما المعاملات C3 وقيمة 200.001 جزء في المليون. جاء C8 بالتساوي مع 199.812 جزء في المليون. وفيما يتعلق بالتفاعل بين تركيز المبيد ودرجة الحرارة فقد كانت العلاقة معنوية عند مستوى معنوي قدره 0.05 مما يدل على أن ارتفاع درجة الحرارة مؤشر مهم على تحلل المبيد. أشارت نتائج الدراسة إلى أنه كلما زاد تركيز المبيد كلما زادت الحاجة إليه، وذلك للمساعدة في تحلل المبيد من خلال البكتيريا والفطريات الموجودة في التربة، والتي استخدم فيها فطر الترايكوديرما وبكتيريا الزائفة في التربة تحلل الغليفوسات.

كلمات مفتاحية: بكتريا السيدوموناس، الترايكودرما، المادة العضوية، مبيد كلايفوسيت، البطاطا.

Introduction

Physical and chemical treatment of pesticides and their metabolites are discouraged by researchers due to issues with time consumption, cost-effectiveness, and sustainability compared to microbial and enzymatic treatment. Microorganisms from diverse taxonomic groups, such as bacteria, fungi, and algae, are known to actively metabolize pesticides and/or alter chemical structures facilitating their degradation and rendering the contaminated environment free of harmful pesticide residues. Similarly, catalytic enzymes, such as lactase and peroxidase (16). Managing residual pesticides remains a global challenge. And the contamination of soil and

water resources with pesticides has a negative impact on agricultural productivity and food security, and therefore they pose threats to microorganisms in the soil. These pesticide residues can be processed in the ecosystem by several biological, chemical and physical processes such as microbial-based degradation and advanced oxidation processes. In doing so, it offers a sustainable solution for remediation of contaminated soil .Pseudomonas bacteria are among the most widespread types of bacteria in the world, and the most widespread species in the soil and cause many diseases, causing many deaths, when compared with other bacteria. It must be used in analyzing the chemicals of pesticides used in the soil. Many studies indicate their ability to secrete and benefit from enzymes (11).

Fungi, including *Trichoderma harizanum*, were used as biofertilizers instead of chemical fertilizers due to its high property in plant growth (from seedlings to plant length, even productivity). Thus, it is considered a biofertilizer useful in decomposition as well as a positive cycle in supporting and feeding the plant, increasing growth and thus increasing the productivity of the cultivated crop (4). The spread of these jungles in all areas, whether cultivated or uncultivated lands, as well as in residential areas and cities, which causes distortion in the views of those cities, and causes disturbance to the population in general, and causes damage to public parks and may be a cause of fires, and causes great losses in the costs of eliminating these jungles, through its harm to crops and livestock as well (19).

Many researchers confirmed that there is great damage to the weeds on the potato crop all over the world, as the weeds caused a decline in the quality and productivity of potatoes, both in terms of quantity and quality, through competition for crop food as well as light and water (9). In addition, these harmful bushes cause the secretion of toxic substances that inhibit the growth and productivity of the crop, as well as their direct impact on the quality and tubers of potatoes, through the rhizomes of these bushes, and tubers may also be punctured. Also, these bushes are considered an important source of fungal and viral diseases of potatoes. (20). This study presents some current and emerging techniques for managing pesticide residues and environmental risks.

Materials and Methods

The experiment includes 25 treatment of glyphosate herbicide with three concentrations 0.10%, 20%, 30% and organic matter treatment at two levels 0 and 10 tons per hectare and soil microorganisms at three levels 0, Pseudomonas bacteria and Trichoderma fungus, and 50% of the fertilizer recommendation and the fertilizer recommendation for potatoes (5 kg/ ton) were added with it. A comparative treatment, adding the complete fertilizer recommendation 100%, without any additions, with three repetitions, and each replicate is five bags of forty kg capacity, between one bag and another 25 cm, and between a line and another 75 cm. Thus, the number of experimental units is 375 bags (4 x 2 x 3 + 1 x 3 x 5 = 375 bags). The experiment was carried out in one of the fields belonging to the College of Agriculture, Department of Soils and Water Resources/ College of Agriculture/ University of Anbar - Al-Boufaraj region. For the agricultural season 2022-2023.

