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EFFECT OF ARGININE, CHITOSAN AND AGRYL MULCHING ON THE GROWTH AND YIELD OF PEPPER PLANT UNDER THE CONDITIONS OF UNHEATED GREENHOUSES

Fadel A.M. Al-Hassani and Bayan H. Majid

Department of Horticulture and Landscape Design, Faculty of Agricultural Engineering Sciences, University of Baghdad, Iraq
Corresponding author: Fadhilag78@gmail.com drbayanhamza@gmail.com

Abstract

An experiment was carried out at the research station in the field of agricultural engineering - University of Baghdad at the site of the Jadriya, in one of the greenhouses for the autumn season 2017 on sweet pepper plant (*Capsicum annuum L.)* that characterized by sweet Italian (Bull Horn type). The experiment included three factors: Arginine (R) spraying at concentrations of 0, 75 and 150 mg.L^{-1} represented by R0, R1, and R2 respectively, and the first spraying was after one month of planting and the plants were sprayed every month until the end of the season. The Chitosan (k) was sprayed at four concentrations 0, 12.5, 25, 37.5 mg.L^{-1} represented by K0, K1, K2 and K3 respectively, and the first spraying was after one month of planting and the plants were sprayed every 15 days until the end of the season. The third factor was Agryl p17 (A) mulching. The experiment was carried out according to Nested Design with three replicates. The obtained results showed that the effect of agryl mulching in increasing plant leaves area, average fruit weight, and total plant yield while uncovered plants were significantly superior in dry weight of roots and fruits number. Arginine (R) spraying resulted in a significant increase R2 in regard with leave area, fruit weight and total yield while R1 was superior in the average number of fruits. The Chitosan (K) spraying had a significant effect represented by higher leaf area as well as increased dry weight of roots and fruits number while K2 was superior in the average fruit weight and total plant yield.

Keywords: Arginine, Chitosan, Agryl

Introduction

The availability of food has become an important issue in light of the increases in all societies and has two dimensions, human and economic dimension, therefore workers in the agricultural field seek all the available means to increase the agricultural production, both vegetative and animal in quality and quantity. The importance of vegetable crops was highlighted by the nutritional value, yield, productivity and diversity at the same time in addition to the flexibility to cultivate them in different lands and environmental conditions as well, its inclusion on many plant families. The family of Solanaceae includes many crops, such as *Capsicum annuum* L. and in recent years its importance has grown in Iraq due to the increasing demand for it. This has led to use protected cultivation patterns to be provided throughout the year. Pepper is characterized by variety of varieties, including helical (Sweet long fruits) which exceeds the price of marketing on other types. The large variation in temperature between night and day has a negative effect on protected agriculture as well as increased humidity that provides a suitable environment for the spread of pathological injuries which consistent with the concern of increasing costs. Therefore the idea of using the agryl cover was highlighted by Bachmann, (2005) as a polypropylene cover with small pores that withstand ultraviolet light and can be placed directly on plants for its light weight and provides an environmentally friendly environment for plant growth as well as provides plant service of watering and control.

Amino acids are of great importance due to the direct or indirect effects on the physiological processes of the plant through its role in the formation of many organic compounds such as vitamins and hormones, which is an essential component of living matter, protoplasm and is involved in the formation of enzymes as well as its a store of carbon and energy (Rai, 2002). The effect of Arginin on vegetative properties represented by a positive role as an important source of nitrogen during the formation of proteins and enzymes which is necessary in cell formation and its effect on increasing of carbohydrates and proteins manufacture as well as stimulating physiological and biological processes within the plant, which is reflected in increased plant growth (Liu *et al*., 2006). The use of natural substances such as Chitosan is a contribution to the achievement of sustainable agriculture. It is a soluble form of Chitin extracted from marine oysters and contributes to the compounds derived from it by providing protection to plants from fungal infections (Hirano *et al*., 1990). In the light of the above, the present study aims to increase the production and to improve the quality of pepper fruits.

Materials and Methods

The field experiment was carried out at the research station B of the Faculty of Agricultural Engineering Sciences, University of Baghdad at the site of Al-Jadriya, in one of the greenhouses for the autumn season 2017. Sweet Pepper was planted (Bull Horn type) and when the seedlings reached four real leaves then transferred to the plastic house on 1 of October 2017. The experiment included three factors: Arginine (R) spraying at concentrations of 0, 75 and 150 mg.L^{-1} represented by R0, R1, and R2 respectively, and the first spraying was after one month of planting and the plants were sprayed every month until the end of the season. The Chitosan (k) was sprayed at four concentrations 0, 12.5, 25, 37.5 mg.L^{-1} represented by K0, K1, K2 and K3 respectively, and the first spraying was after one month of planting and the plants were sprayed every 15 days until the end of the season. The third factor was Agryl p17 (A) mulching. The experiment was carried out according to the design of Nested Design and included 24 treatments divided randomly into three replicates. The experimental units were 72 and distributed into five tables. The experimental unit included 14 plants and the distance between plants was 0.4 m. The results were statistically analyzed using the Genstat program. The mean was compared with the least significant difference

(LSD) and 5% probability. The average of total leave area ($dcm^2.plant^{-1}$), dry weight of roots (g. $plant^{-1}$), average of fruits number ($fruit.plant^{-1}$), average of fruit weight (g) and total plant yield ($ton.h^{-1}$) were calculated and the number of plants in the house was considered 1400 plants.

