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Abstract. The purpose of this study is to investigate the impact of the use of Vermicompost and Vermicompost tea on the growth and yield of broccoli and some soil properties The field experiment was formed In Saqlawiyah sub-district - Anbar – Iraq on 10 October 2019.The experiment lasted approximately three months. In situ analysis and measurements of plant and soil were carried out at the site of the experiment, and also in the laboratories of the Agricultural Research Center, Soil Research Department in Abu Gharib. The treatments consisted of (T1 soil only, T2 DAP chemical fertilization only (according to fertilizer recommendation) 240 kg DAP.ha $^{-1}$,T3 = 8.ton ha $^{-1}$ Vermicompost mixed with soil + half the recommendation of 120 kg DAP. ha^{-1},T4 = 16 tons. ha^{-1} Vermicompost mixed with soil + 120 kg DAP. ha^{-1}T5 = Vermicompost tea spray on the plant + 120 kg DAP. ha^{-1} ,T6 = 8 tons. ha^{-1} Vermicompost mixed with soil + Vermicompost tea sprays on the plant + 120 kg ha^{-1} DAP.. The plant traits were; plant height (cm), the total number of leaves (leaf. plant $^{-1}$), the leaf area (dcm^2.plant $^{-1}$), vegetative dry weight (g. plant $^{-1}$), dry weight of rhizosphere (g.plant^{-1}), the weight of the main flower (gm) which were (52.8, 42.4, 98.6, 190.2, and 865.8), respectively, as well as the percentage of protein%, fat%, N%, P%, and K% that reached (23.37, 2.81, 3.74, 0.79, and 2.93) successively.concluded from this study that the treatment of Vermicompost with Vermicomposting tea combined with half of the fertilizer recommendation enhanced growth and yield of Broccoli plant and some soil properties.

1. **Introduction**

Worm fertilizer (Vermicompost) is a product of earthworm remains called (worm casting), which resulted in worms consuming organic waste such as home, greenhouse, kitchen, tree leaves, cardboard and paper, city and markets, laboratories, etc., and then secreting and extracting those enzymes within the digestive worm system. Then throw them away, as well as organic contaminants arising from some inhabitant fungi and bacteria that feed on worms that live on the plant. The percentage of organic components in this Vermicompost varies depending on the form of organic waste that feeds the worms, sometimes causing certain components to increase or decrease. Also, Vermicompost is the least polluted fertilizer by other pathogenic microorganisms that cause the pathology of plants, and it is also rich in plant nutrients. All Vermicompost components dissolve in water which makes it beneficial and easier to be absorbed by plants. This worm fertilizer can be applied to plants directly, in nursery boxes, or placed at the bottom of the seedlings [1,2,3].

As for Vermicompost tea, it is an extract from Vermicompost fermentation, which is rich in nutrients and beneficial microorganisms. The key explanation for the production of Vermicompost tea is the conversion of microbial biomass, organic microparticles, and soluble chemical components in Vermicompost into a liquid solution that can be applied to the plant as a foliar spray or added to the soil in ways that may be useless or not economically feasible with solid fertilizer. The very important characteristic of Vermicompost

tea compared to normal compost tea (resulting from the fermentation of plant and animal organic waste) is that the normal compost contains bacterial or fungal pathogens which can develop when soaked in humid environments; such environments are; the availability of oxygen, water, and the added saccharides required for the processing of this tea, and when the plants are sprayed with tea, these microbes are transferred to the plant, and thus, they will pass to humans and animals. Whereas the worms secrete substances in the Vermicompost tea that destroy these pathogens, so it does not produce them, making it safe to spray on plants [4].

In a research study conducted by [5], it was found that Vermicompost promoted beneficial organisms in the soil, increased nutrient availability and increased lettuce yield, and also resisted pathogens whether in soil or as sprayed hydro-extracts. He found that the plant's productivity for the soil in which Vermicompost was used increased by 10 % relative to control treatments.

