

EFFECT OF IRRIGATION INTERVALS AND SOME ANTITRANSPIRANTS ON GROWTH AND YIELD OF SNAP BEAN (*PHASEOLUS VULGARIS L*) UNDER DRIP IRRIGATION SYSTEM IN CLAY LOAM SOIL

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ABSTRACT: *The objective of this work is to reduce the quantity of water applied by irrigation, increase the water use efficiency and determine the appropriate period for irrigation snap bean, a field experiment was implemented at the Experimental Station of Vegetable Research Department, Horticulture Research Institute, Agriculture Research Center, Giza Governorate, during the two growing summer seasons of 2016 and 2017. This study involved three irrigation intervals (2, 4 and 8 days) under clay loam soil using drip irrigation system, with spraying the plants by five antitranspirant substances (control, kaolin at 3 g/L, MgCO₃ at 3 g/L, liquid paraffin 2% and bentonite 2%), The results showed that increasing irrigation intervals from 2 days to 8 days decreased the total water content in the leaves, the rate of relative transpiration, whereas caused an increase in the leaf water deficit. While, reducing the irrigation interval from 8 days to 2 days led to a significant increase in vegetative growth parameters i.e. plant height, number of branches, number of leaves, leaf area and plant weight, but dry matter percent was decreased. The yield and pods quality of the plants irrigated every 2 days showed higher values and best quality than the other periods of irrigation, the highest values of N,P and K content in the pods and chlorophyll in the leaves were found with irrigation every 2 days. Spraying snap bean plants with MgCO₃ followed by spraying with kaolin led to the highest total water content, the lowest relative transpiration and the lowest leaf water deficit. The best growth characters, yield and pods quality, N, P and K concentrations and chlorophyll content were obtained from the plants sprayed by MgCO₃ followed by spraying with kaolin. On the other hand, the interactions treatments between irrigation intervals and antitranspirants resulted in a significant effect in many studied parameters whereas, the superior treatment for obtained strong vegetative growth, high pods yield with best quality was the interactions between irrigation every 2days and spraying the plants with MgCO₃ at 3g/L three times, the first one at vegetative growth stage (at 3-4 true leaf stage) and the others after two weeks interval of the first one.*

Key words: *Snap bean, drip irrigation, irrigation intervals, antitranspirants kaolin, MgCO₃, liquid paraffin Bentonite*

INTRODUCTION

Snap bean (*phaseolus vulgaris, L.*) is one of the important economic vegetable crops grown in Egypt for local consumption and for foreign exportation markets. Many factors affecting snap bean production, including cultivars, weather conditions, planting date, nutrition and irrigation. Snap bean plants are sensitive to the changes in the soil

moisture content and the decrease of water irrigation level (water stress), leading to significant reduction in pods quantity and quality.

Water management in green bean production is extremely important at all growth stages of plant development which due to its influence on stand establishment, pod set and its quality. For this reason, the crop must be

supplied with adequate water to ensure vigorous growth. Irrigation is considered very important for its plant growth and pod improvement (Smesrud *et al.*, 1997).

The irrigation scheduling techniques is very critical under using the drip irrigation whereas it is most efficiency and more controllable in irrigation system because excessive amount of the irrigation causes a decrease in the yield, inadequate irrigation results in a water stress and causing reduction in the production in this regard several investigators i.e. Wakrim *et al.*, 2005 on common bean; Onder *et al.*, 2006 and Sezen *et al.*, 2008 on green bean which they reported that, yields decreased significantly if the irrigation interval increased. With drip irrigation systems, water and nutrients can be applied directly to the crop at the root zone, having positive effects on yield and water saving (Phene and Howell, 1984; Bozkurt *et al.*, 2006). For these reasons, drip irrigation systems have seen widespread use in the world in recent years. Moreover, drip irrigation reduces deep percolation and evaporation and controls water status of the soil more precisely within the crop root zone (Singandhupe *et al.*, 2003).

Transpiration means that losses of water by evaporation from the leaves through the stomata. The main source of water for the plants is soil water. It is taken up by roots hair cells by osmosis. Once the water moves through the root hair cells, by osmosis from cell to cell through the endodermis into the Xylem. The water is then pulled under pressure through the transpiration stream up the Xylem (a long hollow tube) to the leaves.

Several investigators reported that using foliar antitranspirants sprays may reduce the rate of transpiration through three ways: 1. Reflecting materials, such as kaolin clay, reduce absorption of radiant energy and thereby reduce leaf

temperatures and transpiration (Bittelli *et al.*, 2001; Erez and Glenn 2004; Gaballah and Moursy, 2004; Moftah and Al-Humaid, 2005); 2. Film forming antitranspirants such as emulsions of wax, latex or plastics dry on foliage to form a thin transparent film, providing a physical barrier over some, not all stomata. This hinders escape of water vapor from leaves and also reduces water losses through guttation. 3. Certain chemical compounds such as magnesium carbonate which it can prevent stomata from opening fully by affecting stomatal guard cells, decreasing losses of water vapor (Davenport *et al.*, 1974, Han, 1990; Steinberg *et al.*, 1990; Nermeen and Shalaby (2011)

Asli and Neumann (2009) found that external colloidal suspensions of either naturally derived bentonite clay particles could significantly reduced water transport through the intact epidermal surfaces by up to 40%.

