Effect of Organic and Biological Fertilization on Some Quantitative and Qualitative Indicators of Some Chili Pepper Varieties

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Abstract

Farmers can adopt clean agriculture strategy to reduce synthetic fertilizer. The study was conducted in the Al-Najaf Agriculture Directorate during the spring season of 2021. The first factor that is studied is three varieties of chili pepper included Local, Barbarian, and Anaheim. The second factor was four fertilizer treatments including control treatment, seaweed extract, bio-fertilizer using A. *chroococcum*, and the combination of organic and biological fertilizers. Randomized Complete Block Design (RCBD) was used modeling Split-Plot system with three replications. Duncan Multiples Range Test was adopted to compare the means at the probability level of 0.05. The results showed that the local variety gave the highest number of fruits, while the Barbarian variety recorded the highest fruit weight, total yield, carbohydrates, vitamin C, and capsaicin. Anaheim variety scored a higher percentage of protein than the local variety, but it did not differ significantly from the Barbarian variety. Bio-fertilizer was superior in terms of the number of fruits, while the combination fertilizer of organic fertilizer and bio-fertilizer was superior in the average fruit weight, total yield, carbohydrates, protein, vitamin C and capsaicin.

Keywords: Organic Fertilization, Biological Fertilization, Chili Pepper Varieties

Introduction

Chili Pepper *Capsicum annuum*. L is an herbaceous plant belonging to the Solanaceae family. It is one of the important crops from a nutritional point of view since it contains many vitamins, proteins, carbohydrates, fats, nutrients, and capsaicin (Jaiswal et al., 2021), which makes it the third most important crop of the Solanaceae family. Thus, its demand increased as the population increased. Therefore, a great interest in raising its productivity by cultivated area was done through importing hybrid and improved varieties (Mohamed and Rasha, 2021).

Recently, some farmers have adopted biological and organic fertilizers to nutrient the crops since studies showed their positive effect on minimizing flowering loss and an increase in the percentage of flower set. The ability of the organisms stimulates plants to produce hormones such as auxins, gibberellins, and cytokinins as well as increase nitrogen fixation (Crisofano et al., 2021).

Chili pepper continues to produce for a long period in the conditions of Iraq, which may extend to eight months, from March to October. Accordingly, it needs a high amount of fertilizers to continue production. Therefore, several problems arise such as increasing the cost as the use of chemical fertilizers increases as well as increasing the labor cost of fertilization operations (Al-Amri, 2012). Soil pollution increases because of fertilizer residues

which are toxic to living organisms. Finally, the yield quality is low as a result of the use of chemical fertilizers compared to the yield resulting from organic farming (Jufri and Sulistyono, 2016). The study aims to evaluate the use of organic and biological fertilizers on different varieties of chili pepper and study its quantitative and qualitative yield.

Materials and Methods

A field study was conducted in Al-Najaf Agriculture Directorate during the spring season of 2021. Random soil samples were collected in different places for analyzing some physical and chemical parameters before planting (Table, 1).

Table (1): Some physical and chemical soil indicators before planting

partical	**Unit**	**amount**
Clay	%	18.6
Silt	%	24.3
Sand	%	57.1
Soil texture		alluvial mixture
parameter	**Unit**	**amount**
EC	decims. M^{-1}	3.9
pH	---------	7.4
available nitrogen	$mg.kg^{-1}$	38.8
available phosphorus	$mg.kg^{-1}$	9.1
available potassium	$mg.kg^{-1}$	223
Organic matter	%	1.2

The field was prepared for planting the seedlings by plowing the soil at a depth of 40-30 cm. Then, 40 m^3.$Hectare^{-1}$ of decomposed organic fertilizer was added to the soil and left for Solarization (Al-Dajwi, 1996).

The seedlings were transferred to the permanent field on 4/16/2021 to be planted in the terraces. The width of each terrace was 0.5 m and the length of 6 m, therefore the area of one experimental unit was 3 m^2. The distance between the experimental units was 0.5 m. The seedlings were planted in an alternating manner on the terrace, with a distance of 30 cm between plant and another, so the total number of plants in the experimental unit was 16 plants.