Results

Average of total leave area ($dcm^2.plant^{-1}$)

The results of Table 1 showed the positive effect of treatment A1 in increasing the leaf area of the plant, with an average of 413.2 $dcm^2.plant^{-1}$ compared to the treatment of uncovered plants A0, with an average leaf area of 209.1 $dcm^2.Plant^{-1}$. The plants leaf sprayed with R showed a significant effect, which reached the highest mean of 334.0 $dcm^2.Plant^{-1}$ in R2 compared with R1 and R0 which recorded means of 311.2 and 288.2 $dcm^2.Plant^{-1}$ respectively. The obtained results also showed a significant effect of K spraying on leaf area with the largest mean of 378.7 $dcm^2.plant^{-1}$ in K3 compared with other treatments. The treatment of K2 with an area of 340.4 $dcm^2.plant^{-1}$ was superior on K1 and K0 that reached an area of 316.8 and 208.6 $dcm^2.Plant^{-1}$ respectively. As for the double interaction between A and R, there was a significant effect on the leaf area, where A1R2 exceeded with mean of 430.3 $dcm^2.Plant^{-1}$ compared with A0R0, which amounted to 176.2 $dcm^2.Plant^{-1}$. Furthermore, the effect of the interaction between A and K was significant and it was evident in the increase of the average leaf area as it reached 472.3 and 467.5 $dcm^2.Plant^{-1}$ in A1K3 and A1K2 respectively compared with A0K0 that recorded mean of 149.2 $dcm^2.Plant^{-1}$. The data of the same table indicated that there was no significant effect of the interaction between R and K. As for the effect of the interaction between A, R and K on the average leaf area, it was significantly higher in A1R2K2 with an area of 490.0 $dcm^2.Plant^{-1}$ compared to A0R0K0, which amounted to 130.3 $dcm^2.Plant^{-1}$.

Dry weight of roots ($g.plant^{-1}$)

The results of Table 2 showed that the roots of the plants in A0 were higher in dry weight and averaged 50.85 $g.plant^{-1}$ compared with plants of A1 which recorded mean of 33.73 $g.plant^{-1}$. Additionally, spraying with R did not significantly affect the dry weight of the roots while spraying with K had a significant effect on pepper plant where K3 and K2 recorded means of 48.06 and 49.07 $g.plant^{-1}$ respectively and were significantly higher than K1 and K0 which reached 37.79 and 34.23 $g.plant^{-1}$ respectively. The K1 treatment was also significantly higher with mean of 37.79 $g.plant^{-1}$ compared with the K0 that reached 34.23 $g.plant^{-1}$. Moreover, the double interaction between A and R had insignificant effect on the dry weight gain while the interaction between A and K had a significant effect on dry weight of A0K3 and A0K2, which were of 56.48 and 61.51 $g.plant^{-1}$ respectively compared to A1K0 that was of 28.22 $g.plant^{-1}$. Regarding the interaction between R and K and the interaction between A, R and K, there were no significant differences in the studied character.

Average number of fruits ($fruit.plant^{-1}$)

Table 3 indicated that the plants of A0 had an increase in the average number of fruits per plant, reaching 76.31 $fruit.plant^{-1}$ while it was 65.56 $fruit.plant^{-1}$ in A1. Additionally, a significant effect of the spraying with R on pepper plants where R1 was the highest number of fruits and reached 72.90 $fruit.plant^{-1}$ compared to R0, which reached 68.88 $fruit.plant^{-1}$. Spraying with K was significantly affect the number of fruits and the higher number was recorded in K3 with mean of 75.54 $fruit.plant^{-1}$ compared to K0 which reached an average of 62.55 $fruit.plant^{-1}$. However, the interactions between the studied factors (A, R and K) did not have any significant effect on the number of fruits.

Average fruit weight (g)

Table 4 showed the effect of covering the pepper plants with the agryl cover (A1) causing a significant increase in the average weight of the fruit which reached 70.00 g when compared with the average fruit weight of uncovered plants (A0) which was 47.3 g. Furthermore, plants spraying with R had a significant effect where R2 reached the average of 61.09 g compared to R1 and R0, which reached 57.76 and 57.10 g respectively. Similarly, a significant effect of K was detected where K2 reached higher average of 68.84 g compared to the other treatments of K3, K1 and K0 of 58.87, 57.84 and 49.06 g respectively. It was noted that there was no significant effect of the interaction between A and R as well as R and K in the average weight of the fruit while the interaction between the A and K had a significant effect whereas A1K2 treatment exceeding the average weight of 81.18 g compared to A0K0 which was of 38.85 g. In the statistical analysis of the triangular interaction between the factors of the study, significant differences were found where A1R2K2 was superior with higher weight of fruit and reached 83.68 g compared to A0R0K0, which averaged 34.80 g.

