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Studies on Reducing the Use of Chemical Fertilizers in the Production of Pepper Inside Greenhouse

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ABSTRACT

This study was conducted to examine the reduction of chemical fertilizers in greenhouse sweet pepper production at the New Valley University College of Agriculture farm during the 2021/2022 and 2022/2023 seasons, namely cattle, poultry manure and compost and mineral fertilizers as control treatments .The study was conducted with the addition of these treatments. The results indicated the following characteristics and Yield ingredient of sweet peppers were greatly affected by fertilizer type. Highest values for both growth traits and yield ingredients were recorded when poultry manure was applied at 100% of the recommended fertilizer ,i.e., plant height, leaves number, branches number ,number of fruits/plant, fruit weight, fruit diameter, dry matter, fruit yield /plant, total water soluble phenols, carotenoids ,total flavonoids and antioxidant activities) both seasons were compared with mineral fertilizers (control). On the other hand, chlorophyll a, b and total carotenoids N, P And K content inside pepper leaves increased significantly in both seasons with the application of poultry manure 25% of recommended fertilizer + 75% of mineral fertilizer vs. mineral fertilizer (control), while vitamin C, vitamin E and total fiber in pepper fruits increased significantly in both seasons .The application of 50% + 50% mineral fertilizer increased significantly compared to mineral fertilizer (control). It can be concluded that 100% application of poultry manure as the recommended fertilizer resulted in improved growth, yield and quality of pepper.

Keywords: Sweet pepper (*Capsicum annum* L.), chemical constituents, poultry manure, NPK-fertilizers.

INTRODUCTION

Pepper is one of the plants that are characterized by the high nutritional value of its fruits, as it is an excellent source of natural pigments, vitamin C and antioxidant which are valuable for human health (Altaey, 2018). Sweet pepper (*Capsicum annum* L.) is a plant in the genus *Capsicum* of the Solanaceae family. The tropical regions of South America, especially Brazil, are considered the origin of *Capsicum annum*. It is one of the most popular vegetable crops produced in Plastic greenhouses Egypt's exports and domestic consumption. It is the second largest vegetable crop grown in plastic greenhouses. Bell peppers are among the best vegetables that provide beneficial components for human health (Block *et al*., 1992).

Bell peppers are becoming increasingly popular due to their importance as a source of large amounts of phytochemicals with excellent antioxidant activity, and their production and consumption is increasing globally at a rate of 18 million tons per year, especially in arid regions. Unlike other vegetables, bell peppers are low in calories (about 30 calories per 100 g) and fat. It is widely consumed both raw and cooked due to its culinary diversity and nutraceutical properties (Komla, 2013). Currently, green house-grown bell peppers (*Capsicum annuum* L.) come in three different colors (red, yellow and orange), and in different distinct shapes (ranged from round to oblong to tapered), is available worldwide. The growth and development of these peppers are the outcome of the interaction between their genetic make-up and the environmental elements, in addition to the applied good agricultural practices Leskovar and Cantliffe (1993). Bell pepper fruits are rich in V.c., polyphenols, chlorophyll, carotenoids and sugars (Flores *et al*., 2009).

It can be said that continuous and disproportionate use of fertilizers not only leads to environmental pollution However, it also has a negative impact on the sustainability of agricultural production (Bagali *et al*., 2012). In addition, chemical fertilizers accumulate heavy metals in plant tissues, reducing the nutritional value of fruits and product quality (Shimbo *et al*., 2001) it increases nitrate concentrations in groundwater (Ajdary e*t al*., 2007). It has been shown that the use of chemical fertilizers can reduce antioxidant levels in crops (Dumas *et al*., 2003).

Therefore, the objective of this experiment was to study the effect of organic fertilizers such as poultry manure, cattle manure and mineral fertilizer addition on growth, productivity and quality of *Capsicum annuum* plants Yellow spring book and red araceli in the greenhouse.

MATERIALS AND METHODS

Definition of the experiment site

The experiment was application of heated plastic greenhouses at the agricultural research farm of the College of Agriculture, New Valley University (25'26'31°N, 30'33'36°E, elevation283 m altitude), Kharja Oasis, Egypt.

Soil analysis of experimental:

Before planting , five soil samples were taken randomly from the surface (0-30 cm depth) of the experimental soil and their physical and chemical properties were determined according to Black (1965) and

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Page *et al.* (1982), respectively. The data obtained from the soil analysis are offered in Table 1.

Experimental design and tested treatments:

The experiment consisted of 10 treatments on two pepper cultivars and was performed according to a factorial experiment (a split plot)in randomized complete block design (RCBD) with three replications. Cultivars were assigned to the main plot , fertilizer rates were distributed randomly in the sub plot .The experimental plot contain 8 plants in each line, with an average of 16 plants; each row is 3.2 m long and 0.8 m wide making an area of 2.56 m^2 using drip irrigation system, The drip irrigation network consisted of lateral's GR of 16 mm in diameter, with emitters at 0.4 m distance.

Red and yellow pepper seedlings were planted on both sides of the row with 40 cm spacing on October 15 and 19 in 2021 and 2022, respectively. The planted seedlings were replaced with the same seedlings one week after planting.

The greenhouse was 40 m long and 9.0 m wide With a total area of 360 m_2 during the two seasons, 50 cm From both sides of the arch of the plastic house near the plastic and 50 cm from the beginning (entrance) and end (exit or outside) of the plastic house was left unplanted. So, the sum number of plants/greenhouses 1000 plants

The field was prepared according to agronomic recommendations for sweet pepper cultivation. Mineral fertilization was dosed according to the results of the chemical analysis of the soil. During the growing season, the crop treatment was carried out. It included mainly irrigation, weeding, soil cultivation and plant protection practices.

Organic fertilizer were received from the Poultry and Livestock Research Institute, Department of Agriculture, University of New Valley, Egypt, and compost from a company in Qena Governorate, Egypt. The fertilizers were analyzed at the Soil and Water Laboratory, Faculty of agriculture, Assiut University are offered in Table 2.

Table 1. Chemical and Physical properties of the experimental station in 2021/2022 and 2022/2023 seasons.

Soil properties		Season 2021/2022	2022/2023
	Particle size distribution (%)		
Physical analysis	Coarse sand	5.01	5.9
	Fine sand	76.33	75.37
	Silt	11.74	12.81
	Clay	6.97	6.70
	Textural class	Sandy	Sandy
Chemical Analysis	E.C. (dsm-1 1:5)	1.33	1.23
	PH (1:2.5 w/v)	8.08	8.18
	Organic matter (%)	0.56	0.57
	CaCO3 (%)	5.75	5.97
	SP %	39.1	41.0
	Available nutrients (mg/kg dry soil)		
	N	39.2	40.9
	P	6.0	4.98
	K	87.5	85.95

Table 2. Cattle and poultry manures chemical analysis during 2021/2022 and 2022/2023 seasons.

Ser.	component	cattle manure		poultry manure		Compost manure	
		2021/2022	2022/2023	2021/2022	2022/2023	2021/2022	2022/2023
1	EC (1:10)	4.31	4.12	3.87	3.75	5.64	5.21
2	pH 1:5	6.49	6.68	6.21	6.09	7.1	7.3
3	O.M %	58.10	60.48	69.09	69.59	59.09	60.59
4	O.C %	33.78	35.16	40.17	40.46	38.17	40.46
5	N %	1.75	1.88	2.28	2.24	2.80	2.78
6	c/n ratio	18.9	18.4	17.2	18.06	13.63	14.55
7	P %	0.41	0.46	0.55	0.58	0.8	0.8
8	K %	0.59	0.65	0.69	0.74	1.2	1.2
9	sp %	131	124	103	107	102	109

Time and treatment modalities:

Mineral fertilizers were applied to the soil in the recommended amounts as indicated next: ammonium nitrate (33.5%) at a concentration of 150 kg/feddan , calcium superphosphate (15.5% p_2o5) an average of 400 kg/feddan and potassium sulfate (48% k_2o) an average of 60 kg/feddan.

Nitrogen, phosphorus and potassium were divided into three doses. The first dose was administered during the service process, then the second additional dose was administered during the four weeks following the appearance of the first two leaves after transplanting, and the third dose was added throughout the growing season in equal doses, so that fertilization was done weekly according to the instructions set by the Egyptian Ministry of Agriculture.

Organic manure, i.e., cattle, poultry and compost manure were append at levels 25, 50, and 100% and mixed into the soil with 0, 50 and 75% of recommended mineral fertilizers, during soil preparation. Organic fertilizers were applied to the soil in the recommended amounts as indicated next: cattle manure at a concentration of 30 m^3 /feddan, poultry manure a concentration of 15 m^3 /feddan and the amounts of cattle and poultry and compost was studied according to the total nitrogen content of this manure.