The potato crop (Burren variety) was cultivated on 14/1/2023, where the field was plowed two perpendicular plows, and then the soil was cleaned from the remnants of the bushes, after which planting bags were filled with soil, 30 kg of soil per bag, and sterile animal manure was added to the treatments that were determined for animal fertilization with the rest of the additives (pesticides, bacteria, fungi, with its concentrations). Drip irrigation pipes were distributed to all treatments, and the homogeneity of the drippers was measured before planting, and the amount of irrigation water that should be added was calculated according to the equation mentioned by (12). Then, potatoes were planted by placing 2-3 sterilized potatoes in the soil, after spraying clifosate, according to the proportions of the treatments to bags before planting. And in addition to the vital vaccines that have been prepared, the vaccine (fungal and bacterial vaccines) was prepared in the Upper Euphrates Basin Laboratory/ Anbar University, where 500 ml of bacteria were prepared for every 1 kg of potato after it was first immersed in a resinous substance (gum arabic),

As for mushrooms, they were prepared with 2 gm per 100 ml of distilled water, 400 ml of mushrooms per 1 kg of potatoes. The fungus was grown on millet seeds, with a moisture content of 60%.

Then samples were taken after 65 days of cultivation to measure the pesticide residue in the soil using the HPLC device, and soil and plant analyzes were carried out after completing the cultivation.

Study bacteria test experiment in the decomposition of Glyphosate pesticide: Soil samples were made decimal dilutions in a physiological saline solution of 0.85% with dilutions 10^{-6} - 10^{-1}. 1 ml of concentration 10-6 was taken and grown on the solid nutrient media, and the cultures were incubated in an incubator at a temperature of 28 C for 48 hours. After the emergence of microbial colonies, their ability to degrade the *Glyphosate* pesticide was tested in order to determine which ones are capable of degrading the pesticide for the purpose of isolating, diagnosing and conducting biological experiments on them. Liquid cultures were prepared from modified mineral saline medium, and the liquid cultures were inoculated with similar concentrations of microbial colonies by transferring 500 microliters of the 6-10 dilution. The liquid cultures were incubated at 28°C for 72 hours. The light density of these cultures was measured after the appearance of uneven microbial growth (12). The number of live cells of the culture with the higher optical density value compared to other cultures was counted (8), and this microbial colony was elected to complete the rest of the isolation and diagnosis tests.

Diagnosis of *Pseudomonase sp*: Conducting microscopic and biochemical examinations based on the internationally used scientific sources for the diagnosis of isolates (8), which includes:

Morphological Characterization: The phenotypic characteristics of the bacterial colonies growing on King B agar were studied in terms of shape, color, odor and edge.

Microscopic Examination: Bacteria were detected by microscopy of stained, g-stained slides to distinguish G-negative bacteria from others.

Isolation of *Pseudomonase Sp*: A local isolate of the *Pseudomonase* genus A6b6 was selected from the type *P- Fluorscens* was used in laboratory and field

experiments due to its resistance and its large number. This bacterium was grown on the liquid culture medium N, broth by placing 50 ml of the medium in a conical flask with a capacity of 100 ml and inoculating with a one-day-old bacterial culture using the carrier and incubated at a temperature of 28 °C for a period of 48 hours and for the purpose of preparing a large amount And enough vaccine for the purpose of using it in the experiments. Conical flasks of 250 ml were used, each containing 100 ml of the culture medium. After sterilization, it was inoculated with 1 ml of the liquid culture and incubated at a temperature of 28 C for 48 hours.

Fungal Pollen *Trichoderma Harzianum*: The fungus was obtained from the Department of Prevention, College of Agriculture, University of Anbar, and classified according to, one gram of spores contains $14 \times 10_6$ (2).

Statistical Analysis: The field experiment was carried out according to the randomized complete block design according to the order of factorial experiments and with three replications, which included three factors: the first factor was the addition of microorganisms (without addition, *pseudomonase sp*, *Trichoderma harzianum* fungus). The second factor is the addition of the organic matter (adding and without adding). And the third factor is pesticide concentrations 0, 10, 20, 30 mg/l in addition to a comparative treatment (adding the full fertilizer recommendation). The data were analyzed according to the additive treatment design of the factorial experiment (10 and 17) according to the analysis of variance table below. Averages were compared according to the Least Significant Difference (LSD) test at a probability level of 0.05. The results were analyzed using Genstat v.12.1 software.