Total plant yield ($ton.plastic\ house^{-1}$)

A significant positive effect for A on the plant yield was noted (Table 5). Treatment A1 was superior in the early increase with mean of 6.405 $ton.h^{-1}$ compared to A0 which recorded 5.080 $ton.h^{-1}$ with an increase of 20.6%. Furthermore, a significant effect of R was demonstrated where R2 was significantly exceeded with higher yield of 5.998 $ton.h^{-1}$ compared to R1 and R0 which reached 5.802 and 5.427 $ton.h^{-1}$ respectively. The obtained results indicated that the K spraying had a significant effect on the yield with a higher value in K2 with mean of 6.879 $ton.h^{-1}$ compared to 5.698 and 4.219 $ton.h^{-1}$ for K1 and K0 respectively. As for the interaction between A and K, it had a significant effect on the total yield of pepper plants whereas A1K2 was superior with value of 7.371 $ton.h^{-1}$ compared to A0k0 which reached 3.594 $ton.h^{-1}$. However, there was insignificant effect of the interaction between A and R while a significant effect of the interaction between A, R and K was detected. Treatment A1R2K2 was superior with the highest plant yield reached 7.836 $ton.h^{-1}$ compared to the lowest plant yield with mean of 3.265 $ton.h^{-1}$ in A0R0K0.

Table 1 : Effect of Agryl mulching (A), Arginine (R) and Chitosan (K) spraying and their interaction on the average of total leaf area of pepper plants ($dcm^2.Plant^{-1}$).

A x R	K3	K2	K1	K0	Treatments	Coverage
176.2	257.5	181.1	136.0	130.3	R0	AO
213.3	290.5	225.9	182.9	154.1	R1	
237.8	307.2	233.1	247.7	163.0	R2	
400.2	502.6	452.6	406.5	239.2	R0	A1
409.0	455.4	460.0	453.1	267.3	R1	
430.3	458.9	490.0	474.6	297.8	R2	
A						
209.1	285.0	213.4	188.9	149.2	A0	A x K
413.2	472.3	467.5	444.7	268.1	A1	
R						
288.2	380.1	316.8	271.3	184.8	R0	R x K
311.2	373.0	343.0	318.0	210.7	R1	
334.0	383.0	361.6	361.2	230.4	R2	
	378.7	340.4	316.8	208.6	K	

ARK	RK	AK	AR	K	R	A	L.S.D
55.3	N.S	36.6	. 34.1	21.3	18.4	32.2	0.05

Table 2 : Effect of Agryl mulching (A), Arginine (R) and Chitosan (K) spraying and their interaction on the dry weight of roots of pepper plant ($g.plant^{-1}$)

A x R	K3	K2	K1	K0	Treatments	Coverage
49.74	55.37	60.40	44.07	39.13	R0	AO
50.97	56.60	61.63	45.30	40.36	R1	
51.84	57.47	62.50	46.17	41.23	R2	
32.43	38.53	34.97	29.10	27.11	R0	A1
34.07	39.76	37.86	30.30	28.34	R1	
34.69	40.63	37.07	31.83	29.21	R2	
A						
50.85	56.48	61.51	45.18	40.24	A0	A x K
33.73	39.64	36.63	30.41	28.22	A1	
R						
41.08	46.95	47.68	36.58	33.12	R0	R x K
42.52	48.18	49.75	37.80	34.35	R1	
43.26	49.05	49.78	39.00	35.22	R2	
	48.06	49.07	37.79	34.23	K	

ARK	RK	AK	AR	K	R	A	L.S.D
N.S	N.S	**6.46**	N.S	**2.47**	N.S	**6.52**	0.05

Table 3 : Effect of Agryl mulching (A), Arginine (R) and Chitosan (K) spraying and their interaction on the average number of fruits of pepper plants ($fruit.plant^{-1}$)

A x R	K3	K2	K1	K0	Treatments	Coverage
73.10	75.93	75.70	73.70	67.07	R0	AO
79.17	82.23	84.93	82.60	66.93	R1	
76.67	79.50	82.30	79.03	65.83	R2	
64.65	70.80	63.27	69.80	54.73	R0	A1
66.63	73.23	65.40	66.60	61.30	R1	
65.41	71.53	67.63	63.03	59.43	R2	
A						
76.31	79.22	80.98	78.44	66.61	A0	A x K
65.56	71.86	65.43	66.48	58.49	A1	
R						
68.88	73.37	69.48	71.75	60.90	R0	R x K
72.90	77.73	75.17	74.60	64.12	R1	
71.04	75.52	74.97	71.03	62.63	R2	
	75.54	73.21	72.46	62.55	K	