Mineral fertilizer (NPK) and organic fertilizer, i.e., cattle manure (cow) and poultry manure (chicken) and compost used at different levels as follows: used at different levels as follows:

1) Control processing as 100% of recommended mineral fertilizers (T1).
2) Cattle manure was applied at 100% of the recommended fertilizer + 0 mineral fertilizer (T2).
3) Cattle manure 50% of the recommended fertilizer +50% of mineral fertilizer (T3).
4) Cattle manure 25% of the recommended fertilizer + 75% of mineral fertilizer (T4).
5) Poultry manure processing as 100% of recommended fertilizers + 0 mineral fertilizer (T5).
6) Poultry manure 50% of the recommended fertilizer + 50% of mineral fertilizer (T6).
7) Poultry manure 25% of the recommended fertilizer + 75% of mineral fertilizer (T7).
8) Compost manure processing as 100% of recommended fertilizers + 0 mineral fertilizer (T8).
9) Compost manure 50% of the recommended fertilizer + 50% of mineral fertilizers (T9).
10) Compost manure 25% of the recommended fertilizer + 75% of mineral fertilizer (T10).

Data recorded:

1- Vegetative growth characters:

Plant height (cm), number of leaves and branches on 10 Ten plants at each growth stage were randomly selected from each plot were recorded 30 day, 60 day, 90 day and 120 day after planting.

2- Chemical constituents of leaves:

According to Lichtenhaler and Wellburn (1983). Plant leaves were collected 135 days after sowing and dried in an oven 70° constant weight. The dried leaf samples were individually crushed and a 0.5 g sample were ground digested with distilled water was diluted to a final volume of 100 ml with a mixture of sulfuric acid and hydrogen peroxide.

Data were recorded Chlorophyll A, B and Total Carotenoids N, P And K and nitrate and nitrite content inside pepper leaves .

3- Fruit Yield and its components:

Harvest is done about 80 to 90 days after planting once the peppers have reached the desired size and their green fruits have ripened, or when the fruits are in the cracking stage where red and yellow stripes begin to appear and discolor the fruits.

Data were collected average number of fruits per plant. The 10 plant samples were randomly selected except for the border rows. Fruit harvested from a total of 10 plants was taken, calculated and are divided into number of plants in the sample.

Average fruit weight / plant , fruit yield /m_2, this was summed by the weight of total fruits harvested from plants divided into number of plants in the sample.

4- Fruits quality characters:

Fruit was picked several times. Fruits were harvested green and fully grown. After harvesting, fruit quality was assessed by number of fruits/plot, length, diameter**,** dry matter.

5- Chemical constituents of fruits:

For the determination of macronutrients, 0.2 g The canned powder for each sample subjected to wet digestion concentrated sulfuric acid mixture acid and per chloric acid and heated until clear (Peterburgski, 1968). After digestion, the washed solution was quantitatively transferred into100 ml measuring vial with filtered water and stored for analysis.

Data were recorded V.C, V.E, Total fiber %, Total phenol, Total flavonoid, Antioxidant activity %,**).**

6. Statistical analysis:

All obtained data were subjected to statistical analysis of variance according to Snedecor and Cochran (1980) and means separation was carried out according to Duncan (1958) at 5 % levels of probability.

RESULTS AND DISCUSSION

1. Characters of vegetative growth:

Figure (1-3) shows the growth response of pepper cultivars to different types of fertilizers . Significant differences in vegetative growth characteristics were observed for each fertilizer. Plants treated with chicken manure compost at 100% of the recommended fertilizer (T5) recorded the highest values in these characteristics at different growth periods in both seasons vs. cattle manure, compost manure and mineral fertilizers (control).

Furthermore, Effects of organic and mineral fertilizer applications and their interactions with sweet pepper cultivars on the growth traits of sweet peppers was evident as the red Araceli cultivar showed the highest sweet pepper plant height values compared to the Yellow Spring book cultivar at all times recorded.

These results are consistent with those reported by Eissa (1996). Namely, the addition of different organic fertilizers-pigeon, chicken, and cow-increased plant growth characteristics, fresh and dry weight of shoots, grass height, stem diameter, and number of leaves in peppers and cucumbers grown under protected cultivation.

As shown in (Figure 1), poultry manure is high in organic matter, organic carbon, N, P and K, which improves the growth of pepper.

In addition, (Garg and Bahl, 2008) reported the poultry manure supplies Phosphorus to plants faster than other organic fertilizers.

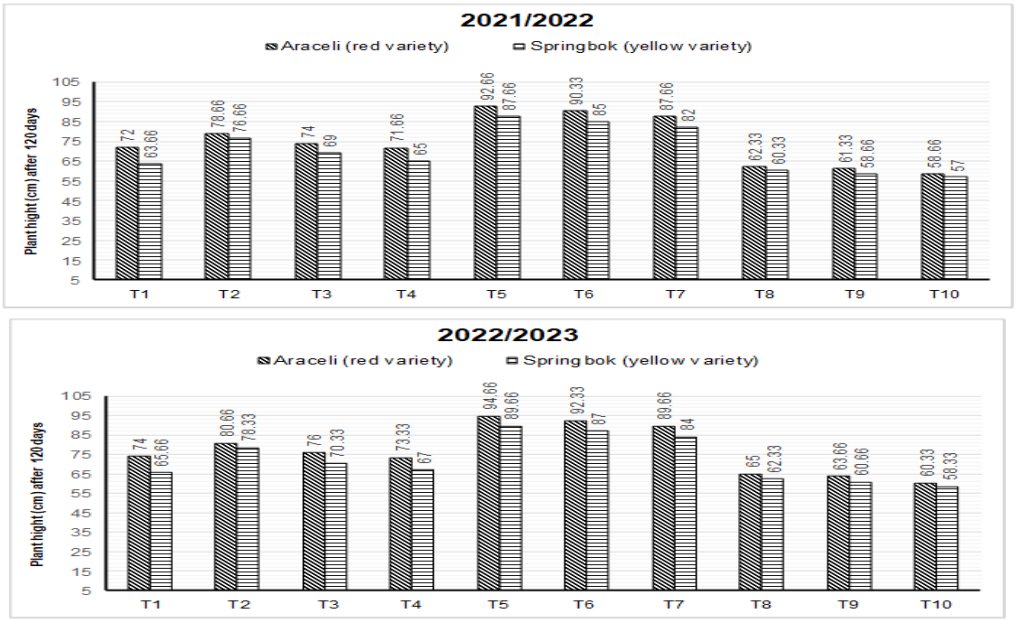

Fig. 1. Effect of interaction between organic and mineral fertilization treatments and pepper cultivars on plant height in pepper at 120 days after transplanting during winter seasons of 2021/2022and 2022/2023.

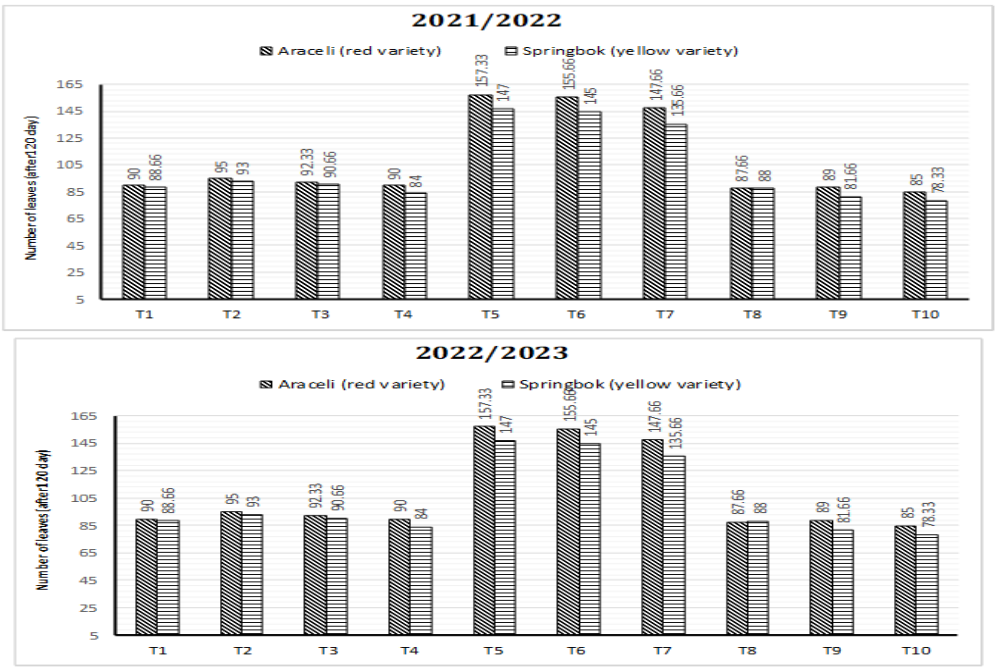

Fig. 2. Effect of interaction between organic and mineral fertilization treatments and pepper cultivars on number of leaves in pepper at 120 days after transplanting during winter seasons of 2021/2022 and 2022/2023.