Results and Discussion

Electrical conductivity (EC) Value: The results of the study, regarding the EC value obtained from the statistical analysis and Figure 1, indicated that the treatment to which fungus was added with organic matter was superior to the rest of the treatments to which bacteria were added. Where the fungus treatment with the organic matter recorded a value of 3.930 with a pesticide concentration of 10%, while the fungus treatment with the organic matter came second and recorded 2.960 with a pesticide concentration of 30%. The results of the study indicated in Figure 1 significant relationship between the average of the treatments at a significant level of 0.05, which was 0.027, and the same was the case with the significant relationship for the average of the neighborhoods and recorded 0.019. An indication of the importance of the additions of organisms with organic matter on their effect on EC in the soil.

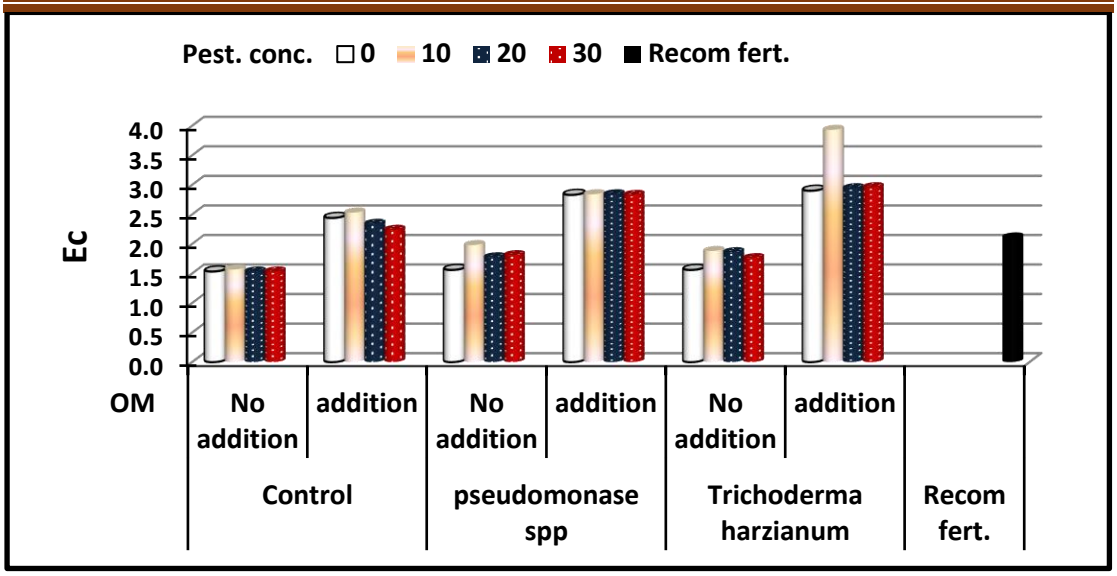

Figure 1: EC value.

The effectiveness of these biofertilizers, including organic ones, depends mainly on their numbers, soil type, and environmental conditions. To raise the level of sub-optimal activity of the microorganisms, the bio-fertilizer is artificially compounded to accelerate the biological activity which ultimately leads to an increase in the availability of nutrients to the plant. Hence, our study was conducted to demonstrate the beneficial effects of T. *viride* and *P. fluorescens* on the morphological quality of cabbage seedlings and field performance to present them as potential biofertilizers for yield enhancement (18).

Amount of Organic Matter: The organic matter remaining in the soil was extracted according to what is shown in Figure 2, to find out what remains of that organic matter added to the planting bags after the end of the potato growing season, and then take the filtrate to be measured by the Oil Content device, where the results shown in Figure 2 appeared, where the highest value of organic matter came for treatment C5 With a value of 200.600 PPm, followed by treatment C1 with a value of 200.101 PPm, followed by treatment C7 with a value of 200.001 PPm, Then treatments C 3 and C8 came equally with 199.812 PPm, and then the rest of the treatments came in a close manner, indicating the survival of a quantity of organic matter in the soil after the end of the potato season. The organic matter is confined and not distributed in the rest of the field due to the short growing season of the potato crop as well. The difference between control treatments and addition treatments with organic matter can be seen in Figure 2, and we notice the clear difference between these treatments.

This coincides with what was indicated by the mechanism of the study (5), which indicated the effective role of organic matter with bacteria in the decomposition of pesticide residues in the sewage, by working with each other and increasing the decomposition of the pesticide. Studies have indicated that many industries generate wastewater of complex and variable composition, which are important sources of pollution (7). Among them, pesticide-producing factories occupy an important role in modern society, due to the wide application of products manufactured in such industrial facilities.