ARK	RK	AK	AR	K	R	A	L.S.D
N.S	N.S	N.S	N.S	3.7	3.2	3.8	0.05

Table 4 : Effect of Agryl mulching (A), Arginine (R) and Chitosan (K) spraying and their interactions on the average weight of fruits of Pepper plant (g)

A x R	K3	K2	K1	K0	Treatments	Coverage
46.47	49.65	57.75	43.68	34.80	R0	AO
46.25	48.82	54.38	42.21	39.59	R1	
49.18	51.80	57.38	45.37	42.15	R2	
67.73	65.67	79.18	66.21	59.84	R0	A1
69.28	67.11	80.68	72.14	57.19	R1	
73.00	70.16	83.68	77.41	60.76	R2	
A						
47.30	50.09	56.50	43.75	38.85	A0	A x K
70.00	67.65	81.18	71.92	59.26	A1	
R						
57.10	57.66	68.47	54.94	47.32	R0	R x K
57.76	57.96	67.53	57.17	48.39	R1	
61.09	60.98	70.53	61.39	51.46	R2	
	58.87	68.84	57.84	49.06	K	

ARK	RK	AK	AR	K	R	A	L.S.D
11.8	N,S	**10.2**	N.S	**3.6**	3.1	**10.4**	0.05

Table 5 : Effect of Agryl mulching (A), Arginine (R) and Chitosan (K) spraying and their interactions on the yield of pepper plants (ton.h^{-1})

A x R	K3	K2	K1	K0	Treatments	Coverage
4.776	5.252	6.090	4.497	3.265	R0	AO
5.155	5.623	6.461	4.868	3.669	R1	
5.309	5.769	6.607	5.014	3.848	R2	
6.078	6.505	6.953	6.306	4.548	R0	A1
6.449	6.876	7.324	6.677	4.919	R1	
6.686	7.022	7.836	6.823	5.065	R2	
A						
5.080	5.548	6.386	4.793	3.594	A0	A x K
6.405	6.801	7.371	6.602	4.844	A1	
R						
5.427	5.879	6.522	5.402	3.907	R0	R x K
5.802	6.250	6.893	5.773	4.294	R1	
5.998	6.395	7.221	5.918	4.457	R2	
	6.175	6.879	5.698	4.219	K	

ARK	RK	AK	AR	K	R	A	L.S.D
0.652	N.S	**0.519**	N.S	**0.219**	0.190	**0.518**	0.05

Discussion

Uncovered plants were lower leaf area compared to covered plants with agryl p17 with an increase ratio of 20-80% which may be due to the fact that leaves of plants living under the sun light are prone to decay due to the high rate of transpiration resulting in a reduction of gas exchange and reduces the rate of photosynthesis (Nobel, 2009). It has been noted that the stomata of the covered leaves are wide and increase the process of transpiration which helps increase the absorption of water and mineral elements and increase in leaf area through the irregularity of the sponge layer (Chalabi, 2019; Taiz and Zeiger, 2010).

The superiority of uncovered plants in regard with dry weight of the roots may be due to the fact that the soil of the plants was less moisture content due to the high temperature as well as the flow of wind movement is more than the covered plant and thus exposing the soil to faster drought compared to the soil covered with acryl which lead to plant adoption and thus pushed the growth of roots to deeper areas to reach the water and increased the surface area that reflected on the dry weight, or may be due to the covered plants have roots with less area when the nutrients of the soil reach to the ideal level due to adequate moisture and the root growth become limited with the quantity of carbohydrates so the plant reduces the distribution of food to the roots as opposed to increasing it to the vegetative group (Taiz and Zeiger, 2010).

The effect of the amino acid arginine in the characteristics of vegetative growth was through its positive role as a source of nitrogen which is important in proteins and enzymes formation that necessary in the construction of cells and its impact directly or indirectly in increasing the manufacture of carbohydrates and proteins as well as stimulate the physiological and biological processes within the plant, which is reflected in the growth of plants (Liu *et al*., 2006). The arginine was the source of nitrogen processing and was ready to be absorbed by the plant directly, thus stimulating plants to manufacture proteins and produce hormones such as auxines by building essential amino acids, especially tryptophan, the initiator of IAA (Wample *et al*., 1991) and Wona *et al*. (2011). The use of amino acids increases the vital functions, especially the

division and expansion of plant cells. It also plays a role in increasing the activity of enzymes that dissolve the organic compounds, which release the elements and increases their readiness, increases the growth rates, leaf area and increase stem diameter as a result of encouraging the division processes and cell expansion (Claussen, 2004) and (Nur *et al*., 2006). Feeding plants with amino acids leads to reduced osmosis and thus increases the cell's ability to withdraw water and dissolved nutrients from the soil and thus increase vegetative growth of the plant (Abu Dhahi and Greece, 1988), Amini and Ehsanpour (2005) and Claussen, 2004).