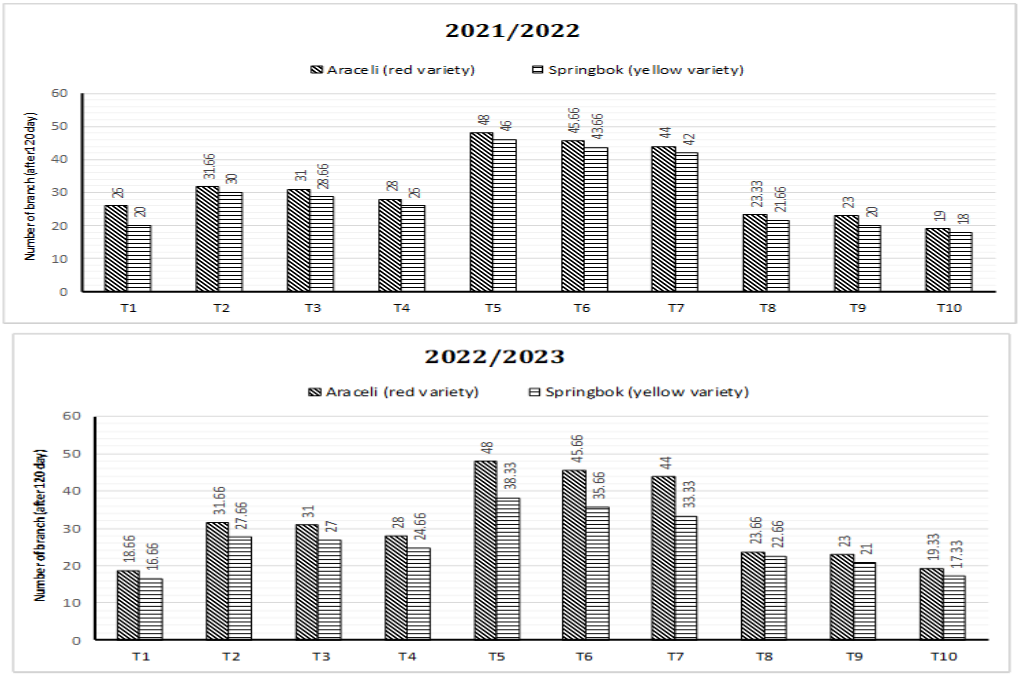

Fig. 3. Effect of interaction between organic and mineral fertilization treatments and pepper cultivars on number of branch in pepper at 120 days after transplanting during winter seasons of 2021/2022 and 2022/2023

2-Composition of leaves Chemicals:

Chemical composition in leaves (Chlorophyll a , b), Carotene, N, P, K, Nitrate and Nitrite content) . Results are offered in Figure (4,5,7,8 and 9). Among the various treating's. Applying poultry manure (T7) containing 25 % of their recommended fertilizer and 75 % of the mineral fertilizer had the highest content of these characteristics vs. cattle manure and mineral fertilizer in both seasons.

Furthermore, nitrate and nitrite content recorded the highest values at 100% of recommended mineral fertilizers (control) the results are offered in Figure (10,11 and 12).

Moreover, Interaction between organic and mineral fertilizer applications and pepper cultivars on chlorophyll a , b , carotenoids, N, P, K in pepper at 135 days after transplanting showed the red Araceli cultivar showed the highest values of pepper plant comparing to the yellow Springbook cultivars in chlorophyll a, b, carotenoids but the Yellow Spring Book cultivar showed the highest values of pepper plant comparing to the red Araceli cultivar in N, P, K all recorded times.

These results are in agreement with Amor (2005) who reported that leaf relative chlorophyll (a+b) content and net photosynthesis decreased in organic treatments.

3. fruit Yield and its components:

Yield upshot and its constituents, namely number of fruits/plot, fruit length (cm), fruit diameter (cm), dry

matter (%), fruits yield/ plant (kg) and fruits yield/ m_2 are offered in Figure (12- 17).

The data for each parameter on pepper fruit yield showed that significant differences were found in all categories depending on fertilizer application parameters.

As a result, this treatment (T5) had a significant increase in the above characteristics traits compared to both of cattle manure, compost together with inorganic fertilizers in both seasons of study. Furthermore, is showing that plants of red Araceli cultivars recorded higher values of fruits yield/ plant (kg) than those of the Yellow Spring Book. Cultivars especially in the two seasons Ravi et *al. (*2004) reported that Organic carbon has increased., nitrogen, phosphorus and potassium content in the soil after the application of compost of Plantation Crops. The increase was to the extent of about 30%. Thus recycling of the wastes available garden has improved the nutrient content of the soil. And organic manure was beneficial on sweet pepper that mineral fertilizers, as organic gave positive effect on fruit weight, number of fruits, fruits size and yield.

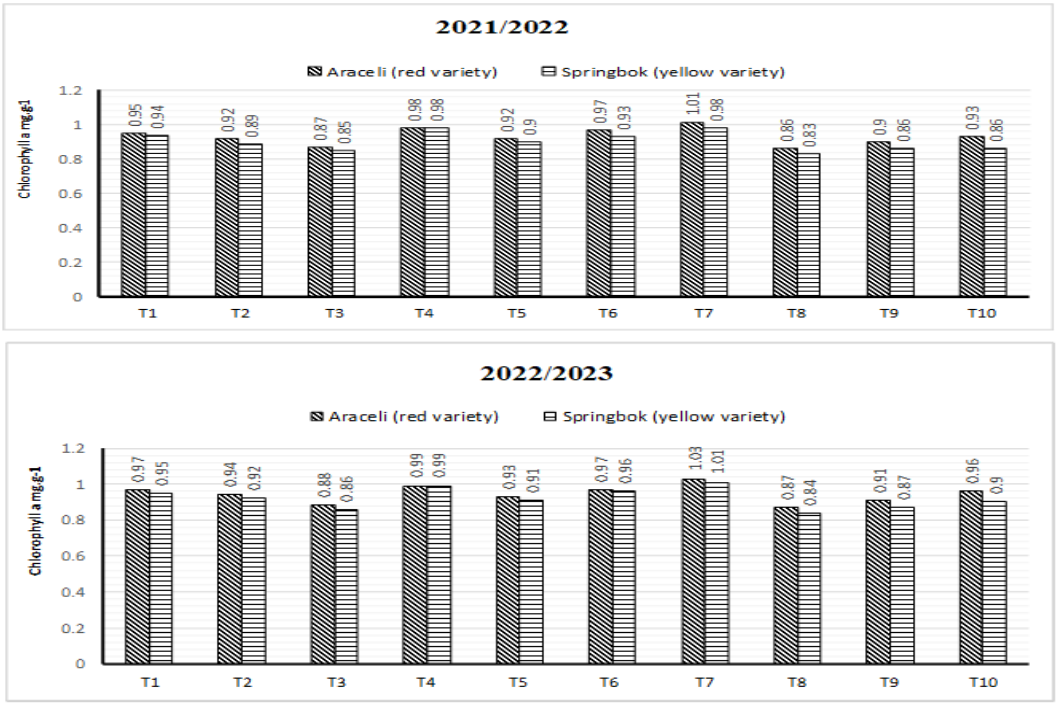

Fig. 4. Effect of interaction between organic and mineral fertilization treatments and Pepper varieties on Chlorophyll a in pepper leaves at 120 days after transplanting during winter seasons of 2021/2022and 2022/2023.

Fig. 5. Effect of interaction between organic and mineral fertilization treatments and Pepper varieties on Chlorophyll b in pepper leaves at 120 days after transplanting during winter seasons of 2021/2022and 2022/2023.