The plants were sprayed with 4 g.liter^{-1} liquid organic fertilizer (seaweed) on vegetative growth until the complete wetness. This application was repeated four times during the growing season. The first spray was two weeks after planting the seedlings in the permanent field on 2/5/2021. The following sprays took place 15 days after each other.

As for the bio-bacterial fertilizer, it was prepared in the laboratories of the Al-Najaf Agriculture Directorate. Bacterial fertilizer was inoculated on the peat moss and added to the plant Rhizosphere three days after the preparation on 1/5/2021. The application rate was 15 g.plant^{-1} (Altufaili, 2015). The vegetative growth indicators of the plant were measured by taking five plants randomly from each treatment, as follows:

The studied parameter was the fruits number (fruit. plant^{-1}), the fruit weight (g. fruit^{-1}), the total yield (ton. hectare^{-1}), and the fruit carbohydrate (%) which was estimated using a Spectrophotometer (Dubois et al., 1956). The fruits content of ascorbic acid (mg. 100 g^{-1} fresh weight) was measured using the 2-6 Dichlorophenol indophenols as stated by AOAC (1980). The percentage of protein in the fruits was also calculated according to the equation (the percentage of protein on the basis of dry weight = nitrogen percentage in fruits × 6.25) (Al-Zamili, 2018). The capsaicin content in fruits (mg. kg^{-1}) was measured according to the method of Sadasivam and Mannikam (1992).

Results and Discussions

Table (2) showed the superiority of local chili variety in the number of fruits, total yield, the percentage of carbohydrates in the fruits, the ascorbic acid content, and capsaicin content which scored 110.4 fruits.plant-1, 3.34 tons. ha^{-1}, 12.12%, 184.4 mg.100 g^{-1} fresh weight, 949 mg. kg^{-1} respectively. However, the percentage of protein in the local chili variety did not differ significantly from the Anaheim Chili variety, which was 12.37% and 12.78%, respectively.

This difference between varieties in yield indicators may be due to the nature of the genetic structure of the variety and environmental factors.

As for the effect of fertilizer treatments, the combination between liquid organic fertilizer and bio-fertilizer was significantly superior in increasing the fruits number of 87.99 fruits.plant^{-1}, the fruit weight of 15.27 g.fruit^{-1}, and a total yield of 5.56 tons.ha^{-1}. This combination recorded a higher percentage of carbohydrates in the fruits of12.56%, the content of the fruits of ascorbic acid of 216 mg. 100 g^{-1} fresh weight, capsaicin content of the fruits of 932.7 mg. kg^{-1}, and protein 16.18%, compared to untreated plants.

This is due to the fact that the organic fertilizer is rich in nutrients, thus increasing its absorption through the leaves directly (Jaafar and Baqer, 2020). Or, the reason may be due to the presence of organic and amino acids in the composition of these fertilizers, which raise the percentage of nitrogen and increase the permeability of cell membranes. Thus, it affects the process of transporting nutrients in the leaf tissue and increases the efficiency of the plant in absorbing these elements and accumulating them in the leaves (Abbas and Salman, 2019).

As for the effect of Azotobacter as a bio-fertilizer, it may be due to the role of these organisms in increasing the nutrients and converting them into a ready form which absorbed by the plant through several biological processes (Al-Fahdawi and Allawi, 2019).

Or, the reason may be due to the role of these organisms in improving the vegetative growth parameters which positively affected the formation of a good root system that can increase the efficiency to absorb nutrients, including nitrogen, phosphorous, and potassium (Al-Zuhairi, 2017). Thises results are consistent with the finding of Jayasingne et al. (2016) and Ashour et al. (2021) on the chili plant.

The interaction between mixture fertilizers with local variety was superior in the number of fruits as it reaches 153.2 fruits, while the interaction between mixture fertilizers with Anaheim variety increased the percentage of protein to 17.33%.