The advantage of antitranspirants causing increase the water potential of the plant by reducing water loss from soil; at the time, the plant growth depends on the water status of the plant more than depends on photosynthesis. In addition to reduce the amount of water consumption it was found that, spraying cucumber plants with liquid paraffin 2% concentration (once, twice or three times), led to a significant increase in total water content of the leaves, plant yield, number of fruits per plant and fruits total yield Khalel, 2003.

The objective of the present investigation was to study the effect of irrigation intervals and some antitranspirants compounds as well as their interactions on growth, pod yield and quality of snap bean plants cultivated under drip irrigation system in clay loam soil as well as enhancing water use efficiency.

MATERIALS AND METHODS

Two field experiments were carried out during the two growing summer seasons of 2016 and 2017 at the Experimental Station of Vegetable Research Department, Horticulture Research Institute, Agriculture Research Center, Giza Governorate, to investigate the effect of irrigation intervals and some anti-transpirants compounds on growth and yield of snap bean (*Phaseolus vulgaris* L) cv. Polista under drip irrigation system in clay loam soil. The physical and chemical properties of the experimental soil are presented in Table (1).

This experiment included three irrigation intervals *i.e*, 2, 4 and 8 days under drip irrigation system and spraying the plants by five antitransparent substances namely:

- (1) Control treatment (spraying with water).
- (2) Spraying with kaolin at 3 g/L.
- (3) Spraying with MgCO₃ at 3g/L.
- (4) Spraying with liquid paraffin 2%.
- (5) Spraying with bentonite 2%.

Spraying with antitranspirant compounds were done three times: the first one at vegetative growth stage (at 3-4 true leaf stage) and the others after two weeks interval from the first one. Bean seeds were sown on 15th of February at

2016 and 2017 seasons. The design of the experiment was split- plot system with 3 replicates where irrigation intervals were distributed in the main plots and the foliar application of anti-transpiration compounds beside the control were arranged in the sub plots. The plot area was 8.4 m² where consisted of 4 rows, each row was 3 m length and 70 cm width. Three seeds were sown per hill at 15 cm a part and the growing plants were thinned to one plant after 20 days from sowing. After 21 days from seed sowing the other agricultural practices took place according to the recommendation of Ministry of Agriculture.

Data recorded:-

1: Vegetative growth parameters:

Sample of 5 plants, from each sub plot were taken at 50 days after sowing (flowering stage) to determine the following data:

- 1- Plant height (cm).
- 2- Number of leaves per plant.
- 3- Number of branches per plant.
- 4- Leaf area (cm²) measured by Li-300 leaf area meter produced by Li-Cor, Pinclivania.
- 5- Total fresh weight of vegetative parts of the plant (leaves + stems).
- 6- Dry matter %.

Table (1): Physical and chemical properties of the experimental soil.

Physical properties						Chemical properties									
Practical size distribution			Texture	pH	EC	Cation meq/l			Anion meq/l			Field capacity	Available water	Balk density	
Sand	Silt	Clay			s/m	Ca ⁺⁺	Mg ⁺⁺	Na ⁺⁺	K ⁻	HCO ₃ ⁻	So ₄ ⁻	%	%	g/cm ³	
2016															
23.25	16.4	60.3	Clay	7.8	2.29	32.01	17.55	11.253	1..15	1.0	0.62	28.6	12.8	1.43	
2017															

23.30	17.2	59.5	Clay	7.4	2.25	31.86	17.81	11.28	1.45	1.1	0.60	28.2	12.4	1.38
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2: Water status of the plant:

a- Total water content (TWC) of the leaves: it was registered after 2 days from the third spraying of antitranspirants using the following equation:

$$\text{TWC}\% = (\text{wet weight} - \text{dry weight}) / \text{wet weight} \times 100$$

b- Relative transpiration (RT): it was measured by taking a fixed area (100 cm²) of the leaves and an equal water surface in glass dishes; the samples were left at 30 °C for 6 h period and then measured the loss weight from each, using the following equation to calculate the relative transpiration:

$$\text{RT} = (\text{weight of water loss from plant leaves} / \text{weight of water loss from water surface}) \times 100$$

c- Leaf water deficit (LWD): it was estimated by weighing the plant leaves taken randomly at the early morning (wet weight); then placed on the surface of distilled water for 1 h until saturated and then weighed again (saturated weight); then dried in oven and Weighed (dry weight). The LWD was calculated as follows:

$$\text{LWD}\% = (\text{saturated weight} - \text{wet weight}) / (\text{saturated weight} - \text{dry weight}) \times 100$$

3- Yield and Pods quality:

- 1- Total pods yield(kg/feddan)
- 2- Pod length (cm).
- 3- Pod diameter (cm).
- 4- Pod fresh weight (g).
- 5- Pod dry weight (g)

4- Chemical contents in the leaves and pods:

Total chlorophyll of the third leaf from the plant top was measured using chlorophyll meter (SPAD).