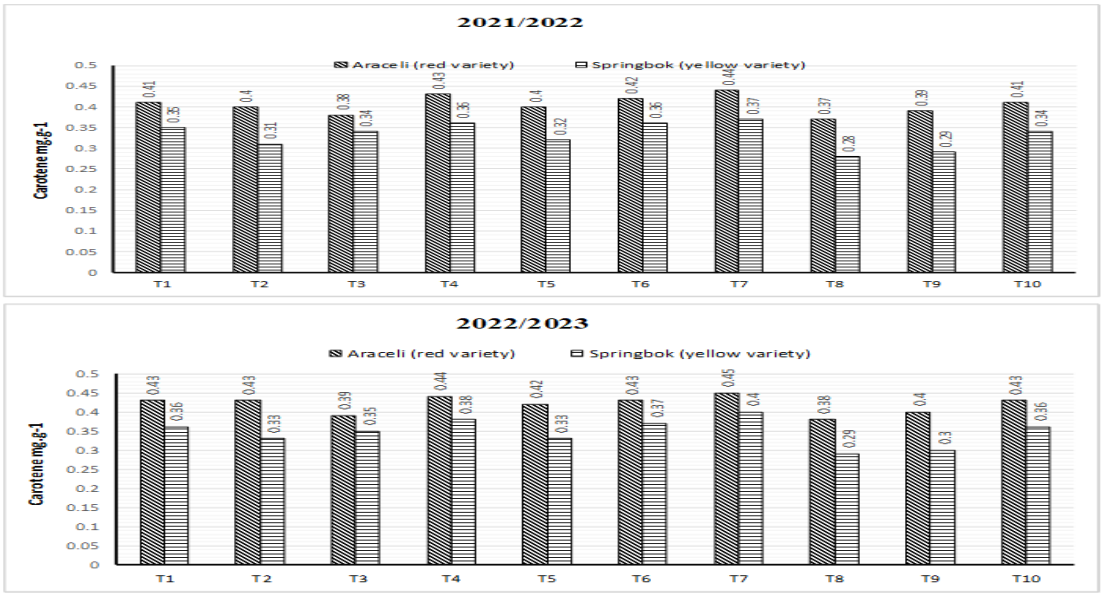

Fig. 6. Effect of interaction between organic and mineral fertilization treatments and Pepper varieties on Caroten in pepper leaves at 120 days after transplanting during winter seasons of 2021/2022and 2022/2023.

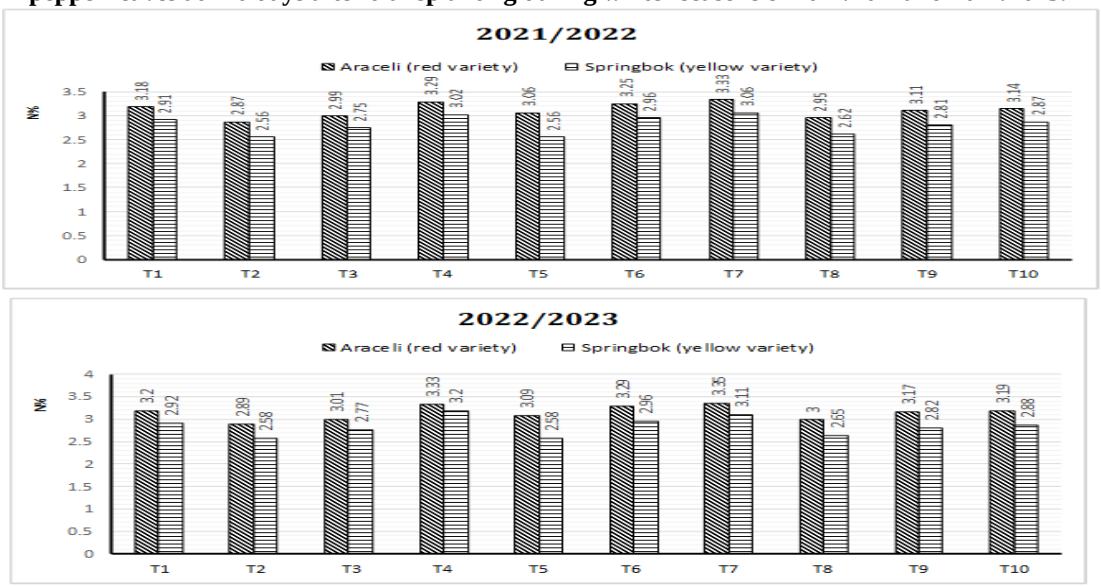

Fig. 7. Effect of interaction between organic and mineral fertilization treatments and Pepper varieties N in pepper leaves at 120 days after transplanting during winter seasons of 2021/2022and 2022/2023.

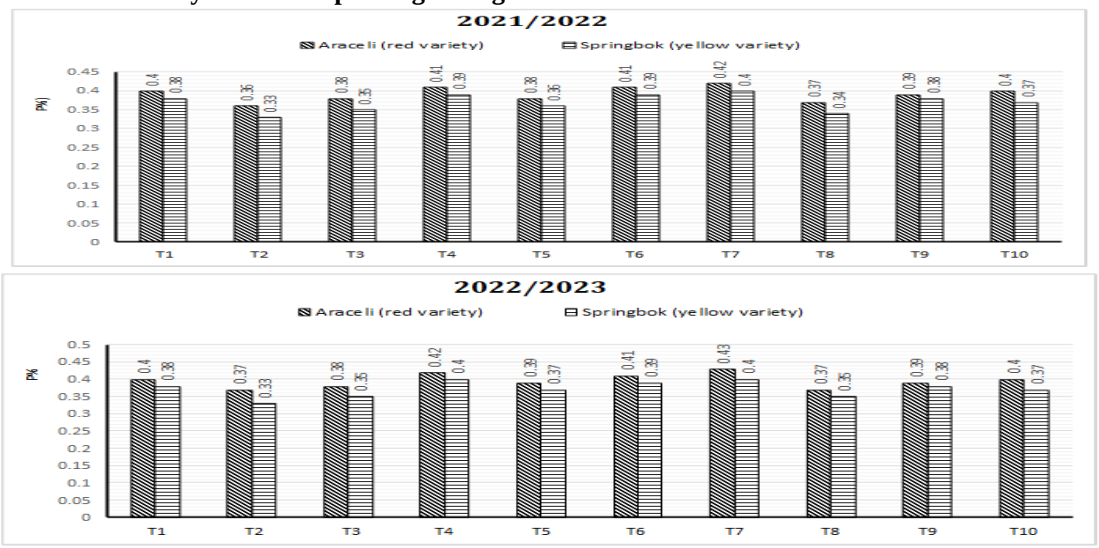

Fig. 8. Effect of interaction between organic and mineral fertilization treatments and Pepper varieties on P in pepper leaves at 120 days after transplanting during winter seasons of 2021/2022and 2022/2023.

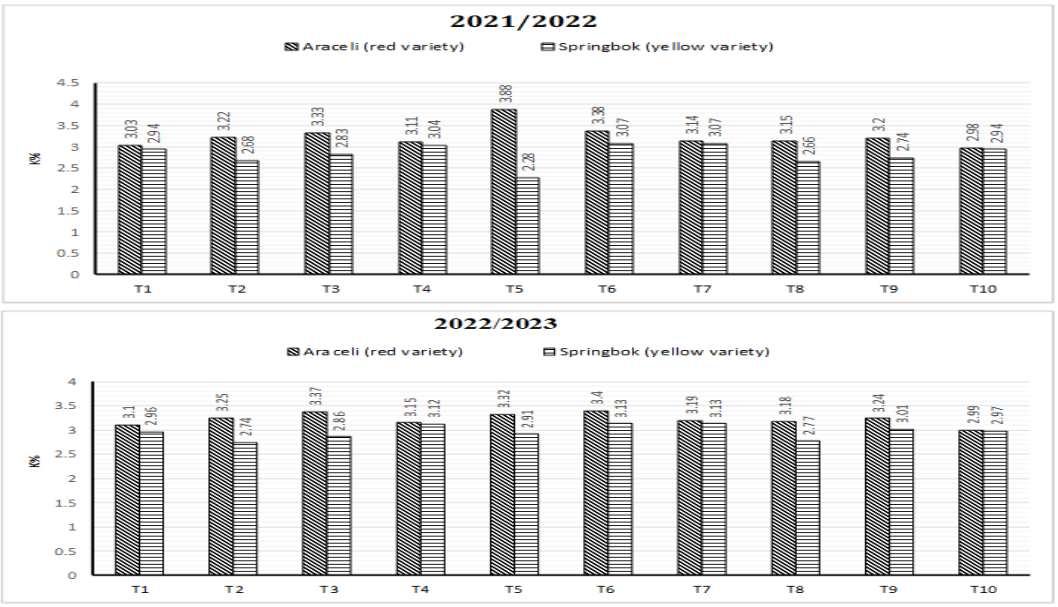

Fig. 9. Effect of interaction between organic and mineral fertilization treatments and Pepper varieties on K in pepper leaves at 120 days after transplanting during winter seasons of 2021/2022and 2022/2023.

