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Simulative Effect of Vigimax as Foliar Fertilizer on Growth, Head Yield and Quality of Some Broccoli (*Brassica oleraceae L. var. italica*) Cultivars

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ABSTRACT

An experiment was conducted at the horticultural station of kassaseen, Ismailia Governorate. Six cultivars of broccoli named Southern star, Premium crop, Prominence, Atlantic local, Atlantic F1and Monotop were cultivated in the winter season of 2003/2004.Plants were sprayed with five concentrations of Vigimax, i .e. 0,1, 2, 3 and 4 cm^3/l. Results indicated that premium crop cv. recorded the highest values of plant height followed by Atlantic local cv. The shortest plants were those of Monotop cv. Plants of cv Atlantic hybrid recorded the highest numbers of leaves per plant but the lowest were recorded by premium crop. Prominence cv. yielded the highest head yield per feddan with the best quality. The lowest head yield was recorded by Atlantic local. Monotop, Premium crop, Southern star and Atlantic hybrid cvs. yielded in-between prominence and Atlantic local in a descending order. The tallest plants with denser leaves were obtained by foliar application of the highest Vigimax concentration, i .e. 4 cm^3/l. Lower values of plant height and leaf numbers per plant were obtained by the lower Vigimax concentrations. The highest values of plant height and leaf numbers were obtained by premium crop and Atlantic local plants sprayed with the highest concentration of Vigimax, respectively. On the contrary, the shortest plants were the untreated plants of Premium crop and Monotop cvs. The highest total yield and head weight was obtained by spraying plants by the high concentrations (3 and 4 cm^3/l.) Vigimax solution,respectively. On the other hand, the lowest head yield and head weight were recorded by the untreated plants. The other interaction treatments ranged in-between these two values.

Key words: Broccoli, Vigimax, Foliar Fertilizer, Quality, yield

Introduction

Broccoli (*Brassica oleraceae* var.*italica*) is a vegetable crop which cultivated in Egypt in small scattered areas around Cairo and Alexandria. Total area of broccoli in Egypt still unknown. Broccoli is a promising crop especially in the newly reclaimed soils. Since these soils are poor in their hydrophilic and chemical prosperities, low fertility, water scarcity and salinity. It became of great importance to follow proper agricultural management system, i.e., soil preparation, irrigation requirements, fertilization programs, nursery care, suitable cultivars and new techniques for all the growing factors.

Many investigators recorded variations in the vegetative growth and head yield of the different broccoli cultivars under these conditions in Egypt (Hassan, 1999; Abou El-Magd, 2013; Abou El-Magd *et al*, 2006; Hanaa, *et al*, 2016; Hassan *et al*, 2013 and Abou El-Magd *et al*, 2015).

Both macro and micro nutrients availability is influenced by soil chemical and physical properties. Foliar feeding is a technique of feeding plants by applying liquid fertilizer directly to their leaves. Plants are able to absorb essential elements through their leaves. The absorption takes place through their stomata and also through their epidermis. Transport is usually faster through the stomata but total absorption may be as okosidim, Wuxal amino, Amino acids. Vigimax is a natural plant supplement comprising the essential micro elements in organic form. Vigimax replaces the missing essential micronutrients in all growing plants producing higher yields, healthier plants and more attractive product. Helps plant fight against disease due to the presence of trace elements. Vigimax increased micronutrients in the soil which increase water and nutrients absorbency. Vigimax usually applied as foliar fertilizer. Foliar application of Vigimax (0.2 ml/ l) increased all the studied growth

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characters of snap bean plants expressed as plant height, number of leaves and branches/ plant, leaf area as well as dry weight of shoots and roots , pigments content, mineral contents as well as yield and quality (Hanafy *et al*., 2010).The requirements of amino acids in essential quantities is well known as a means to increase yield and overall quality of crops (Fawzy *et al*., 2010 and Hassan *et al*., 2013). Foliar fertilization with Amino magnical, Amino tec and Root most increased onion growth, fresh weight and bulb yield of onion crop (Mona and Abou El-Magd, 2015). Foliar fertilization was followed for obtaining higher yields and better quality (Fawzy *et al*., 2010; Hassan *et al*., 2013 and Mona and Abou El -Magd, 2015) working on snap beans, broccoli and onions, respectively).