The interaction between mixture fertilizers with Barbarian variety increased the fruit weight, the total yield, the percentage of carbohydrates in the fruits, the ascorbic acid content, and capsaicin content which recorded 34.66 g.fruit^{-1}, 7.43 ton.ha^{-1}, 12.84%, 247 mg. 100 g^{-1} fresh weight, and 1253.1 mg.kg^{-1} respectively. (Al Kaabi, 2016) (Fernandez et al., 2021).

Conclusions:

The results showed that the Barbarian variety affected most of the indicators under study since it was significantly superior in the characteristic of fruit weight and yield, percentage of carbohydrates, the content of ascorbic acid, and capsaicin content of fruits. The local variety increased the fruits number per plant, while the Anaheim variety was superior in the percentage of protein. This is due to the genetic structure of the plant and the planting environment. As for the fertilizer treatments, the combination between the liquid organic fertilizer and bio-fertilizer increases most of the studied indicators. Accordingly, planting the Barbarian variety with the fertilizer combination is recommended.

Table 2: The effect of the variety and fertilizer combination on some quantitative and qualitative yield parameters

variety	Fertilizer treatment	number fruits fruit/ plant	Fruit weight g/Fruit	total yield ton/ha	carbohydrates (%)	Protein (%)	Vitamin C (mg. (100g-1	Capsaicin (mg. (kg-1
Local	Comparison	68.27 de	1.79 e	0.89 e	10.76 g	6.25 i	123.9 e	480.6 e
	Liquid organic fertilizer	114.8 b	3.37 de	2.65 cd	11.21 fg	7.67 h	152.6 de	590.3 d
	Bio-fertilizer	153.2 a	5.07 d	5.26 b	11.65 cdef	11.52 e	163.2 cd	695.9 c

	Liquid organic fertilizer + bio-fertilizer	105.6 bc	5.69 d	3.76 c	12.17 bc	14.57 c	217.9 b	798.3 b
Barbarian	**Comparison**	23.33 f	5.73 d	0.88 e	11.53 def	8.91 g	140.9 de	686.4 d
	Liquid organic fertilizer	24.40 f	12.33 c	2.01 de	12.10 cd	10.82 ef	163.1 cd	825.3 c
	Bio-fertilizer	26.67 f	21.66 b	3.85 c	12.01 cde	13.43 d	186.4 c	1031.5 b
	Liquid organic fertilizer + bio-fertilizer	32.27 f	34.66 a	7.43 a	12.84 a	16.33 b	247.0 a	1253.1 a
Anaheim	**Comparison**	43.70 ef	3.10 de	0.93 e	10.92 g	8.78 g	126.9 e	442.3 e
	Liquid organic fertilizer	63.97 de	5.03 d	2.14 de	11.49 ef	10.15 f	142.3 de	520.6 d
	Bio-fertilizer	84.10 cd	4.63 d	3.14 cd	11.58 def	14.87 c	165.8 cd	657.1 c
	Liquid organic fertilizer + bio-fertilizer	90.67 bcd	5.46 d	3.92 c	12.67 ab	17.33 a	183.0 c	746.9 b
means of fertilizer effect	**Comparison**	45.10 c	3.54 d	0.90 d	11.07 c	7.98 d	130.5 d	536.4 d
	Liquid organic fertilizer	67.73 b	6.91 c	2.27 c	11.60 b	9.54 c	152.7 c	645.4 c
	Bio-fertilizer	87.99 a	10.45 b	4.08 b	11.75 b	13.28 b	171.8 b	794.7 b
	Liquid organic fertilizer + bio-	76.18 ab	15.27 a	5.04 a	12.56 a	16.08 a	216.0 a	932.7 a

	fertilizer							
متوسط الصنف	**Local**	110.4 a	3.98 b	3.14 ab	11.45 b	10.00 b	164.4 b	641.2 b
	Barbarian	26.67 c	18.61 a	3.54 a	12.12 a	12.37 a	184.4 a	949.0 a
	Anaheim	70.61 b	4.56 b	2.53 b	11.66 b	12.78 a	154.5 b	591.7 b

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