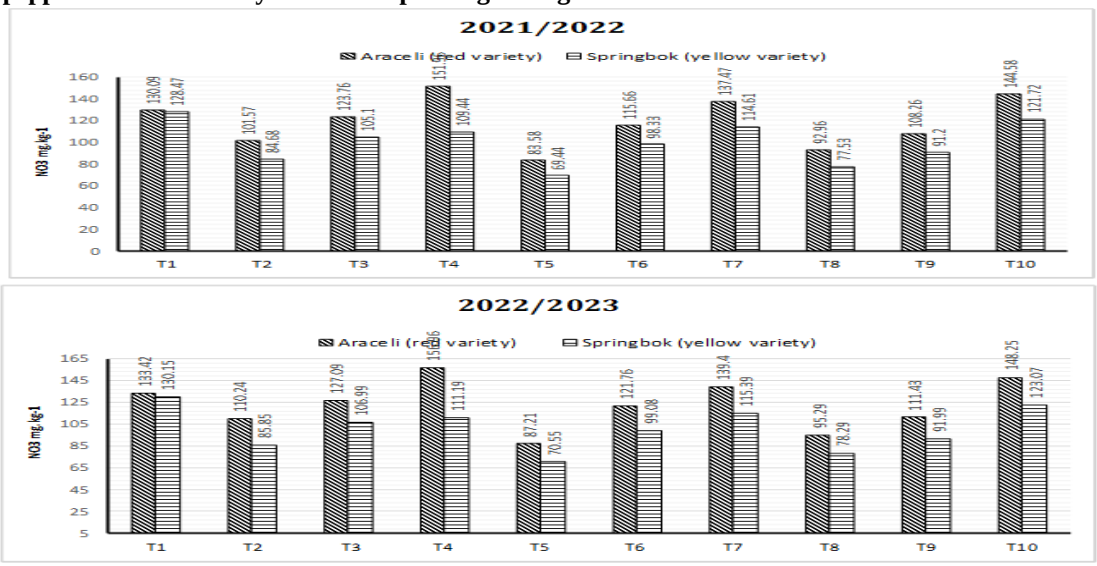

Fig. 10. Effect of interaction between organic and mineral fertilization treatments and Pepper varieties on NO3 in pepper leaves at 120 days after transplanting during winter seasons of 2021/2022and 2022/2023.

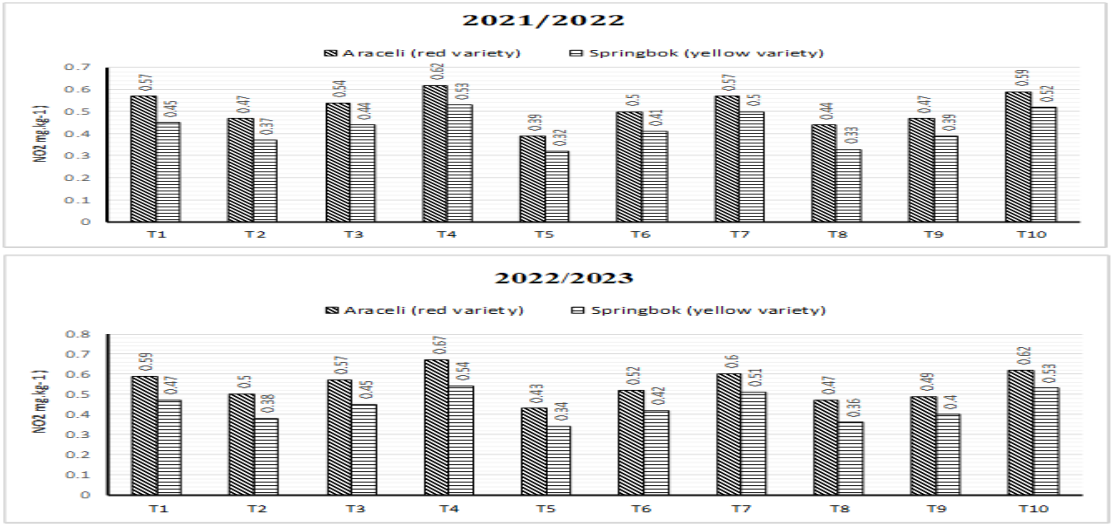

Fig. 11. Effect of interaction between organic and mineral fertilization treatments and Pepper varieties on NO2 in pepper leaves at 120 days after transplanting during winter seasons of 2021/2022and 2022/2023.

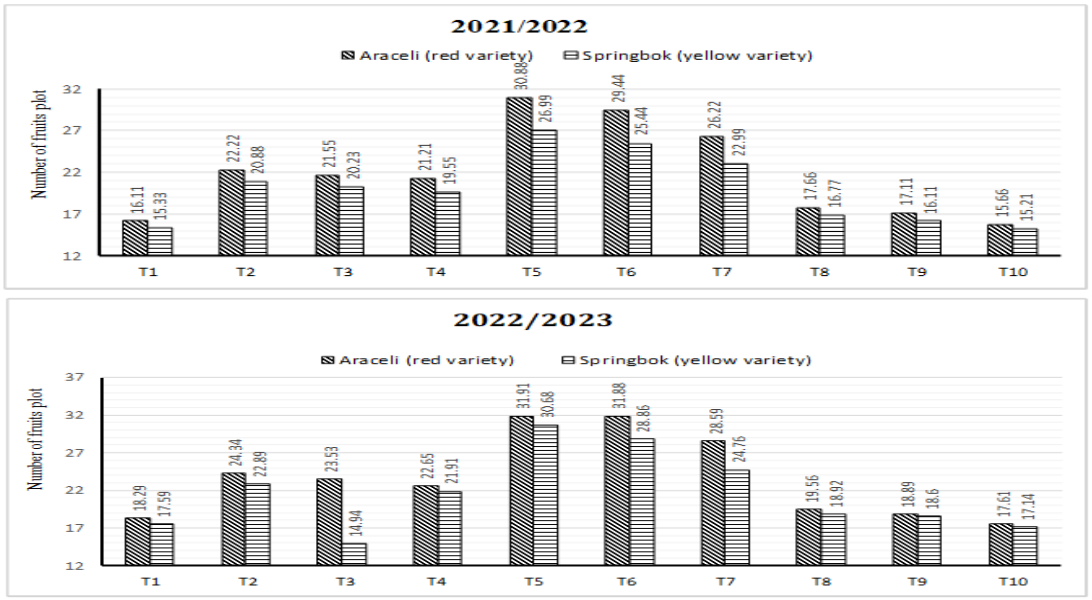

Fig. 12. Effect of interaction between organic and mineral fertilization treatments and Pepper varieties on Number of fruits /plot in pepper fruit during winter seasons of 2021/2022and 2022/2023.

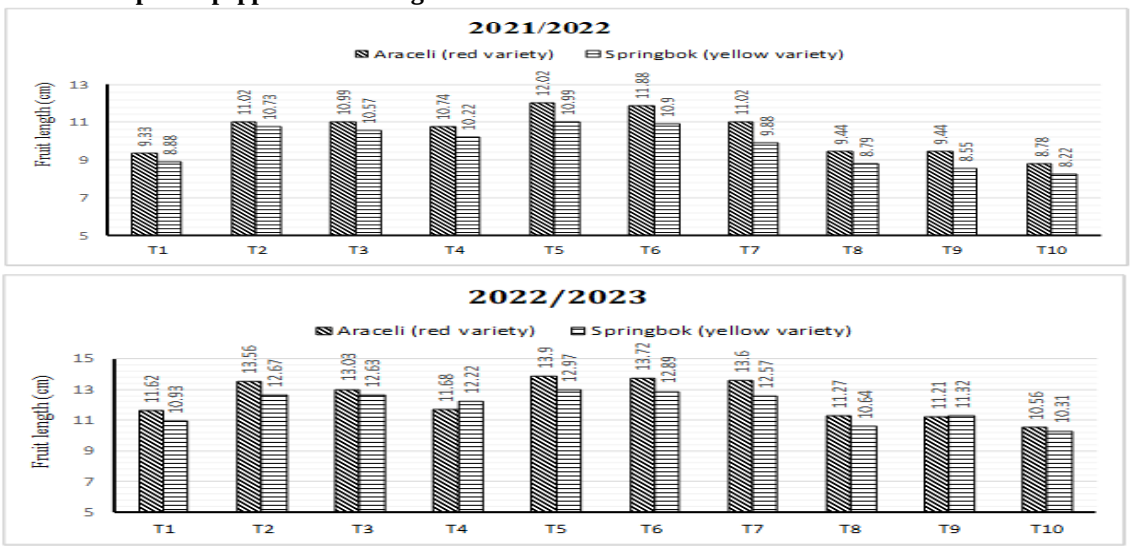

Fig. 13. Effect of interaction between organic and mineral fertilization treatments and Pepper varieties on Fruit length in pepper fruit during winter seasons of 2021/2022and 2022/2023.