In a greenhouse pots experiment, [6] observed that Vermicompost tea applied to soil or sprayed on lettuce plants had increased vegetative weight and root length, improved plant-specific features, and increased the availability of essential nutrients in soil absorbed by plants in its contrast between Vermicompost tea and Vermicompost filtered liquid collected during the production process, they found that tea was better and richer than filtered liquid concerning the nutrients necessary for the plant and other characteristics the ratio of organic matter and carbon, as well as total nitrogen in Vermicompost tea were 21, 12 and 2.4%, respectively, corresponds to 3.4, 2 and 0.9% for Vermicompost extract, respectively. As for the macronutrients, which are phosphorus and potassium in tea, their concentration as was (1862 and 2482 mg. L^{-1}), orderly which meets 1907 and 1677 mg. L^{-1} in the extract [7]. Whereas the concentrations of micronutrients in tea were; 12, 0.1, 25, and 0.5 mg. L^{-1} on sequence for iron, copper, zinc, and manganese, were; 3, 0, 8, and mg l^{-1}in the extract, respectively, Whereas in tea the pH, EC, C / N ratio 7, 2.5 $dS.m^{-1}$, and 5% were successively present, while in the extract were; 7.5, 2.4 $dS.m^{-1}$, and 2.2%, respectively. The purpose of this experiment was to determine the effect of Vermicompost and Vermicompost tea on broccoli growth and some soil properties.

2. Materials and Methods

The fertilizer to the Vermicompost worm, listed in Table (1), was used. 1 kg of the above-mentioned fertilizer was taken for the extraction of Vermicompost tea fertilizer to be placed in a gauze sack (a fine mesh holes), to prevent flowing out, then, 10 tablespoons of date molasses were added as a nutritious liquid for beneficial microorganisms, any other nutrient solution such as sugar cane extract can be used. They were placed in a plastic pool containing 100 liters of chlorine-free water (i.e. 1% fertilizer to water ratio). A small oxygen pump was later used to inject air into the water to kill harmful anaerobic microorganisms, and to cause aerobic microorganisms as well. This process took about 30 hours (24-48 hours) before the solution color became closer to the colour of dark tea. This tea can be used to irrigate plants or sprinkle on the leaves as it contains many necessary macro and micronutrients, as well as growth regulators, and some important enzymes for the plant. It can also be sprayed as a biological controller on the plant, since it eradicates many pathogens, especially fungal ones. It is best to use this tea immediately after its development or at most within a week, as it will cause harmful anaerobic bacteria at the cost of beneficial bacteria, as it is preferred to spray it on the plant in the early morning or evening, especially in the summer and avoid fertilization under direct sunlight so as not to affected Plant negatively (exactly like foliar application) [4,8].

Table 1. Some properties and elements of Vermicompost.

			%						mg.kg^{-1}			
EC dS.m^{1}	pH	C	N	P	K	Ca	Mg	C/N	Fe	Zn	Mn	Cu
5.2	7.1	24	1.9	1.4	0.9	1.8	0.6	12.6	850	87	135	38

To measure the effect of Vermicompost, Vermicompost tea, and DAP fertilizer on broccoli *(Brassica oleracea* cv. Italica), a factory pot experiment was performed using three replicates of randomized complete block design (RCBD). The treatment combinations were 6 processes as follows:

T1 = Control without addition (soil only).
T2 = DAP chemical fertilization only (according to fertilizer recommendation) 240 kg DAP.ha $^{-1}$.
T3 = 8.ton ha $^{-1}$ Vermicompost mixed with soil + half the recommendation of 120 kg DAP. ha^{-1}.
T4 = 16 tons. ha^{-1} Vermicompost mixed with soil + 120 kg DAP. ha^{-1}.
T5 = Vermicompost tea spray on the plant + 120 kg DAP. ha^{-1} .
T6 = 8 tons. ha^{-1} Vermicompost mixed with soil + Vermicompost tea sprays on the plant + 120 kg ha^{-1} DAP.

The numbers of experimental units were 18. The units used for this purpose are 20 kg capacity plastic pots and filled with soil from one of the College of Agriculture / Anbar University fields in the Hamidhiya research station provided a depth of 0-30 cm. The properties of the soil before the cultivator are shown in Table (2). The soil was compressed and sieved through a sieve (4mm). The pots are filled with 20 kg of soil for each pot. The treatments were wetted to the limits of the field capacity (0.312- 0.106) using the weighting method. on 10 October 2019, the broccoli seedlings were grown by three seedlings for each pot, after the success of the transplantation; it was thinned to one plant for each pot. All treatments positioned in the appropriate position surrounded by BRC fence were randomly distributed according to the design used in each of the three replicates. The gravimetric method used to estimate soil moisture, irrigation process continued at the loss of 50% of the available water.

The following up, service, and observation of the crop continued until the date of the harvesting on October 1, 2020,i.e. after approximately three months of cultivation.