Concerning the organic matter, the results of the study showed, with Table 1, the superiority of the treatment to which the fungus *Trichoderma harzianum* was added with the addition of the organic matter, and a value of 12.90 was recorded at two concentrations of the pesticide 0% and the other 30%. Secondly, the addition of bacteria, *pseudomonase fluorescens*, scored 12.80, and the concentration of the pesticide was 0%, as well as the fungus *Trichoderma harzianum* added to it, with a concentration of the pesticide of 20%. While the third percentage of bacteria added to it scored 12.70 and the concentration of the pesticide was 30%.

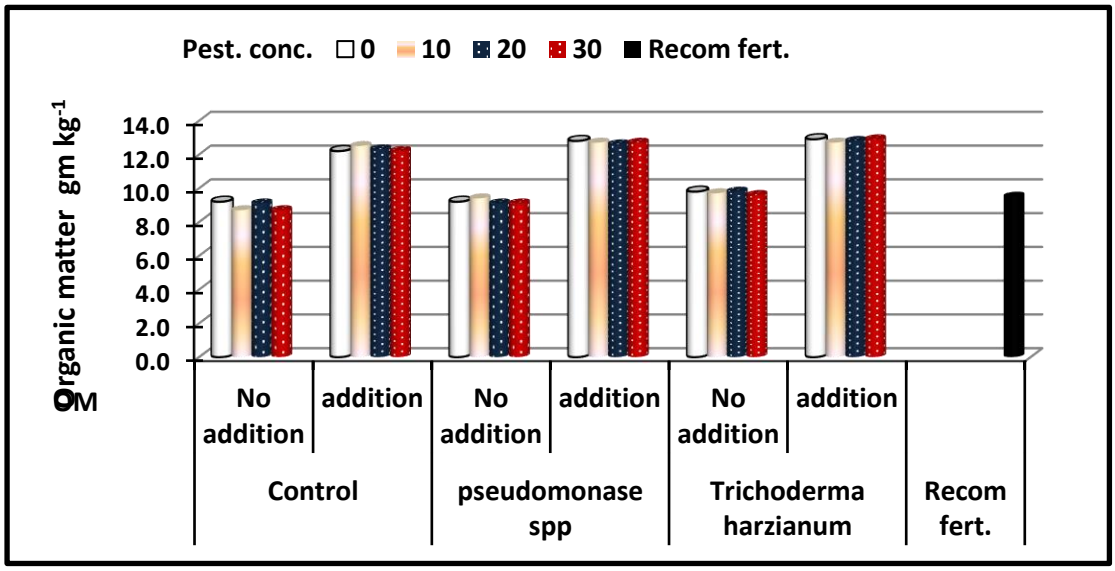

Figure 2: Remaining Organic matter.

PGPR affects plant growth directly either by stimulating plant metabolism or by producing plant hormones such as auxins and gibberellins, dissolving minerals and fixing atmospheric nitrogen, or indirectly by mitigating the negative effects of phytopathogenic microbes and improving stress tolerance. They also affect plant growth by increasing nutrient availability and reducing pathogenic infestation. Therefore, the use of T. *viride* and *P. fluorescens* as biological control agents may be beneficial to obtain higher crop yields in a sustainable manner to improve seedling quality and yield performance characteristics with low chemical inputs. (6).

Table 1: The remainder of the organic matter is gm^{-1}.

B * O	C Pesticide concentration / mg /				organic matter	Biology
	30	20	10	0	O	B
8.93	8.70	9.10	8.70	9.20	without	Control
12.30	12.20	12.30	12.50	12.20	Addition	
9.20	9.10	9.10	9.40	9.20	without	*pseudomonase sp*
12.70	12.70	12.60	12.70	12.80	Addition	
9.73	9.60	9.80	9.70	9.80	without	*Trichoderma Harzianum*
12.83	12.90	12.80	12.70	12.90	addition	
			9.50		Complete fertilizer	
0.17 LSD B*O			0.34		LSD B*O*C	
			B * C			
Biology average	30	20	10	0	Biology B	
10.61	10.45	10.70	10.60	10.70	Control	
10.95	10.90	10.85	11.05	11.00	*pseudomonase sp*	
11.28	11.25	11.30	11.20	11.35	*Trichoderma harzianum*	
0.12 LSD B*C			غ.م		LSD B*C	
			O * C			
average organic	30	20	10	0	organic matter	
9.28	9.13	9.33	9.27	9.40	without addition	
12.61	12.60	12.57	12.63	12.63	Addition	
0.10 LSD O			غ.م		LSDO*C	
			C			
	30	20	10	0	pesticide concentration	
	10.87	10.95	10.95	11.02	average concentrations	
			غ.م		LSDC	