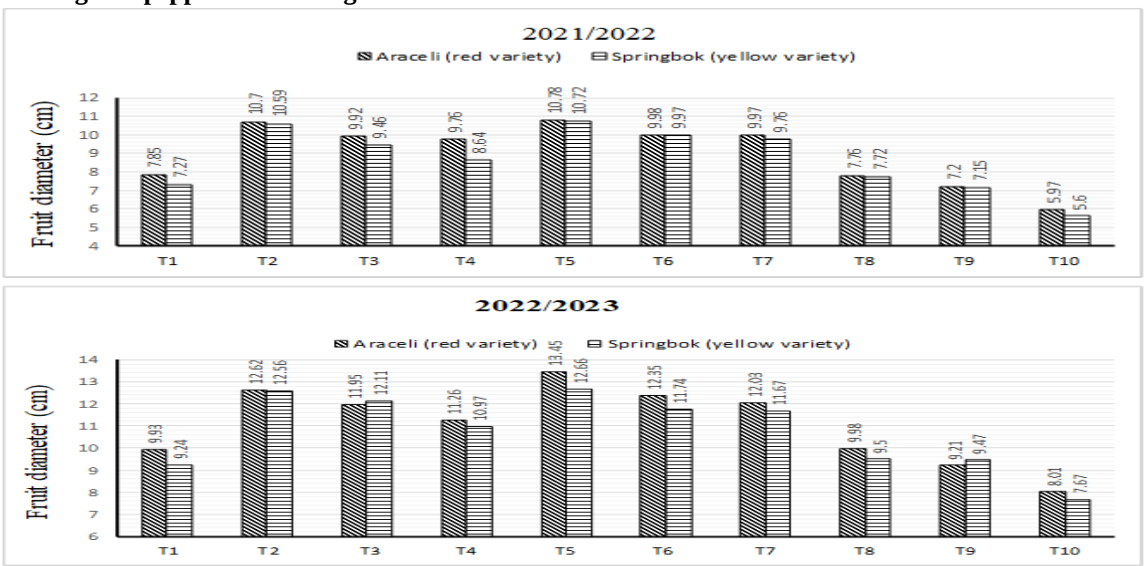

Fig. 14. Effect of interaction between organic and mineral fertilization treatments and Pepper varieties on Fruit diameter in pepper fruit during winter seasons of 2021/2022and 2022/2023.

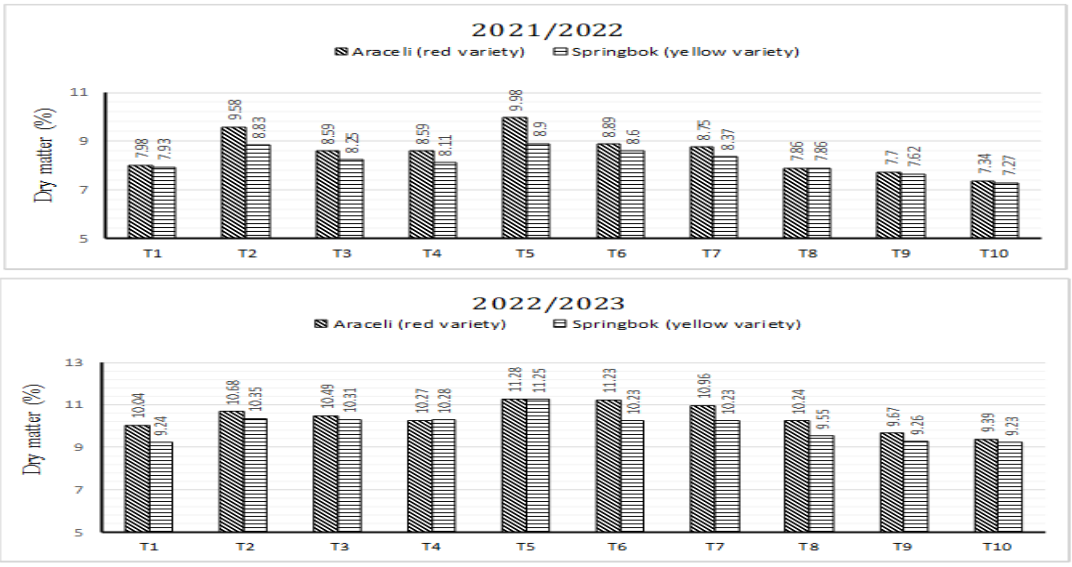

Fig. 15. Effect of interaction between organic and mineral fertilization treatments and Pepper varieties on Dry matter in pepper fruit during winter seasons of 2021/2022and 2022/2023.

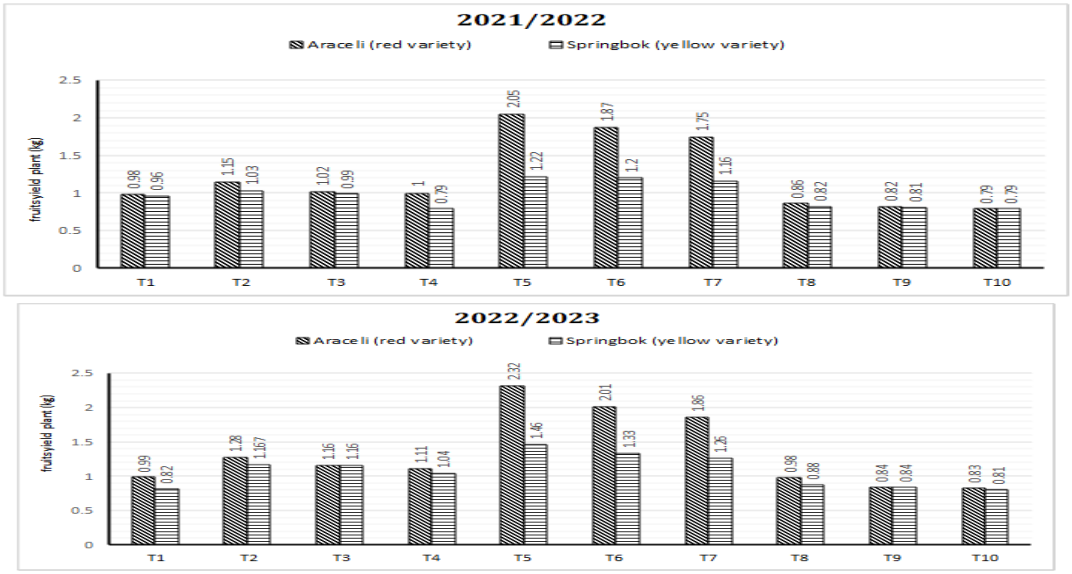

Fig. 16. Effect of interaction between organic and mineral fertilization treatments and Pepper varieties on fruits yield/ plant in pepper fruit during winter seasons of 2021/2022and 2022/2023.

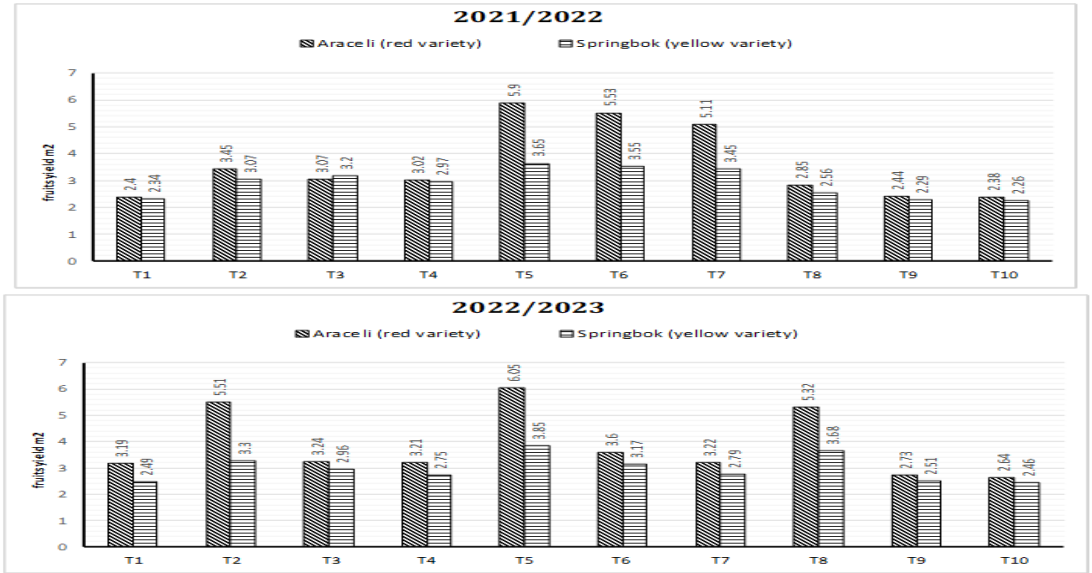

Fig. 17. Effect of interaction between organic and mineral fertilization treatments and Pepper varieties on fruits yield/m$_2$ in pepper fruit during winter seasons of 2021/2022and 2022/2023.