Table 2. Some chemical and physical properties of soil

Characteristic		Unit of measurement	values
Electrical conductivity EC of 1: 1 extract		dS. m^{-1}	2.75
degrees of soil reaction pH		-----	7.84
Organic matter OM		gm. kg^{-1}	8.6
Lime (carbonate minerals)		gm.kg^{-1}	165
Gypsum		gm.kg^{-1}	3.5
Available water		cm^{-3}	0.205
Bulk density		Mg. m^{-3}	1.32
		Sand	302
Minutes volumes distribution	gm.kg^{-1}	Silt	555
		Clay	143
Tissuegh		Silty loam	
Available Nitrogen		mg. kg^{-1}	82.0
Microbial density		CFU x 10^6 gm^{-1}.soil	3.2
Available phosphorous		mg. kg^{-1}	12.3
Available Potassium		mg. kg^{-1}	143.0
Cation Exchange Capacity (CEC)		$Cmol_c kg^{-1}$	26.25
		Ca^{++}	16.5
		Mg^{++}	7.61
		K^{+}	5.70
Soluble ions	$Mmol.L^{-1}$	Na^{+}	9.8
		SO_4	7.45
		Cl^{-}	8.44
		HCO_3^{-}	4.54
		$CO_3^{=}$	-

cfu = colony forming unit

Measurements of plants and soils, including italic samples, laboratory study are carried out in the laboratories of the Agricultural Research Center in Abu-Gharib-Department of Soil Science. The traits are; plant's height (cm), the total number of leaves, the leaf area, vegetative dry weight, rhizosphere dry weight, and the yield weight (represented by the weight of the main flower disc). Some physiological and some necessary elements properties being estimated in flower disc; which are, the percentage of each protein%, fat%, N%, P*%,* and K%. Some important soil properties were also estimated like pH, EC, CEC, O.M %, microbial density, total N, available P, and available K.

The results were tabulated and statistically analyzed using analysis of variance (ANOVA), F test, and the value of the least significant difference (LSD) at the 0.05 probability level.

3. Results and Discussion

Table (3) shows the effect of the treatments on the average of some morphological properties of the broccoli plant and that there were significant differences among the treatments. The T6 treatment gave the highest rate for each plant height, number of leaves, leaf area, vegetative dry weight, and yield represented by the weight of the main flower disc of the plant to reach (52.8%, 42.4%, 98.6%, 190.2%, and 865.8%), respectively. This result showed that increases in plant growth and yield due to improved soil physicochemical properties, increased enzymatic activity, increased microbial diversity and activity, nutritional factors, and regulators of plant growth [4,6,9,10]. Growth and yield with the higher

Vermicompost level may also be due to better absorption and assimilation of essential elements [9]. Vermicompost contains a well-balanced composition of nutrients. Humic acid and Vermicompost substances may have enhanced soil physical conditions and increased the growth of soil microorganisms and contributed to the solubility of reserved mineral substances which subsequently resulted in increased uptake and availability of plant nutrients during the plant's growth period [1,11].

Table 3. Effect of treatments on the average of some morphological characteristics of broccoli

Treatment	plant height (cm)	number of leaves	leafy area(cm^2)	dry weight (gm)	weight of the main flower disc (gm)
T1	24.2	22.8	51.3	130.4	526.6
T2	30.7	28.9	69.5	149.8	639.2
T3	38.5	32.2	78.4	161.3	750.3
T4	43.7	35.0	85.9	172.9	822.3
T5	44.6	37.6	87.2	176.4	834.7
T6	52.8	42.4	98.6	190.2	865.8
LSD: 0.05	2.5	3.1	3.7	5.3	16.8

Table (4) shows the effect of treatments on some physiological traits and necessary elements in flower disc, there were significant differences among the treatments. The T6 treatment gave a higher rate for each protein %, fat %, N%, P%, and K% to be (23.37, 2.81, 3.74, 0.79, and 2.93), respectively. These results revealed that the presence of Vermicompost and its extract (Vermicompost tea) had promoted the efficiency of the inorganic fertilizers and better inorganic nutrient utilization may be due to the quick decomposition of organic substances results in more supply of N, P, K, and micronutrients to the crop that enhanced plant growth, results in higher metabolic activities and higher carbohydrate synthesis and ultimately resulted in higher yield [12]. Results from this experiment showed that the increase in plant growth and yield with the addition of Vermicompost is correlated with higher nutrient uptake such as P, K, Fe, and Zn. Applying Vermicompost as an organic source had significantly enhanced the available nutrient quality of soil [9]. Vermicompost enhanced P concentration and uptake in soil, increasing the solubility of P either by microorganisms activation with excretion of organic acids likes citric, glutamic, tartaric, succinic, lactic, oxalic, malic, and fumaric (13) or by higher phosphatase activity [14]. Bhasker *et al.*, [15] stated that the increase in K uptake by application of Vermicompost could be due to an increase in K availability by shifting the balance between K forms from relatively exchangeable K to soluble K forms in Soil [16].