At the second harvest, random samples of green pods were taken from each plot and oven dried at 70°C till

constant, the dry matter was then finally ground to determine nitrogen, phosphorus and potassium concentrations by the method described by Plummer (1971) Brown and Lilliand (1964) and Jackson (1973), respectively.

Statistical analysis:

The obtained data were subjected to the analysis of variance procedure and means and compared using the L.S.D. method at 5% level of significance according to Gomez and Gomez (1984).

RESULTS AND DISCUSSION

1-Vegetative growth parameters:

1-a-Irrigation intervals

The data in Table (2) shows that, reducing the irrigation interval from 8 d to 2 days led to a significant increase on vegetative growth parameters *i.e.* plant height from 27.47cm to 31.8 cm and 28.27cm to 32.27cm, number of branches per plant from 3.73 to 5.53 and 3.97 to 5.80, number of leaves/plant from 13.6 to 20.07 and 14.09 to 20.53, plant weight from 28.6g to 56.67g and 30.67g to 60.20 g and leaf area from 126.25 cm² to 155.47 cm² and 130.30 cm² to 159.56 cm² at the two seasons, respectively during the two seasons. Conversely, dry matter percent was decreased by reducing the irrigation interval from 8 days to 2 days. These results correspond with finding of Ramadan and Omar (2017) they indicated that frequent irrigation with 100% replenishment of evaporation losses resulted in the highest vegetative growth parameter of cabbage. On other hand, the dry matter percentage recorded a negative liner.

The obtained results clearly indicated that, the irrigation at shorter period resulted more vigor plants if compared with that plants which received it's needed from water requirements at

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longer period. It is well known that supplying the plants with adequate moisture may accede rate the physiological processes in the plant.

TABLE 2

Moreover, it increase translocation of metabolites which in turn, increased the accumulation of organic compounds in the plants. It could be concluded that, the reduction in plant growth measurements was pronounced when snap bean were subjected to high soil moisture stress. Such response might be attributed to lack of water absorption, inhibition of meristemic activity and reduction in photosynthetic efficiency under the prolonged irrigation interval. However, the reduction in leaves and branches numbers and weights might be due to the reduction in assimilates translocated to new developed leaves and shoots were not enough to maintain or develop these organs (Fayza *et al.*, 2013)

1-b-Antitranspirant compounds

it was found from the data in Table (2) that, spraying snap bean plants with different antitranspirant compounds play an important role which markedly affected vegetative growth of snap bean as a result of application antitranspirants which has a significant effect on plant height, No. of branches, No. of leaves per plant, plant weight, dry matter % and leaf area. The best growth characters were produced in plants which sprayed by $MgCO_3$ followed by spraying the plants with kaolin. The effect of antitranspirants in plant growth is recognize through improving water potential of the plant in the stage that plant growth supports on the water status more than photosynthesis. This increase in the growth will produce a good leaf area, which stimulate photosynthesis. These results are in harmony consistent with Abd El-Aal *et al.*, (2008) on eggplant and Khalel (2015) on potato, they reported that, spraying the plants with antitranspirant led to a

significant increase in vegetative growth parameters.

1-c – The interactions effect

Effects of the interactions between irrigation intervals and antitranspirants on vegetative growth are presented in Table (2). The data cleared that the best growth characteristics were obtained in the plants which irrigated every 2 d with spraying these plants by $MgCO_3$ which it is consider the superior over many other interaction treatments in the first and the second seasons under investigation. All physiological process like photosynthesis, transpiration, cell turgidity and tissue growth in plants are directly affected by availability water. This means that the products of photosynthesis are being used more rapidly for growth to occur, photosynthesis must be greater than respiration under this case.

2- Water status of the plants

2-a- Irrigation intervals

The results presented in Table (3) show the effect of irrigation intervals on water status of snap bean plants. The increase in irrigation interval from 2 days to 8 days led to a significant decrease in the total water content of the leaves from 79.9 % to 71.21% and 80.33% to 71.60%, respectively, the rate of relative transpiration from 0.35% to 0.26% and 0.37% to 0.27% during the first and the second seasons respectively, while the leaf water deficit increased from 27.56% to 32.13% and 27.86% to 32.70% during the first and the second seasons, respectively.