4. Chemical composition of sweet pepper:

Pepper results chemical composition (V.C, V.E, Total fiber %, total phenol, total flavonoid, Antioxidant activity %,) are illustrated in Figure (18- 23).

Furthermore, The results in Figure (21- 23). show that poultry manure at 100% of recommended one fertilizers (T5) had significantly increase in total phenol , total flavonoid , antioxidant activity % vs. kine manure , compost manure mineral fertilizers (control).

These results Pepper Chemical's highest values was recorded. content of V.C. , V.E , Total fiber % cleared that the results showed that treatment (T6) had the highest V.C. ,V.E , total fiber %, in pepper cultivars compared to kine manure , compost manure and inorganic fertilizers (control).

These results in agreement with Qiang *et al.* (2001) who reported that compared with mineral fertilizer, mixed organic fertilizer and organic-mineral complex Fertilizers contribute significantly to the growth and development of peppers.

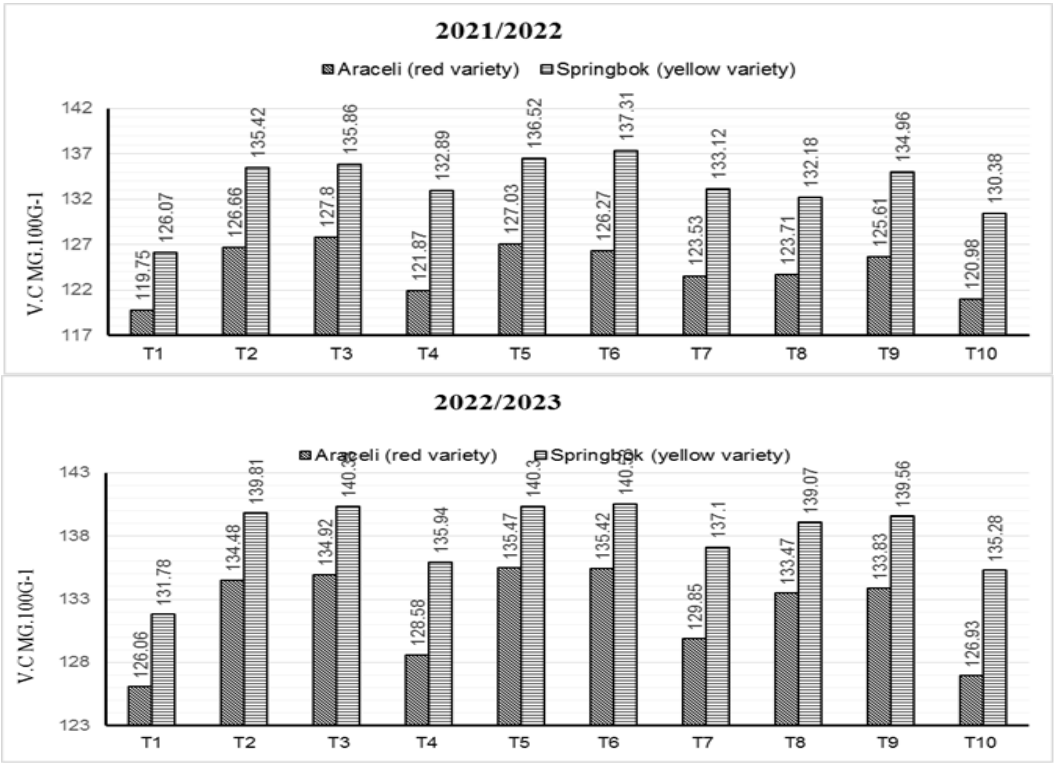

Fig. 18. Effect of interaction between organic and mineral fertilization treatments and Pepper varieties on V.C. in pepper fruit during winter seasons of 2021/2022and 2022/2023.

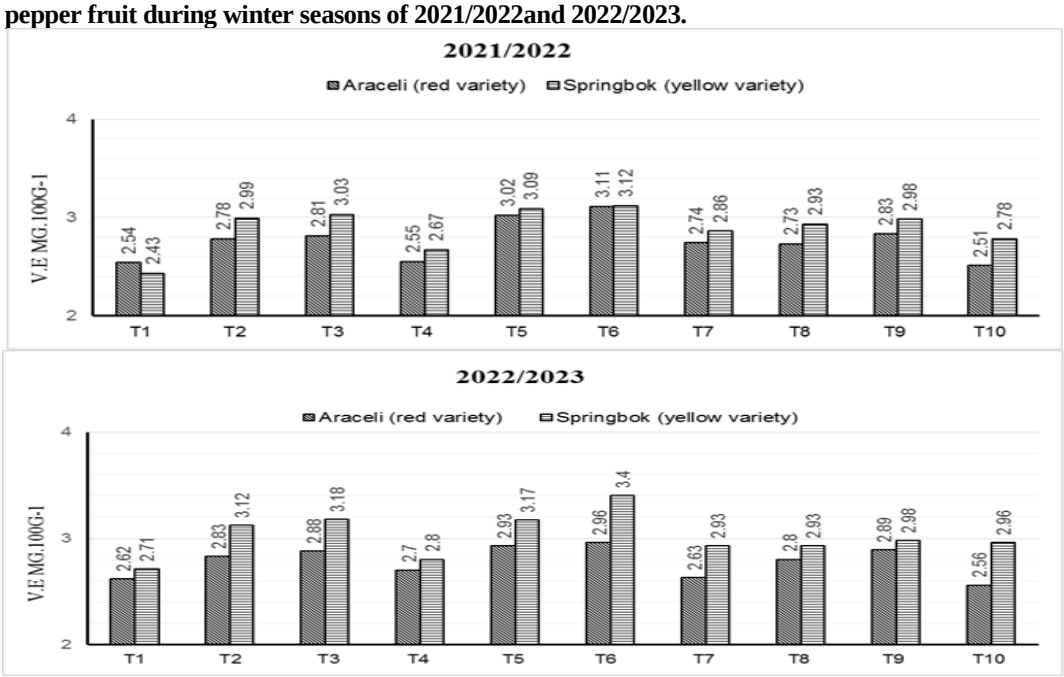

Fig. 19. Effect of interaction between organic and mineral fertilization treatments and Pepper varieties on V.E. in pepper fruit during winter seasons of 2021/2022and 2022/2023.

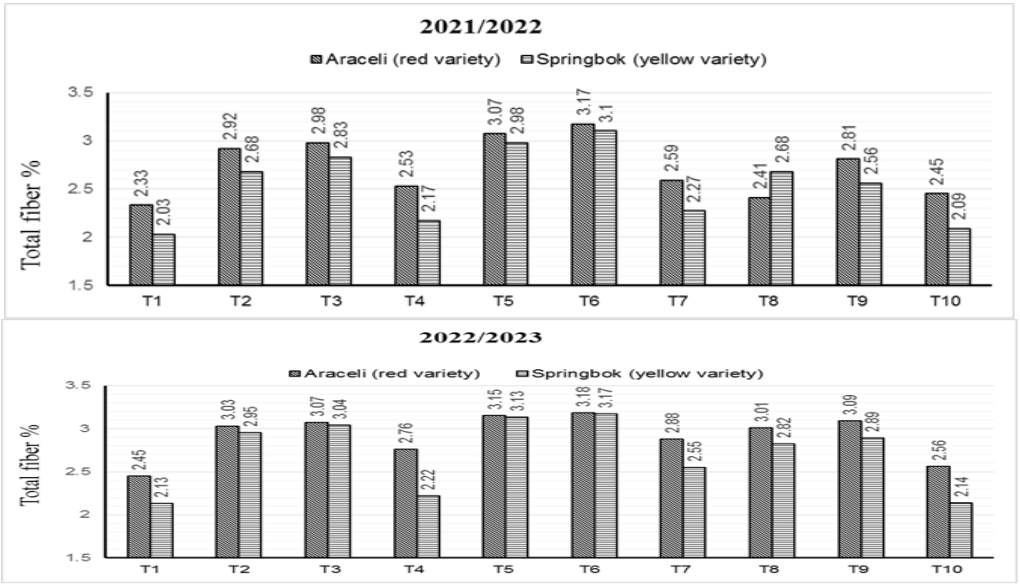

Fig. 20. Effect of interaction between organic and mineral fertilization treatments and Pepper varieties on total fiber in pepper fruit during winter seasons of 2021/2022and 2022/2023.