The increase in growth indicators from the spraying of arginine was due to increased bio-construction of the plant as it did not disrupt free radicals by delaying the bio-synthesis of degraded enzymes and hormones or by preventing the conversion of active compounds into ineffective forms (El-Bassiouny *et al*., 2008). The results were agreed with El-Bassiouny and others (2008), Ghoname *et al*. (2010), Ferg (2011), Gerry *et al*. (2014), Gerry and Surgeon (2015), Zubaidi (2016) and Al-Shamri (2017).

The spraying of pepper plants with Chitosan resulted in a significant increase in all vegetative growth characteristics of the plant as well as the content of the leaves of chlorophyll. Chitosan worked to increase the growth of the plants by processing them with the necessary mineral elements. Table 3, 4 and 5, which the plant is likely to be unable to provide adequately because of problems related to soil or from the provision of certain amino compounds required for plants (Chibu and Shibayama, 2001). The growth of root hairs has been enhanced and the plant was good because of the increased spread of roots in the soil (Gornik *et al*., 2008, Borkowski, 2007 and Chmielewski *et al*., 2007).

Chitosan possesses high adsorption capacity for a number of metal ions because it possesses a number of functional groups such as the hydroxyl group and the amines group, which can be linked to metal ions, either by chemical adsorption or by physical adsorption (Dean and Dixon, 1992; Findon *et al*., 1993 and Bailey *et al*., 1999). Chitosan acts on the metal element as it corresponds to the basic natural properties of multiple positive ions (Khan, 2003). Chitosan stimulates the activity of the key enzymes in the metabolism of nitrogen and improves its transfer in leaves. This stimulates leaf function in growth and development (Chibu *et al*., 2000; Abdel-Mawgoud and Tantawy, 2010). Furthermore, Chitosan is a polysaccharide which is very important in the nutrition of plants and particularly in horticulture, as well as its defense and increased yields (Monirul *et al*., 2018). It causes an increase in photosynthesis to double (Barka *et al*., 2004). The Chitosan molecule varies in action from cell to cell and depends on its physiological chemistry. It causes an increase in root mass, flowering and end-production (Chandrkrachang and Ahernhausen, 2005)

The effectiveness of roots and absorption of nutrients has been reflected significantly in increasing the effectiveness of photosynthesis and the formation of carbohydrates and sugars, which led to an increase in growth and length of internodes and accumulation of food resulted in an increase in stem diameter and leaf area. The results were in agreement with findings of Eltantawy (2009), Ghonam (2010), Mondal (2012), Salma *et al*. (2017), Abdelkader (2018) and Monirul (2018)

The increase in the average number of fruits in uncovered plants was due to the increase in the percentage of the nodes, while the average weight of the fruit was higher for the fruits of the covered plants by agryl which can be attributed to the lack of competition between the fruits on the food because the number of fruits was less than the number In uncovered plants or may be due to the relationship between source and sink because the covered plants with acryl were best in most characteristics of vegetative growth and higher in the proportion of mineral materials which resulted in plants capable of building carbohydrate materials and high carbonation reflected in the increase in the average weight of fruit. Plant coverage result in an accumulation of carbohydrates materials and low water consumption (Juan-Juan *et al*., 2012), or may be due to favorable environmental conditions of temperature and relative humidity and the intensity of light reflected a positive increase in the average weight of the fruit.

Regarding the total yield, Table (5) revealed that the covered plants were higher in total yield compared to uncovered plants due to the average weight of the fruit is increased due to the reflection of all vegetative characteristics and the appropriate environmental effects. The results were agreed with Milenkovic *et al*. (2012), Carlos Dıaz (2013), Ilahy *et al*., (2013), Ambrozy and others (2015) and Ilic *et al*. (2017).

Amino acids are the formation unit of proteins that perform multiple functions in the plant. They are metabolic processes, transport and nitrogen storage. Experiments have shown that all amino acid processes increase nitrogen and protein in treated plants (Bidwell, 1979) and Fowden (1973). All the data recorded in increasing the marketable tomato yield due to the treatment of amino acids may increase the content of chlorophyll leaves, which leads to increase the formation of carbohydrates and thus increase production as well as increase pollination of pollen, leading to an increase in the number of fruits and the average weight of fruit and thus increase the total yield (El-Tantawy, 2009). It was found that amino acid spraying increases the total phenolic content of the plant and this increases the IAA content in the branches, which was reflected in the activation of growth and production (Graham and Graham, 1996).

Moreover, the role of arginine in the yield qualities, which has a clear effect in the characteristics of vegetative growth and mineral elements which reflected in the number of fruits and weight of the fruit due to the abundance of food from carbohydrates and sugars and reflections in the early and total yield. Several studies have shown that spraying plants with amino acids has accelerated their growth and increased chlorophyll in the leaves which accompanied by an increase in the amount of processed food as a result of the increase in the volume of the vegetative and then the increase the total yield. There was a positive linear relationship between vegetative growth and plant production (Bolarin *et al*., 1995). The results of the arginine have agreed with both El-Bassiouny *et al*., (2008), Ghoname *et al*. (2010), Verg (2011), Jaguar (2013), Gerry (2014) and Gerry and the surgeon (2015). Furthermore, it was also observed that the use of Chitosan mixing with fertilizer in rice feed resulted in an increase in chlorophyll, dry matter and yield due to the effectiveness of Chitosan thus providing 45-40% of the added amount of fertilizer (Boonlertnirun *et al*., 2012).