Nitrogen Concentration: The results of Figure 3 showed the effect of adding microorganisms (bacteria and fungus) and organic matter with the concentration of the pesticide on the nitrogen percentage, as the results showed that there were significant differences in the addition of microorganisms B, as the highest rate of nitrogen was reported for the treatment of fungus (*Harzianum Trichoderma*) B2, reaching 43.3 mg/ liter with a pesticide concentration of 20%. It was also met by the fungus (*Trichoderma harzianum* B2) treatment, which reached 42.7 mg/ liter, with a pesticide concentration of 10%, with a significant difference from the no-additive treatment/ control treatment (B0), which recorded the lowest nitrogen percentage at a rate of 9.7 mg/ liter and with a pesticide concentration of 30%. Significant differences between the treatments, where the highest nitrogen percentage was with treatment B2 (*Trichoderma harzianum*) and recorded 33.8 mg/L with the addition of organic matter and a pesticide concentration of 10%, and the bilateral interaction between the added organisms and the concentration of the pesticide also had a significant variation, and it gave the highest nitrogen percentage with the fungus (B2) *Trichoderma harzianum*, and it recorded 31.9 mg, with a significant difference from the rest of the treatments.

The results indicated that all co-immunization treatments showed beneficial effects. Then came the treatment to which the fungus *Trichoderma harzianum* was added with the organic matter and recorded a quantity of 42.7 mg/ liter and a concentration of the pesticide was 10%, and the third came the treatment to which the fungus *Trichoderma harzianum* was also added and recorded an average of 39.7 mg/ liter and a concentration of the pesticide was 30%, and thus all treatments are Superior added mushrooms with organic matter as shown in Figure 3.

The combination of *Trichoderma* viride and *Pseudomonas fluorescens* showed the maximum increase in all considered parameters, i.e., seedling emergence, seedling

height, stem diameter, leaf area, root length, seedling vigor index, fresh weight of seedlings, dry weight of seedlings, total chlorophyll content, plant height at DAT 30, plant height at DAT 60, number of leaves, leaf area index, root length, root dry weight, number of unwrapped leaves, number of rolling leaves, head weight, head diameter, and head productivity. It is due to the availability of a high percentage of nitrogen for the plant (18). This is indicated by the mechanism of the study (14), whereby their study indicated an increase in the readiness of the macroelements of the plant when using Pseudomonas bacteria with organic fertilizer.

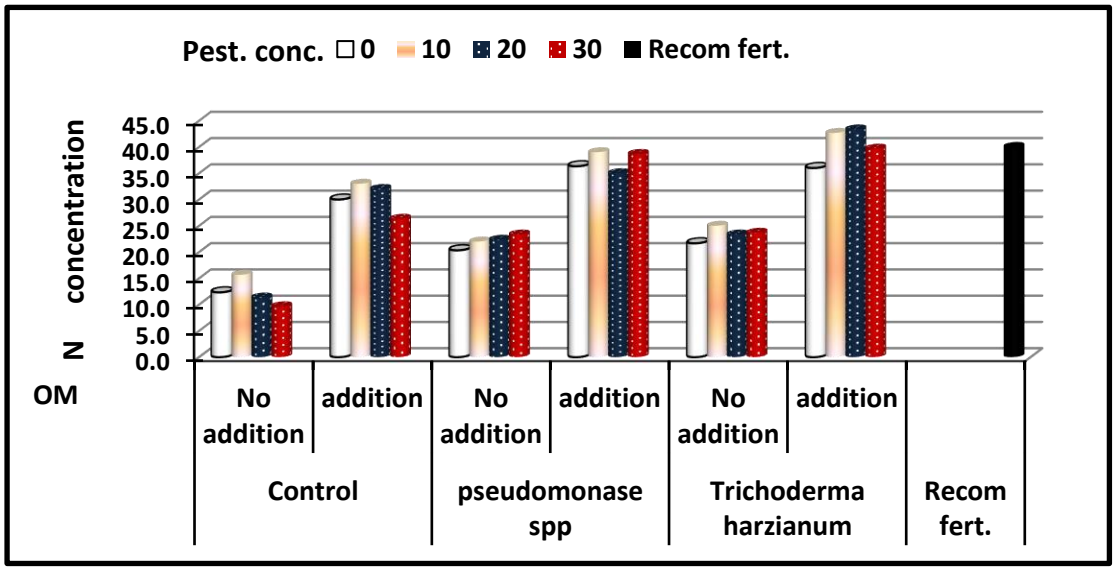

Figure 3: The effect of nitrogen on soil and growth.