The reduction in total water content of the leaves and relative transpiration rate, and the increase in leaf water deficit, when prolonged the irrigation period from 2 days to 8 days, may be due to the low content of the soil moisture, especially in the surface layer of the soil where the distribution of most snap bean

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roots are found in this zone which lead to exposure the plants to water stress and reduce the efficiency of water absorption through plant roots and thus lead to a decline in the total water content of the leaves and the relative transpiration rate. These findings results are in harmony

with Khalel, 2015 which he reported that, the increase in irrigation interval from 3 d to 6 days decreased the total water content of the leaves and the rate of relative transpiration while, the leaf water deficit increased in potato.

Table 3: Effect of irrigation intervals and spraying with some antitranspirant compounds on water status of snap bean plants

Treatments		Total water content TWC%		Relative transpiration rate LT%		Leaf water deficit LWD%	
		2016	2017	2016	2017	2016	2017
2days		79.90	80.33	0.35	0.37	27.56	27.86
4days		76.38	76.35	0.28	0.28	27.82	27.98
8days		71.21	71.60	0.26	0.27	32.13	32.70
L.S.D. at 5%		1.88	1.98	0.03	0.03	1.60	1.93
MgCO ₃		80.50	80.70	0.24	0.25	22.31	22.44
Kaolin		77.78	78.13	0.28	0.29	29.93	29.96
Bentonite		75.87	76.46	0.27	0.28	30.32	31.02
Paraffin		74.17	74.48	0.33	0.34	30.66	31.14
Control		70.83	70.70	0.38	0.39	32.63	33.01
L.S.D. at 5%		1.65	1.75	0.02	0.03	1.85	1.84
2days	MgCO ₃	84.35	84.79	0.27	0.28	20.72	21.06
	Kaolin	80.69	81.54	0.29	0.30	25.52	25.56
	Bentonite	79.00	79.37	0.32	0.34	30.37	30.79
	Paraffin	79.02	79.30	0.43	0.43	30.33	30.70
	Control	76.44	76.67	0.48	0.48	30.86	31.19
4days	MgCO ₃	79.10	79.00	0.23	0.24	21.53	21.56
	Kaolin	77.02	77.10	0.29	0.28	31.01	31.03
	Bentonite	75.84	76.10	0.25	0.25	27.82	27.81
	Paraffin	75.92	76.33	0.30	0.29	27.74	27.75
	Control	74.02	73.20	0.35	0.35	31.02	30.75
8days	MgCO ₃	78.06	78.30	0.22	0.23	24.68	24.70
	Kaolin	75.65	75.76	0.26	0.28	33.25	33.29
	Bentonite	72.77	73.90	0.23	0.24	32.77	34.46
	Paraffin	67.58	67.80	0.28	0.29	33.91	34.97

	Control	62.02	62.23	0.31	0.33	36.02	36.09
L.S.D.at 5%		2.85	3.04	0.04	0.06	3.20	3.19

2-b- Antitranspirant compounds

Spraying the plants by some antitransparent compounds resulted in a significant increase in the total water content in the leaves as shown in Table (3) whereas, a significant decrease obviously noticed in the relative transpiration and the leaf water deficit compared with control. It may be due to the activity of these substances in partial closing of stomata, which helps in reducing the rate of transpiration and reducing water loss through stomata containing a waxy layer above it. This finding was mentioned by Davenport, 1977 and Abdallah *et al.*, 1996, they told that, antitranspirants increased the total and relative water content of the leaves by reducing the rate of transpiration and water loss from the soil, increasing water use efficiency of the plant and improving plant growth, it is known that the plant growth depends on the water status of plant more than photosynthesis. This result is agreement with Gawish, 1992 on snap bean and Khalel, 2015 on potato, they found that spraying antitranspirants increased the total water content and decreased the relative transpiration and the leaf water deficit.

2-c – The interactions effect

Table (3) illustrate the effect of the interactions between irrigation intervals and antitranspirants on water status of snap bean plants. The highest total water content (84.35% and 84.79%) were resulted from the interactions between irrigation every 2 days and spraying the plants with MgCO₃. While the highest rate of relative transpiration (0.48%) was found from the interactions between the irrigation every 2 days and without spraying with antitranspirants (control)

which showed significantly superior over most than the other interactions during the first and the second seasons, respectively. The highest leaf water deficits (36.02% and 36.09%) were obtained from the interactions between irrigation every 8 day with the control during the two seasons, respectively.