All growth indicators, such as plant height, number of dry leaves, vegetative growth, photosynthesis, chlorophyll, and yield in cowpea plant were increased when treated with Chitosan (Mondal *et al*., 2013). There was a lack of studies that demonstrated the effect of Chitosan on flowers, however, it was found that Chitosan affect the increase in the number of flowers and nodules (Ohta *et al*., 1999). Furthermore, it was found that Chitosan increased the yield of tomato plant (Lafontaine and Benhamou, 1996) as well as it affects the increase of biomass in relation to the amount of water by reducing transpiration (Bittelli *et al*., 2001). Moreover, Chitosan had an important role in the plant nutrition also a positive role in increasing the speed of growth, vegetable qualities and metal elements. As a result for the previous effects of Chitosan and the abundance of feed from carbohydrates and sugars, the early yield has been increased. The results of the Chitosan were in agreement with EL-Tantawy (2009), Mondal (2012) and Mondal *et al*. (2013).

References

Abdelkader, Z.M. Effect of planting date, certain nutrients and biochemical catalysts on growth and chemical content of sugar leaf plant *Stevia rebaudiana* Bertoni. Ph.D. thesis. College of Agricultural Engineering Sciences - University of Baghdad.

Abdel-Mawgoud, A.M.R.; Tantawy, A.S.; El-Nemr, M.A. and Sassine, Y.N. (2010). Growth and yield responses of strawberry plants to chitosan application. European Journal of Scientific Research, 39(1): 170-177.

Abdul, H. and Al-Yazeed, A.A. The use of amino acids and vitamins in the improvement and performance, growth and quality of plant crops under Egyptian conditions. United for Agricultural Development (UAD).

Al-Bayati, S.K.S. and Al-Hassani, F.A.M. (2012). Effect of acryl cover, silver soil cover and nitrogen and potassium spray in the quantity of watermelon and quantitative under the conditions of non-heated greenhouses. Anbar Journal of Agricultural Sciences: 10 Issue (2).

Ambrozy, Z.S.; Daood, H.; Nagy, Z.S.; Darazsi, L.H. and Helyes, L. (2015). Effect of net shading technology and harvest times on yield and fruit quality of sweet pepper applied ecology and environment al research, 14(1): 99-109.

Bachmann, J. (2005). Season extension techniques for market gardeners. www.attra.ncat.org.

Bailey, S.E.; Olin, T.J.; Bricka, R.M. and Adrian, D.D. (1999). Water Research, 33(11): 2469–2479.

Barka, A.E.; Eullaffroy, P.; Cle´ment, C. and Vernet, G. (2004). Chitosan improves development, and protects *Vitis vinifera* L. against Botrytis cinerea. Plant Cell Reports, 22: 608–614.

Basile, B.; Romano, R.; Giaccone, M.; Barlotti, E.; Colonna, V.; Cirillo, C.; Shahak, Y. and Forlani, M. (2008). Use of photo-selective nets for hail protection of kiwifruit vines in southern Italy. Acta Hort., 770: 185–192.

Bittelli, M.; Markus, F.; Gaylon, S.; Campbell, E.; Nichols, J. (2001). Reduction of transpiration through foliar application of chitosan. Agricultural and Forest Meteorology (107): 167–175.

Bolarin, M.C.; Cruz, A.S.; Cayuela, E. and Preze-Alfocea, F. (1995). Short- term solute changes in leaves and roots of cultivated and wild tomato seedlings under salinity. Plant Physiology, 147: 463-468.

Borkowski, J.; Dyki, B.; Felczynska, A. and Kowalczyk, W. (2007). Effect of biochikol 020 pc (chitosan) on the plant growth, fruity yield and healthiness of tomato plant roots and stems. Polish Chitin Soc. Monograph, 12: 217-223.

Carlos, J. and Dıaz-Perez (2013). Bell Pepper (*Capsicum annum* L.) Crop as Affected by Shade Level: Microenvironment, Plant Growth, Leaf Gas Exchange, and Leaf Mineral Nutrient Concentration. Hortscience, 48(2):175–182.

Chalabi, S.A.K. (2019). Anatomy Lectures. Department of Agricultural Engineering and Gardening. Faculty of Agricultural Engineering Sciences. Baghdad University.

Chandrkrachang, S.; Sompongchaikul, P. and Sangtain, S. (2005). Profitable spinoff from using chitosan in orchid farming in Thailand. Journal of Metals, Materials and Mineral, 15: 45–48.