Potassium Concentration: The results of Figure 4 showed the effect of adding microorganisms (bacteria and fungus) and organic matter with the concentration of the pesticide on the percentage of remaining potassium for the plant. It reached 158.4 mg/L with a pesticide concentration of 10%. It was also followed by the treatment of bacteria (*pseudomonase* B1) and reached 157.8 mg/L with a concentration of the pesticide 30%, with a significant difference from the non-additive treatment/ control treatment (B0), which recorded the lowest percentage of remaining potassium at a rate of 102.7 mg/L. liters, with a pesticide concentration of 0%. Addition of the organic matter O * C also recorded a significant effect, as it reached the highest rate of concentration of the residual potassium percentage with the addition of the organic matter O2, which amounted to 150.8 mg/ liter, significantly superior to the treatment of no addition, which amounted to 113.4 mg/ liter. As for the concentration of Glyphosate, the concentration of 10% and 30% gave the highest percentage of residual potassium 136.4 and 137.8, and the lowest value was with the concentration of 0% and the concentration of 20%, and it reached 127.9 and 135.7 with significant differences. The interaction between the organic matter and the microorganisms (B * C) recorded significant differences between the treatments, where the highest percentage of residual potassium was with the treatment of B1 *pseudomonase* sp. It was 143.6 mg/ liter with the addition of the organic matter and the concentration of the pesticide was 30%, and the lowest value with the comparison treatment without adding. The triple interaction (microorganisms, pesticide concentration, and organic

matter) recorded significant differences between the treatments, as the treatment of adding organic matter gave the percentage of remaining potassium 36.0, superior to the treatment of not adding the full recommendation for mineral fertilization, and recorded 116.2, with simple non-significant differences. The reason may be attributed to the addition of organic fertilizer, as it increases the availability of nutrients, and at the same time, organic fertilization affects the proportion of potassium, as the organic matter contains a good proportion of ready-made potassium. The addition of organic matter to the soil increases the availability of nutrients, including nitrogen, phosphorus, and potassium. The results are with what he mentioned (14).

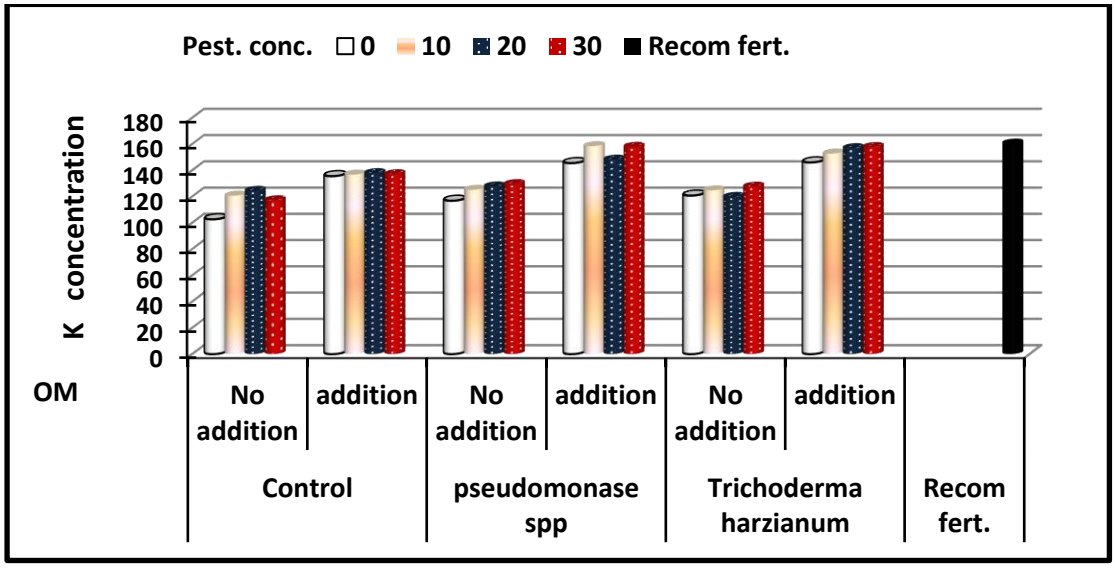

Figure 4: Effect of potassium on soil and growth.