3- Yield and Pods quality:

3-a-Irrigation intervals

Data in Table (4) show a significant effect of irrigation intervals on snap bean pods quality *i.e.* pod length, diameter, fresh and dry weight as well as pods yield. The yield and pods quality of plants irrigated every 2 days registered higher yield and best pods quality than the other periods of irrigation. Data in Table (4) showed also that reducing the irrigation interval from 8 d to 2 d led to a significant increase in the pod length from 10.83cm and 11.09cm to 12.69cm and 12.71 cm, pod diameter from 0.68cm and 0.69cm to 0.74cm and 0.77 cm, weight of the pod from 3.01g and 3.39 g to 3.97g and 4.37 g, pod dry weight from 0.48g and 0.50g to 0.53g and 0.55g as well as yield from 3.26 and 3.59 ton/ fed to 4.54 and 4.95 ton/ fed, respectively in the two seasons. A significant decline in the pods quality, average of pod weight, and total pods yield are shown when the irrigation interval increased from 2 d to 8 d, and this reduction possibly was due to the reduction of soil moisture content and the water status of the plant as shown in (Table 3) which affected the absorption rate of nutrient elements from the soil Abu-Dahy and Al-Yuonis, 1988 and it was reflected in decreasing photosynthesis rate which reduced cell division and elongation and consequently reduced plant leaf area, activity of plant enzymes

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and hormones. Yasin. 1992: Khalel, 2015, reported that reducing the irrigation interval led to a significant increase in the plant yield and quality.

Table 4: Effect of irrigation intervals and spraying with some antitranspirant compounds on Yield and Pods quality of snap bean plants

Treatments	Pod length (cm)		Pod diameter (cm)		Pod weight (g)		Pod dry weight (g)		Total yield Ton/feddan		
	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017	
2 days	12.69	12.71	0.74	0.77	3.97	4.34	0.53	0.55	4.54	4.95	
4 days	12.19	12.35	0.72	0.73	3.61	4.00	0.52	0.53	4.05	4.39	
8 days	10.83	11.09	0.68	0.69	3.01	3.39	0.48	0.50	3.26	3.59	
L.S.D. at 5%	0.28	0.27	0.04	0.02	0.38	0.28	0.01	0.02	0.21	0.07	
MgCO ₃	13.06	13.28	0.77	0.79	4.16	4.72	0.60	0.62	5.24	5.62	
Kaolin	12.40	12.56	0.74	0.76	3.70	4.20	0.58	0.59	4.85	5.21	
Bentonite	12.29	12.44	0.73	0.73	3.43	3.85	0.56	0.57	4.28	4.62	
Paraffin	11.16	11.27	0.70	0.71	3.50	3.50	0.45	0.47	3.44	3.93	
Control	10.60	10.71	0.62	0.66	3.06	3.31	0.36	0.39	1.99	2.18	
L.S.D. at 5%	0.31	0.28	0.03	0.04	0.27	0.23	0.01	0.02	0.29	0.22	
2days	MgCO ₃	12.23	14.27	0.80	0.87	5.07	5.27	0.63	0.66	5.92	6.18
	Kaolin	13.20	13.20	0.80	0.80	4.24	4.72	0.60	0.61	5.42	5.71
	Bentonite	13.00	13.10	0.77	0.77	3.70	4.47	0.58	0.59	4.94	5.39
	Paraffin	11.70	11.67	0.70	0.73	3.53	3.87	0.47	0.50	4.14	4.69
	Control	11.30	11.33	0.63	0.67	3.30	3.40	0.39	0.39	2.28	2.78
4days	MgCO ₃	13.50	13.73	0.80	0.80	4.03	4.64	0.60	0.61	5.17	5.80
	Kaolin	12.73	12.90	0.73	0.77	3.67	4.50	0.59	0.59	4.96	5.51
	Bentonite	12.43	12.67	0.73	0.73	3.54	3.81	0.58	0.57	4.23	4.39
	Paraffin	11.43	11.47	0.70	0.70	3.47	3.60	0.45	0.47	3.97	4.09
	Control	10.83	10.97	0.63	0.67	3.33	3.47	0.36	0.39	1.93	2.16
8days	MgCO ₃	11.46	11.83	0.70	0.70	3.37	4.24	0.56	0.58	4.64	4.88
	Kaolin	11.27	11.57	0.70	0.70	3.20	3.38	0.56	0.58	4.17	4.40
	Bentonite	11.43	11.57	0.70	0.70	3.03	3.27	0.51	0.54	3.68	4.07
	Paraffin	10.33	10.67	0.70	0.70	2.91	3.05	0.43	0.44	2.21	3.01

	Control	9.67	9.83	0.60	0.63	2.53	3.03	0.34	0.38	1.59	1.60
L.S.D. at 5%		0.53	0.49	N.S	N.S	0.47	0.40	0.02	0.03	0.38	0.5

3-b-Antitranspirant compounds

Application of antitranspirant compounds as foliar spraying has a significant effect on pods quality and yield. The highest yield and best pods quality resulted from spraying the plants with MgCO₃ followed by kaolin. The positive impact of spraying antitranspirants may be due to the active role of the waxy substance in maintaining the cells turgid and reducing water loss from the plant by partial closing of stomata and reducing the rate of transpiration (Davenport, 1977). It helps for keeping soil moisture, increasing water use efficiency (Abdallah, 1996) and keep continues of the normal rate of biological processes, especially photosynthesis, and this is reflected in the positive growth and yield of the plant.