Chibu, H.; Shibayama, H.; Mitsutomi, M. and Arima, S. (2000). Effects of chitosan application on growth and chitinase activity in several crops. Marine & Highland Bioscience Center Report, 12: 27-35.

Chibu, H. and Shibayama, H. (2001). Effects of chitosan applications on the growth of several crops, in: T. Uragami, K. Kurita, T. Fukamizo (Eds.), Chitin and Chitosan in Life Science, Yamaguchi, 235-239.

Chmielewski, A.G.; Migdal, W.; Swietoslawski, J.; Swietoslawski, J.; Jakubaszek, U. and Tarnowski, T. (2007). Chemical-radiation degradation of natural oligoamino- polysaccharides for agricultural application. Radiation Physics and Chemistry, 76: 1840–1842.

Claussen, W. (2004). Proline as a measure of stress tomato plants .Plant Science 168 p 241- 248.Avilable online at www. Science direct.Com.

Deans, J.R. and Dixon, B.G. (1992). Uptake of Pb^{2+} and Cu^{2+} by novel biopolymers. Water Res., 26(4): 469 - 472.

El–Bassiouny, H.M.S.; Mostafa, H.A.; El–Khawas, S.A.; Hassanein, R.A.; Khalil, S.I. and Abd El–Monem, A.A. (2008). Physiological responses of wheat plant to foliar treatments with arginine or putrescine. Austr. J. of Basic and Applied Sci., 2(4): 1390-1403.

El-Tantawy, E.M. (2009). Behaviour of tomato plants as affected by spraying with chitosan and aminofort as natural stimulator substances under application of soil organic amendments. Pak. J. Biol. Sci., 12: 1164-1173.

Faraj, A.H.; Abdul, W. and Abdul, R.S. Effect of the addition of amino acids in the tolerance of tomato plant for salt stress. Journal of Iraqi Agriculture Research (Special Issue). Folder: 16 Issue 2.

Findon, A.; McKay, G. and Blair, H.S. (1993). Transport studies for the sorption of copper ions by chitosan. J. of Environ. Sci. and Health, 28(1): 173 - 185.

Ghoname, A.A.; El-Nemr, M.A.; Abdel-Mawgoud, A.M.R. and El-Tohamy, W.A. (2010). Enhancement of Sweet Pepper Crop Growth and Production by Application of Biological, Organic and Nutritional Solutions. Journal of Agriculture and Biological Sciences, 6(3): 349-355.

Ghoname, A.A.; Mona, G.D.; Amira, M.S. and Hegazi, M.A. (2010). Improving nutritional quality of Hot pepper (*Capsicum annuum* L.) plant via foliar application with Arginine or Tryptophan or Glutathione. J. Biol. Chem. 5(1): 409- 429.

Gornik, K.; Grzesik, M. and Romanowska-Duda, B. (2008). The effect of chitosan on rooting of grapevine cuttings

and on subsequent plant growth under drought and temperature stress. J. Fruit Ornamental Plant. Res., 16: 333-343.

Graham, T.L. and Graham, M.Y. (1996). Signalling in soybean phenylpropanoid responses. Dissections of primary, secondary and conditioning effects of light, wounding and elicitor treatments. Plant Physiol, 110: 1123-1133.

Hassani, F.A.M. (2012). Effect of acryl cover, silver soil cover and nitrogen and potassium spray in the quantity of watermelon and quantitative under the conditions of non-heated greenhouses. Master Thesis. Department of Gardening and Gardening. Faculty of Agricultural Engineering Sciences. Baghdad University.

Hirano, S.; Itakura, C.; Seino, H.; Akiyama, Y.; Nonaka, I.; Kanbara, N. and Kawahami, T. (1990). Chitosan as an ingredient for domestic animal feeds. J. Agric. Food. Chem., 38: 1214–1217.

Ilahy, R.; Thouraya, R.; Imen, T. and Hager, J. (2013). Effect of Different shading Levels on growth and yield parameters of a Hot pepper (*Capsicum annuum* L.) Cultivar Beldi Grown in Tunisia. Global Science Books. Food 7(special Issue 1): 32-35.

ILIC, Zoran, S.; Lidija, M.; Ljubomir, S.; SaSa, B.; Jasna, M.; Zarko, K. and Elazar, F. (2017). Effect of shading by coloured nets on yield and fruit quality of sweet pepper. Zemdirbyste -Agriculture, 104(1): 53–62.

Jari, A.N. and Mutashr, M. (2015). Effect of paper spray in arginine, cysteine and potassium nitrate in the growth and yield of tomato plants in greenhouses. Kufa Journal of Agricultural Sciences. 7(2).

Joury, A.N.; Abdel-Sayed, K. and Jassem, H.F. (2014). Effect of planting date Arginine workshops in growth indicators and the yield of plants of the class Vicia faba L. Kufa Journal of Agricultural Sciences. 6(1).