Phosphorus concentration: The results of the study on the effect of adding microorganisms and organic matter with the concentration of the pesticide on the concentration of phosphorus in the soil (Fig 5). And its role in providing phosphorus to the plant and increasing its readiness through the root system of the plant. The treatment followed with the addition of the fungus *Trichoderma harzianum* with the addition of organic matter, as it recorded a quantity of 30.67 mg/ liter and a concentration of the pesticide was 10%, while the comparison treatment had the lowest concentration in the percentage of phosphorus and recorded 9.00 and a concentration of the pesticide was 0% and 30%. Addition of the organic matter O * C also recorded a significant effect, as it reached the highest rate of phosphorus concentration with the addition of the organic matter O2, which amounted to 27.22 mg/ liter, significantly superior to the treatment of no addition, which amounted to 11.56 mg/ liter.

Most of the types of suitable probiotics belong to the bacterial or fungal groups. Among the various bacterial prebiotics, *Pseudomonas sp*. Due to its diverse metabolic potential and wide distribution, this genus is mainly used as a bait crop that enhances the plant's growth-promoting activities in several ways (6). *Pseudomonas fluorescens* may help stimulate aspects related to plant growth, especially promoting rapid growth of seedlings and reducing transplant shock. In addition, in a series of fungal biotopes, *Trichoderma* is frequently used because of its rapid growth, well-

constructed spore production, ease of isolation, and secretion of enzymes associated with cell wall degradation (3). These traits may improve nutrient solubility, nutrient uptake capacity, root growth, plant health, enhanced microbial activity, and degradation of xenobiotics and polysaccharides, making them effective biocontrol agents (15). Application of most *P. fluorescens* isolates alone or together with T. *viride* showed a positive effect on plant growth by improving plant height, fresh stem weight and root length. Indoor plant colonization in an ecological niche similar to that in the advancement of plant pathogens and biological control with indoor plants is an effective strategy for future pest management (1). Inoculation with mycorrhiza-PGPR substrate and *Trichoderma* fungus increased the pH of the rhizosphere regardless. Consider foliar fertilization. The plant mineral content was significantly modified by the treatments in all the cultivars examined. In particular, changes in the adsorption of N, P, K, Fe, B and Mn were observed. The results showed an interaction between foliar fertilization and root inoculation with microorganisms, in addition to genotype-dependent effects, on growth and root pH responses of strawberry plants (7).

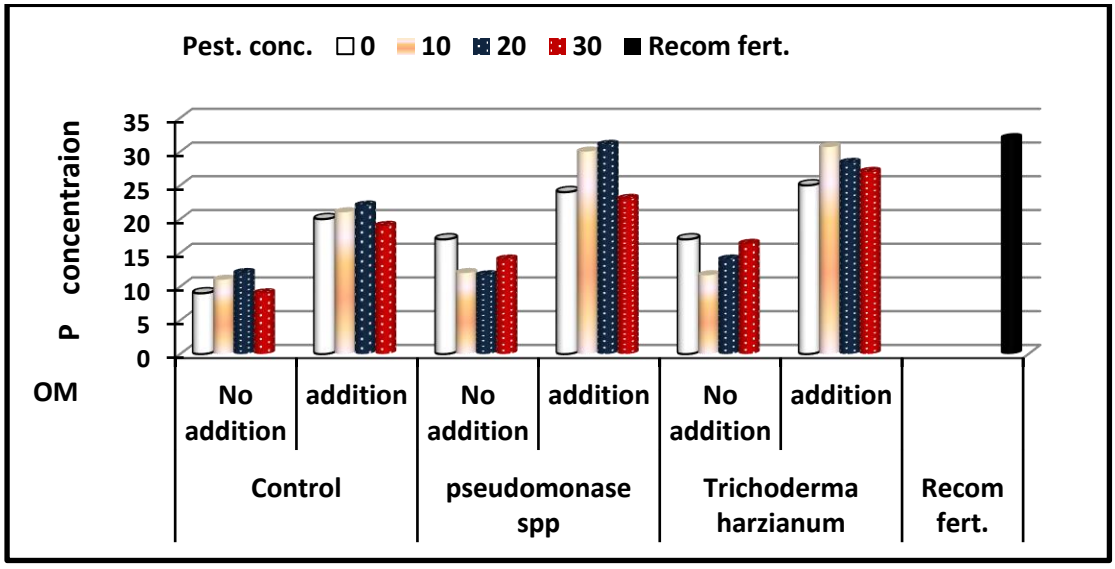

Figure 5: The effect of phosphorus on soil and growth.