3-c – The interactions effect

Data in Table (4) illustrate the effect of the interaction between irrigation periods and foliar spry by some antitranspirants in total yield and pods quality. The highest total yield of pods resulted from the interactions between irrigation every 2 d and spraying the plants by MgCO₃. While no significant were found with the interactions in pod diameter. The effect of antitranspirants on plant growth is through improving water potential of the plant in the stage that plant growth supports on the water status more than photosynthesis. This increase in the growth will produce a good leaf area, which stimulate photosynthesis and that reflect on pods yield and its quality.

3- Chemical Composition

The effect of three different irrigation intervals and some antitranspirant

compounds and their interaction on chemical composition are presented in Table (5).

4-a-Irrigation intervals

Concerning to the effect of different irrigation intervals on N, P and K content in pods as well as chlorophyll contents in the leaves are shown in Table (5). The data illustrate that, the highest values of N, P and K content in the pods and chlorophyll in the leaves were found with irrigation the plants every 2 days, while the lowest values were found with irrigation every 8 days. It is well known that water plays a crucial role in the nutrient uptake, transportation and photosynthesis.

The reduction in levels of each N, P and K % due to stress of irrigation intervals period in both seasons were ascertained by the work of Khalil *et al.* (2012); Ramadan and Omar, 2017, they found that when soil moisture decreased, the mobility of nutrient in the soil is towered and the rate of nutrients flow to root absorption zone decreased. Such reductions in their contents in different tissues were attributed primarily to soil water deficiency which markedly reduces the flow rates of elements from the soil to the plants, their absorption by stressed root cells and also its ability to translocate through the different organs and tissues within the plant (Sawhney and Singh, 2002). Also, Hassan *et al.* (2013) and Soha and Khalil (2015) recorded stimulatory effect of water on the absorbing efficiency of ions and their movement. Results of decreasing chlorophyll content under advanced water stress was similar to that reported by Prakash and Ramachandran (2000b)

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they postulated that moisture stress would have inhibited the biosynthesis of chlorophyll a precursor, which in turn would have reduced the total chlorophyll content and that reflect also on mineral uptake.

Table 5: Effect of irrigation intervals and spraying with some antitranspirant compounds on chemical composition in the leaves and pods of snap bean plants

Treatments		N (%)		P (%)		K (%)		Chlorophyll (SPAD)	
		2016	2017	2016	2017	2016	2017	2016	2017
2days		2.61	2.69	0.75	0.77	1.19	1.22	45.01	45.59
4days		2.53	2.58	0.69	0.71	1.14	1.18	41.82	42.29
8days		2.39	2.40	0.61	0.62	1.07	1.11	37.20	37.91
L.S.D 5at %		0.14	0.03	0.02	0.04	0.02	0.04	0.42	0.71
MgCO ₃		2.87	2.90	0.98	1.00	1.30	1.33	43.93	44.64
Kaolin		2.72	2.75	0.69	0.70	1.21	1.23	42.02	43.03
Bentonite		2.48	2.51	0.64	0.66	1.15	1.19	41.38	41.87
Paraffin		2.4	2.42	0.62	0.62	1.09	1.14	40.34	41.00
Control		2.1	2.19	0.49	0.51	0.93	0.96	39.06	39.11
L.S.D.at 5%		0.06	0.03	0.02	0.04	0.02	0.03	0.43	0.61
2days	MgCO ₃	2.95	2.99	1.12	1.14	1.36	1.39	47.40	47.70
	Kaolin	2.77	2.80	0.74	0.77	1.25	1.27	46.03	46.50
	Bentonite	2.57	2.72	0.68	0.70	1.21	1.22	44.77	45.20
	Paraffin	2.49	2.57	0.67	0.68	1.13	1.15	43.96	45.10
	Control	2.25	2.36	0.55	0.56	1.02	1.05	42.90	43.40
4days	MgCO ₃	2.88	2.91	0.99	1.02	1.30	1.33	43.88	45.37
	Kaolin	2.70	2.76	0.68	0.69	1.21	1.23	42.72	43.93
	Bentonite	2.45	2.51	0.61	0.64	1.15	1.21	42.57	42.83
	Paraffin	2.42	5.43	0.65	0.65	1.11	1.16	40.53	40.83
	Control	2.23	2.29	0.52	0.53	0.92	0.99	39.40	38.50
8days	MgCO ₃	2.77	2.79	0.83	0.85	1.24	1.27	40.50	40.81
	Kaolin	2.66	2.69	0.64	0.65	1.18	1.21	37.30	38.64
	Bentonite	2.43	2.31	0.63	0.64	1.08	1.13	36.80	37.57
	Paraffin	2.29	2.27	0.53	0.54	1.03	1.11	36.53	37.09
	Control	1.83	1.93	0.40	0.43	0.84	0.85	34.87	35.42
L.S.D.at 5%		0.11	0.05	0.04	0.07	0.03	0.06	0.74	1.05