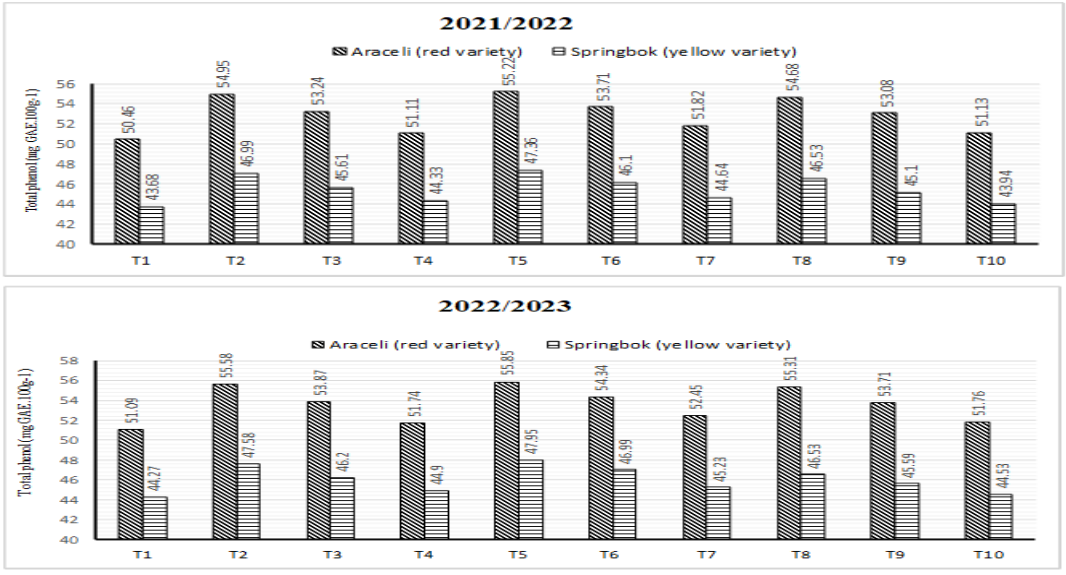

Fig. 21. Effect of interaction between organic and mineral fertilization treatments and Pepper varieties on total phenol in pepper fruit during winter seasons of 2021/2022and 2022/2023.

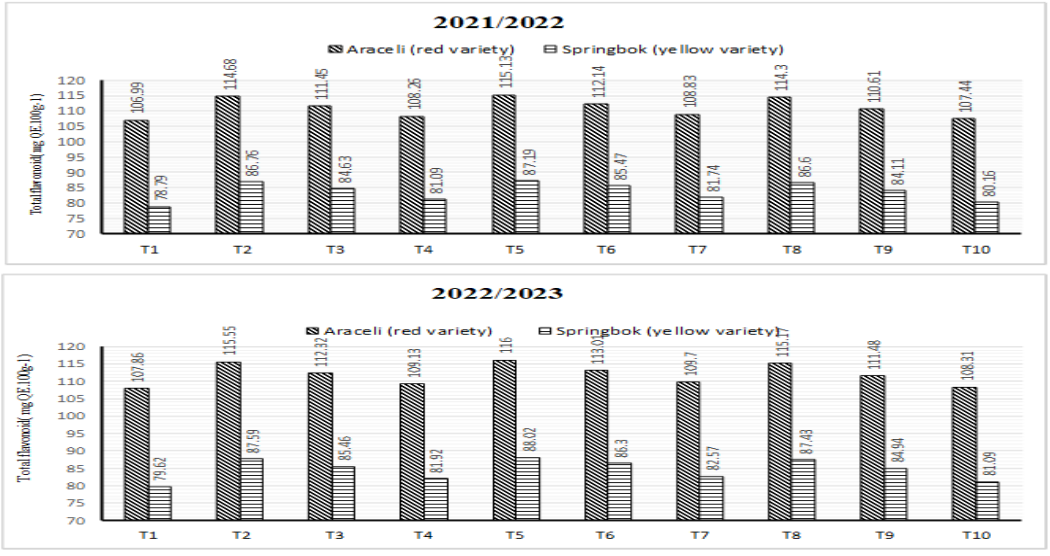

Fig. 22. Effect of interaction between organic and mineral fertilization treatments and Pepper varieties on total flavonoid in pepper fruit during winter seasons of 2021/2022and 2022/2023.

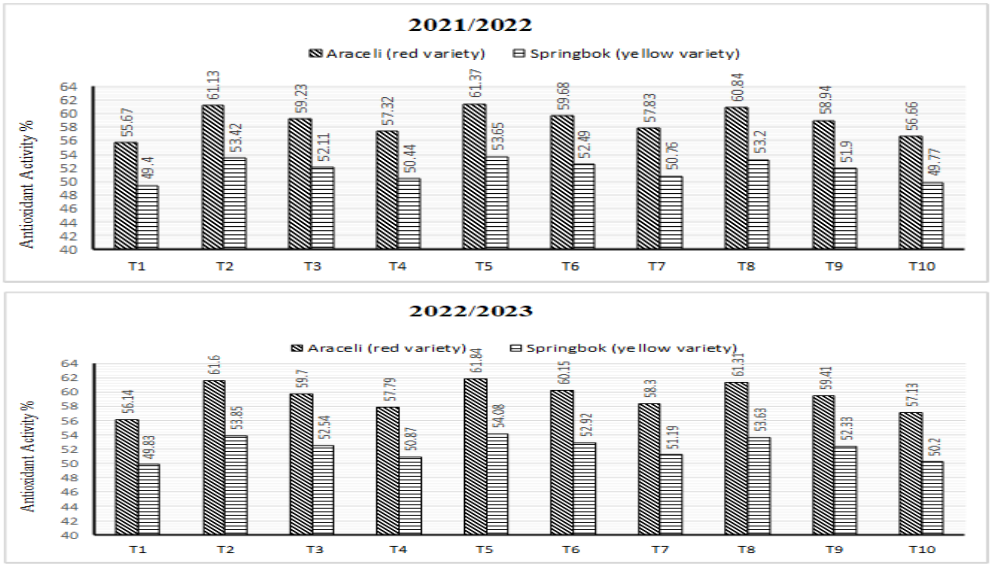

Fig. 23. Effect of interaction between organic and mineral fertilization treatments and Pepper varieties on antioxidant activity in pepper fruit during winter seasons of 2021/2022and 2022/2023.

CONCLUSION

These results indicate that the application of 100% of the recommended fertilizer with poultry manure to cv. Araceli (red cultivar) and Springbok (yellow cultivar) pepper cultivars under New Valley State conditions increased the growth, yield and quality of pepper in the greenhouse.

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دراسات علي الحد من استخدام الأسمدة الكيميائية في إنتاج الفلفل داخل البيوت المحمية

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الملخص

أجريت الدراسة بمزرعة البحوث بكلية الزراعة جامعة الوادي الجديد خلال موسمى ٢٠٢٢/٢٠٢١ و ٢٠٢٣/٢٠٢٢ بهدف دراسة تقليل استخدام الأسمدة الكيميائية فى إنتاج الفلفل داخل البيوت المحمية، حيث تم استخدام بعض الأسمدة العضوية (سماد الأبقار وسماد الدواجن وسماد الكومبوست) بالإضافة إلى الأسمدة المعدنية كمعاملة تحكم، وقد أظهرت النتائج المتحصل عليها أن صفات النمو الخضري ومكونات المحصول لنباتات الفلفل تأثرت معنوياً بأنواع الأسمدة، حيث سجل سماد الدواجن بنسبة ١٠٠٪ من الأسمدة الموصى بها أعلى القيم لكل من صفات النمو الخضري ومكونات المحصول (طول النبات، عدد الأوراق، عدد الأفرع، عدد الثمار/نبات، وزن الثمار، قطر الثمار، المادة الجافة، محصول الثمار/نبات، محصول الثمار/م٢، الفينولات الكلية الذائبة فى الماء، الكاروتينات الكلية، الفلافونويدات الكلية وأنشطة مضادات الأكسدة) بالمقارنة بالأسمدة المعدنية (التحكم) فى كلا الموسمين. بينما زاد محتوى الكلوروفيل أ، ب، الكاروتينات الكلية، النيتروجين، الفسفور والبوتاسيوم فى أوراق الفلفل، وفى ثمار الفلفل معنوياً بإضافة سماد الدواجن بنسبة ٢٥٪ من الأسمدة الموصى بها بالإضافة إلى ٧٥٪ من الأسمدة المعدنية مقارنة بالكنترول فى كلا الموسمين، كما زاد فيتامين ج، فيتامين هـ الألياف الكلية فى ثمار الفلفل معنوياً بإضافة سماد الدواجن بنسبة ٥٠٪ من الأسمدة الموصى بها بالإضافة إلى ٥٠٪ من الأسمدة المعدنية مقارنة بالكنترول فى كلا الموسمين. ويمكن الاستنتاج أن إضافة سماد الدواجن بنسبة ١٠٠٪ من الأسمدة الموصي بها أدى إلى زيادة النمو والإنتاجية وتحسين جودة نباتات الفلفل الحلو داخل الصوبات الزراعية تحت ظروف محافظة الوادي الجديد.