Effect of soil acidity on the cultivation: The results of the study indicated Figure 6 to the clear convergence between all the treatments of the study, but the treatment to which bacteria and Bonn were added in addition to the organic matter excelled over the rest of the added treatments, and it recorded a pH value of 7.57 for the soil without adding the pesticide. 7.50. As for the relationship between the study coefficients only, the relationship was positive for the average organic matter and recorded a value of 0.04 (the significance of the relationship at the level of significance of 0.05). The relative abundance of fungi was not affected by pH and fungal diversity was weakly correlated with pH. The composition of bacterial communities was closely determined by soil pH; There was as much variation in bacterial community composition across the 180-m distance of this liming experiment as across soils collected from a wide range of North and South American biomes, confirming the dominance of pH in structuring bacterial communities. The apparent direct effect of pH on bacterial community composition is probably due to the narrow pH ranges for optimal bacterial growth. Fungal community composition was less

affected by pH, which is consistent with pure culture studies, demonstrating that fungi generally exhibit wider pH ranges for optimal growth (13).

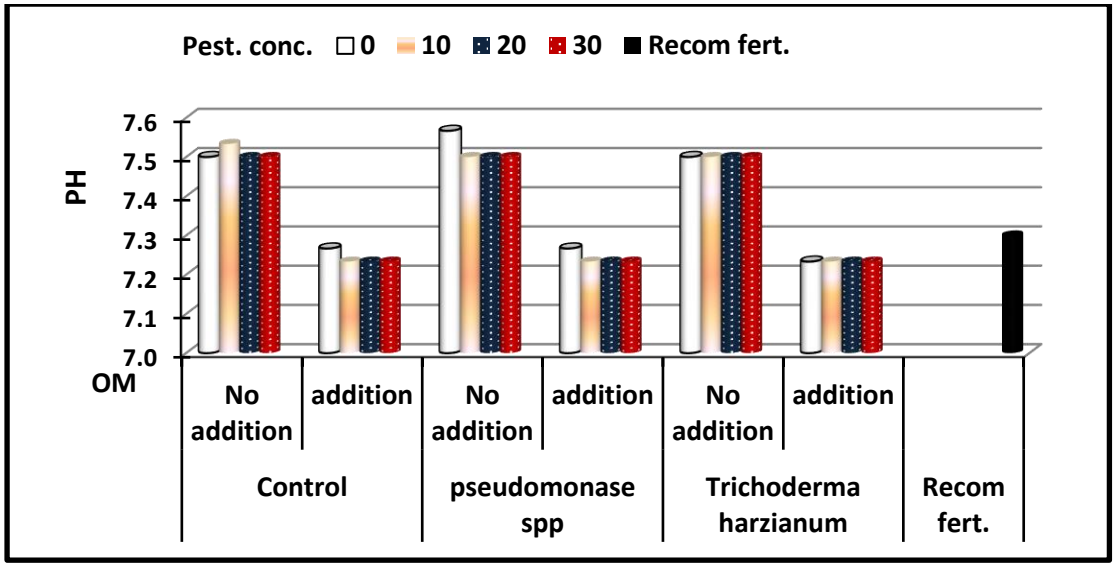

Figure 6: Effect of soil acidity on the cultivation.

Conclusions

The study indicated the effective effect of the main nutrients (nitrogen, potassium, and phosphorus) and the effect of organisms in increasing their quantities, and thus the effective effect in increasing potato growth. Researcher recommends the necessity of bringing in potato varieties with productivity that keep pace with global productivity, as the purina variety has begun to decrease in productivity in the current years, and the need to bring in the best varieties with high productivity and higher economic returns. Transactions mixed with Pseudomonase sp. and Trichoderma harzianum, to which organic matter was added, excelled with the proportions of the pesticide used in the study, Glyphosate. Increasing the percentage of bacteria in the treatments to which organic matter was added in the soil. Increasing the percentage of nutrients and increasing the absorption of N, P, K, Fe, B and Mn with its readiness for the plants to the treatments added to the bacteria Pseudomonase sp and Trichoderma harzianum. The necessity of plowing the soil perpendicularly, cleaning the soil before planting of bushes and weeds harmful to the crop before planting, and reducing the use of chemical pesticides. Using a combination of Trichoderma Harzianum and pseudomonase sp with potatoes to increase fertilizer decomposition and increase productivity.

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No Supplementary Materials.

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Author 1; methodology, writing—original draft preparation, Author 2 and Author 3 writing—review and editing. All authors have read and agreed to the published version of the manuscript.

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