4-b-Antitranspirant compounds

Regarding to the effect of antitranspirants application, data in Table (5) indicate significant increments on N, P and K concentrations in the pods and

chlorophyll content in the leaves comparing with the untreated plants in both seasons. In this regards foliar spraying of MgCO₃ was the superior treatment followed by kaolin. On the

other hand, untreated plants recorded the lowest nutrient concentrations in both seasons. The effect of foliar spray by antitranspirants recorded the better uptake of all nutrients compared to the control and this induced beneficial influence on growth (Table 1). The obtained results are consistent with the most previous investigators, which pointed out the same direct correlation between antitranspirants materials and some elemental nutrition in tissues of the plant (Ramadan and Omar, 2017). chlorophyll percentage increased by all treatments, these results were correlated with the vase life results, however, high concentration of chlorophyll in the treated plants could be due to the effect of anti-transpirant, in improving water use efficiency, by reducing leaf transpiration rate via increasing leaf reflecting or inducing stomata closure. These results are in agreement with those obtained by Rabiza-Świder and Skutnik (2004) they found that, postharvest longevity of *Zantedeschia* and *Hosta* was extended by inhibiting leaf senescence through delaying chlorophyll loss and soluble protein degradation. Nevertheless, Abd El-Kader *et al.* (2006) recorded that spraying antitranspirants increased growth parameters. El-Abd (1996) on citrus, Ranney *et al.* (1989) on cherry trees recorded that pruning and antitranspirant were successful in delaying plant water stress, and relative growth rate.

4-c – The interactions effect

The effect of the interactions between different irrigation intervals and foliar application of antitranspirants on N, P and K and chlorophyll contents were illustrated in Table (5). The data showed that, there was a significant increase in N, P and K content in green snap bean pods and chlorophyll in the leaves in both seasons as affected by foliar applications with different source of antitranspirants under different irrigation intervals in the both seasons. Plants sprayed with $MgCO_3$ at (3%)

concentration under irrigation every 2 d recorded the highest values of the obtained parameters under these study compared with the other treatments. These results agree with that reported by Abd-El-Aal *et al.* (2008) on eggplant and Ramadan and Omar, 2017 on cabbage

CONCLUSIONS

It can be concluded from this study that irrigation snap bean plants under using drip irrigation method at interval every two days is preferable to get the best water status for the plants, in addition to obtain the highest vegetative growth characteristics, exultant pod characteristics and the highest total yield per unit area. The uses of antitranspirants were contributed to improve water status of the plants and reduce water loss through transpiration, as a result of the partial closure of the stomata. It means that antitranspirants can be used for water lacking in arid and semi-arid regions, in addition to lowering the effect of water stress on growth and yield of plants. The superior treatments for obtain strong vegetative growth, high pod yield with best quality were the interaction between irrigation every 2days and spraying the plants with $MgCO_3$ then the treatment of irrigation every 2days and spraying the plants by kaolin.

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تأثير فترات الري وبعض مضادات النتج على نمو وإنتاجية الفاصوليا تحت نظام الري بالتنقيط في التربة طينية

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الملخص العربي

الهدف من هذا العمل هو تقليل كمية المياه التي يتم اضافتها عن طريق الري ، وزيادة كفاءة استخدام المياه وتحديد الفترة المناسبة لري الفاصوليا تحت نظام الري بالتنقيط في الاراضي الطينية ، تم تنفيذ التجربة في اقسام بحوث الخضر ، معهد بحوث البساتين ، مركز البحوث الزراعية ، محافظة الجيزة ، خلال موسمي الصيف لعامي 2016 و 2017. وقد تضمنت هذه الدراسة ثلاث فترات ري كل (2 و 4 و 8 ايام) تحت نظام الري بالتنقيط ، مع رش خمسة مواد مضادة للنتج (كنترول و الكاولين 3 جم / لتر و كربونات المغنيسيوم 3جم/لتر و البارافين السائل 2٪ و البنتونيت 2٪). وقد أظهرت النتائج أن زيادة فترات الري من 2 إلى 8 ايام أدت إلى انخفاض إجمالي محتوى الماء في الأوراق ، ومعدل النتج النسبي ، و تسببت في زيادة نقص الماء في الورقة. كما أدى تقليل فترة الري من 8 إلى 2 يوم إلى زيادة معنوية في نمو النباتات ، من حيث ارتفاع النبات و عدد الافرع ، وعدد الأوراق في النبات ووزن النبات الطازج ومساحة الورقة ، كما ان كمية المحصول وجودة القورن كانت في النباتات المروية كل يومين أعلى من في الفترات الأخرى من الري ، كذلك تم الحصول على أعلى قيم لمحتوى النيتروجين والفوسفور والبوتاسيوم في القورن والكلوروفيل في الأوراق مع النباتات المروية كل يومين.