Juan-juan, Z.H.U.; Qiang, P.E.N.G.; Yin-li, L.I.A.N.G.; Xing, W.U. and Wang-lin, H.A.O. (2012). Leaf Gas Exchange, Chlorophyll Fluorescence, and Fruit Yield in Hot Pepper (*Capsicum anmuum* L.) Grown Under Different Shade and Soil Moisture During the Fruit Growth Stage. Journal of Integrative Agriculture. 11(6): 927-937.

Khan, W. (2003). Signal compounds involved with plant perception and response to microbes alter plant physiological activities and growth of crop plants. PhDThesis, McGill University, Canada, 185 pp.

Kraepiel, Y.; Agnes, C.H.; Tiery, L.; Maldiney, R.; Miginiac, E. and Delarue, M. (2001). The growth of tomato (*Lycopersicon esculentum* Mill.) hypocotyls in the light and in darkness differentially involves auxin. Plant Sci. 161: 1067-1074.

Lafontaine, P.J. and Benhamou, N. (1996). Chitosan treatment: an emerging strategy for enhancing resistance of greenhouse tomato plants to infection by *Fusarium oxysporum* F. sp. radicis-lycopersici. Biocontrol Sci. Technol., 6: 11–124.

Liu, J.H.; Nada, K.; Honda, C.; Kitashiba, H. and Wen, X.P. (2006). Polyamine biosynthesis of apple callus under salt stress. Importance of the arginine decarboxylase pathway in stress responses. J. Exp. Bot. 57: 2589-2599.

Milenkovic, L.; Ilic, Z.S.; Đurovka, M.; Kapoulas, N.; Mirecki, N. and Fallik, E. (2012). Yield and pepper quality as affected by light intensity using colour shade nets. Agriculture & Forestry, 58: 19-33.

Mohammed, A.Z.K. and Al-Rayes, A.H. (1982). Plant Classification Part II. Dar Al Kutub Printing & Publishing Est. University of Al Mosul. Iraq.

Mondal, M.M.A; Male, M.A.; Puteh, A.B. and Ismail, M.R. (2013). Foliar application of chitosan on growth and yield attributes of mungbean (*Vigna radiata* (l.) wilczek). Bangladesh J. Bot. 42(1): 179-183.

Mondal, M.A. and Malek, A.B.P. (2012). Effect of foliar application of chitosan on growth yield in Okra. Australian Journal of Crop science. AJCS6 (5): 918-921.

Monirul, I.M.; Kabir, M.H.; Mamun, A.N.K.; Islam, M.; Islam, M.M. and Das, P. (2018). Studies on yield and yield attributes in tomato and chilli using foliar application of oligo-chitosan. GSC Biological and Pharmaceutical Sciences, 03(03): 020–028.

Nur, D.; Selcuk, G. and Yuksel, T. (2006). Effect of organic manure application andsolariziation of soil microbial biomass and enzyme activities under greenhouse conditions. Biol. Agric. Hortic. 23: 305-320.

Ohta, K.; Taniguchi, K.; Konishi, N. and Hososki, T. (1999). Chitosan treatment affects plant growth and flower quality in *Eustoma glandiflorum*. Hort. Science, 34: 233–234.

Rai, V.K. (2002). Role of amino acids in plant responses to stresses. *Biologia plantarum* 45(4): 481-487.

Salma *et al*. (2017). Effect of foliar Application of oligo-chitosan on Growth, yield and Quality of tomato and Eggplant. Asian journal of Agricultural. Dol: 10. 3923.

Shammari, A.M.; Akram, A.W.H. and Ali, A.A.W. Effect of genotype and paper spray on arginine and yeast in some vegetative growth characteristics of the potato (*Solanum tuberosum* L.). Diyala Journal of Agricultural Sciences. (2): 169-158.

Taiz, L. and Zeiger, E. (2010). Plant physiology. Fifth edition. Sinauer Associates Inc., Publishers Sunderland, Massachusetts U.S.A.

Wample, R.L.; Spayd, S.E.; Evan, R.G. and Stevens, R.G. (1991). Nitrogen fertilization and factors influencing grapevine cold hardiness. Inter. Symposium on Nitrogen in Grapes and Wine: 120-125, Seattle, Amer. J. Enol. Vitic., Davis, USA.

Wona, C.; Shena, X.; Mashiguchib, K.; Zhengc, Z.; Daia, X.; Chenge, Y.; Kasaharab, H.; Kamiyab, Y.; Choryc, J. and Zhaoa, Y. (2011). Conversion of tryptophan to indole-3-acetic acid by tryptophan aminotransferases of Arabidopsis and yuccas in Arabidopsis. PNAS, 108(45): 18518- 18523.

Zubaidi, N.A.G. and Zainab, N.I. (2016). Effect of Spraying Proline and Arginine on Wet and Dry Weight of Vegetative and Root Group and Eggplant Plant in Protected Agriculture. Diyala Journal of Agricultural Sciences. 8 (1): 133-124.