These results are also consistent with what was reported by Orlando *et al.* [17] that the humic substances and growth auxins extracted from worm fertilizer that was sprayed on lettuce leaves had early in the lettuce production period for a period of 21 days, which means early production without affecting the quality of the product. This is achieved by increasing the number of leaves and head weight, increasing protein and reducing carbohydrates, as well as improving the quality traits of the plant, as wellas these results are consistent with what [6,18,19] found in a greenhouse pot experiment that adding Vermicompost and Vermicompost tea to the soil and spraying on the lettuce plant led to an increase in wetting weight, head size, number of leaves, leaf length. Leaf width, plant dry matter weight, and lettuce yield.

Table 4. Effect of treatments on some physiological traits and essential elements in flower disc

Treatments	Protein %	Fat %	N %	P %	K %
T1	7.18	1.33	1.15	0.22	1.42
T2	9.00	1.85	1.44	0.36	1.87
T3	15.12	2.19	2.42	0.50	2.15
T4	20.06	2.43	3.21	0.63	2.42
T5	22.62	2.69	3.62	0.65	2.56
T6	23.37	2.81	3.74	0.79	2.93
LSD: 0.05	0.36	0.19	0.27	0.10	0.23

Data in Table (5) showed the effect of treatment on some soil properties and their nutrient content after cultivation. This table showed that the T6 has a highly significant difference as compared with other treatment in both pH, ECe, CEC**,** O.M content, Microbial density, chemically available N, P, and K which have values of (7.30, 2.18, 46.7, 2.96, 4.4, 174.5, 21.6 and 188.5) respectively. The interpretation of this may be that Vermicompost has many favorable properties, including high organic and carbon content, and macro- and micronutrient content, despite the high EC value due to its high Na and Cl content [8,20, 21]. The

reported results showed that vermicompos with Vermicomposting tea treatment was more effective;. Likely due to the more organic acid and antibiotic content Soil pH decreased with broccoli plants; possibly because of more root broccoli exudates that contain organic acids such as folic acid [22,23]. The results of the research are consistent with what Mehdi *et al*. [7] noted in a comparison between Vermicompost tea and the liquid extracted by Vermicompost, collected during the production period of Vermicompost, found that tea is better and richer than the liquid candidate for nutrients necessary for the plant in terms of increasing the proportion of organic matter, nitrogen, phosphorus, potassium and essential micronutrients such as iron, copper, zinc, and manganese.

4. Conclusion

It can be concluded that, combined with half of the fertilizer recommendation for the studied broccoli, the treatment of Vermicompost with Vermicomposting tea had succeeded in giving the highest plant yield and nutrient content. It also positively affected the soil chemical characteristics in particular the availability of the studied macronutrients ,micro nutrients and organic material**.**

Table 5. Effect of treatment on some soil properties and their nutrient content after cultivation

Treatment	Ph	ECDs.m^{-1}	CEC Cmole.Kg^{1}	O.M%	cfu x 10^{7} GM^{-1}soil Microbial density	available NO3 - NH4 (mg.kg $^{-1}$)	availableP (mg. kg ^{1})	available k (mg.kg^{-1})
T1	7.81	2.50	17.7	0.95	0.8	91.3	11.2	116.6
T2	7.75	2.46	19.2	1.13	1.1	120.4	14.7	120.6
T3	7.46	2.40	38.4	2.85	3.5	145.9	17.8	166.7
T4	7.38	2.48	48.6	2.91	4.2	163.4	20.5	179.4
T5	7.58	2.35	37.6	1.87	3.9	155.2	17.4	156.8
T6	7.30	2.18	46.7	2.96	4.4	174.5	21.6	188.5
LSD: 0.05	0.39	0.10	4.0	0.13	0.3	8.2	2.26	13.21

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