كما ادى رش نباتات الفاصوليا باستخدام كربونات المغنيسيوم يليه بالرش بواسطة الكاولين إلى الحصول على أعلى محتوى مائي إجمالي و أدنى معدل للنتج النسبي وأقل نقص في المياه في الورقة ، كما تم الحصول على أفضل قياسات للنمو، وارتفاع في كمية المحصول وجودة القورن، وتركيز النيتروجين والفوسفور والبوتاسيوم في القورن ومحتوى الكلوروفيل في اوراق النباتات التي عوملت بالرش بكربونات المغنيسيوم يليه الرش بالكاولين. من ناحية أخرى ، أدت معاملات التفاعل بين فترات الري ومضادات النتج إلى تأثير كبير في العديد من القياسات المدروسة. وكانت افضل المعاملات للحصول على اقوى نمو خضري واعلى محصول للقورن بمواصفات جيدة عن طريق معاملات التفاعل بين الري كل يومين والرش بكربونات المغنيسيوم يلي ذلك الري كل يومين والرش بمادة الكاولين.

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Table 2: Effect of irrigation intervals and spraying with some antitranspirant compounds on vegetative growth parameters of snap bean plants

Treatments		plant height (cm)		No. of branches /plant		No. of leaves /plant		plant weight (g)		dry matter %		Leaf area (cm ²)	
		2016	2017	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017
2days		31.80	32.27	5.53	5.80	20.07	20.53	56.67	60.20	18.78	18.93	155.47	159.56
4days		29.93	30.40	5.20	5.60	19.33	19.87	46.33	47.73	20.02	20.38	137.03	151.12
8days		27.47	28.27	3.73	3.97	13.60	14.07	28.60	30.67	22.00	22.50	126.25	130.30
L.S.D. at 5%		1.17	1.32	0.60	0.48	0.37	0.93	2.89	3.70	0.49	0.51	2.72	1.39
MgCO ₃		35.11	36.00	5.89	6.44	20.78	21.33	65.33	67.78	21.19	21.69	166.23	171.34
kaolin		32.11	33.11	5.44	5.78	19.78	20.22	54.44	56.22	22.43	22.92	148.09	159.98
Bentonite		31.22	31.67	5.11	5.44	19.22	19.56	37.78	39.33	19.69	19.56	136.68	142.50
paraffin		28.67	29.00	4.33	4.44	16.89	17.33	36.67	38.33	19.92	20.25	129.91	137.16
Control		21.56	22.11	3.33	3.50	11.67	12.33	25.11	29.33	18.09	18.59	117.01	123.99
L.S.D. at 5%		0.96	0.82	0.49	0.46	0.77	0.83	3.79	4.60	0.59	0.65	3.95	3.04
2days	MgCO ₃	37.00	37.67	6.67	7.33	23.33	24.00	80.33	85.67	20.56	20.73	176.52	177.66
	Kaolin	35.00	35.33	6.33	6.67	22.33	22.67	63.67	66.00	19.89	20.89	165.07	170.34
	Bentonite	33.33	34.33	6.00	6.33	22.00	22.33	53.67	55.33	18.42	17.35	154.67	158.20
	Paraffin	31.67	32.00	5.00	5.00	19.33	19.67	53.67	55.00	18.87	19.21	150.15	151.35
	Control	22.00	23.00	3.67	3.67	13.33	14.00	32.00	39.00	16.16	16.49	130.99	140.24
4days	MgCO ₃	35.67	36.33	6.33	7.00	23.00	23.67	74.33	75.00	20.87	21.54	168.42	173.03
	Kaolin	32.00	33.33	6.00	6.33	22.00	22.33	61.00	62.33	22.88	23.01	141.94	167.20
	Bentonite	31.67	31.67	5.67	6.00	21.00	21.33	36.33	38.00	18.91	19.24	130.99	143.74
	Paraffin	28.00	38.33	4.67	5.00	18.00	18.33	33.67	36.00	19.45	19.78	125.56	141.94
	Control	22.33	22.33	3.33	3.67	12.67	13.67	26.33	27.33	17.99	18.33	118.21	129.71
8days	MgCO ₃	32.67	34.00	4.67	5.00	16.00	16.33	41.33	42.67	22.15	22.81	153.74	163.34
	Kaolin	29.93	30.67	4.00	4.33	15.00	15.67	38.67	40.33	24.53	24.87	137.25	142.40
	Bentonite	28.67	29.00	3.67	4.00	14.67	15.00	23.33	24.67	21.76	22.09	124.40	125.56
	Paraffin	26.33	26.67	3.33	3.33	13.33	14.00	22.67	24.00	21.43	21.77	114.02	118.20
	Control	20.33	21.00	3.00	3.17	9.00	9.33	17.00	21.67	20.12	20.95	101.82	102.02
L.S.D. at 5%		1.66	1.43	0.84	0.79	1.34	1.43	6.57	7.96	1.03	1.12	6.84	5.26