This work was determined to study the effect of six broccoli cultivars under foliar fertilization of five Vigimax concentrations and their combined action on growth, head yield and quality of heads.

Materials and Methods

Field experiments were conducted in the experimental farm of the horticultural station, Kassaseen, Ismailia Governorate, Egypt in the winter season of 2003/2004.Soil of the experiment is sandy light in texture, chemical and physical analysis of the experimental soil are tabulated in Table (1). Irrigation water analysis is shown in Table (2). Soil of the experiment was carefully prepared. Ditches 20 cm. depth and 20 cm. width were ditched in the locations of the drip irrigation lines. Calcium superphosphate (200 Kg) and poultry manure (5 m^3/ fed.) were mixed and spread through ditches and covered with sand. Drip irrigation lines were located over the ditches 75 cm apart and10 m. length. Healthy transplants 30 days age were selected and planted on the eastern side of the irrigation line one beside each dripper (50 cm apart). Ammonium sulphate (200 kg) + potassium sulphate (100 kg) / feddan were added in equal portions beginning after three weeks from transplanting. One portion every 15 days beside drippers.

Table 1: Physical properties and chemical analysis of the experiment soil .

Physical analysis							
(Sand %)	Clay (%)	Silt (%)	Texture	F.C. (%)	W.P. (%)	(Bulk density g/cm^3)	
87.96	11.38	0.66	Sandy	16.77	5.65	1.44	
Chemical analysis							
E.C.	PH	Meq./L					
(mmhos)		Ca^{++}	Mg^{++}	Na +	K^{+}	HCO_3^-	Cl^-
9.1	8.4	26.00	3.00	62.00	2.79	2.1	26.00

Table 2: Analysis of irrigation water .

pH	E.C. m/mhos	(Mill equivalent/L)						
		Cations				Anions		
		Ca^{++}	Mg^{++}	Na +	K^{+}	CO_3-	HCO_3^-	Cl^-
7.10	2.69	8	6	15.2	0.44	Nill	5.2	14

Treatments:

A. Cultivars:

Six cultivars named Southern star, Premium crop, Prominence, Atlantic local, Atlantic F1and Monotop.

B. Foliar fertilization: Vigimax solution: five concentrations, i .e. 0,1, 2, 3 and 4 cm^3/ l.

Data recorded:

A. Vegetative growth: plant height and leaf numbers/plant.
B. Heads yield: total heads yield per fed.
C. Head quality: head diameter, head length and height.

Statistical analysis:

This experiment included thirty treatments which were the combinations of six cultivars with five vigimax concentrations. The split plots design with three replicates was used. Cultivars were assigned in the main plots and vigimax treatments in the sub-plots. Data were subjected to proper statistical analysis according to Snedecor and Cochran, 1991.

Results and Discussion

A. Vegetative growth

1. Cultivars:

Data tabulated in Table (3) show that the tested broccoli cultivars varied significantly in their vegetative growth expressed as plant height and leaf numbers per plant. The highest values of plant height were recorded by plants of cv. Premium crop followed by Atlantic local. The shortest plants were those of cv. Monotop. Plants of Southern star, Prominence and Atlantic hybrid cvs. ranged in-between these values in a descending order. Plants of cv. Atlantic hybrid recorded the denser numbers of leaves and the lowest were recorded by Premium crop. The other tested cultivars (Atlantic local, Prominence, Monotop and Southern star plants) ranged in-between these two cultivars in a descending order in leaf numbers. The differences among cultivars in their vegetative growth might be due to their genetic differentiations which allow some to benefit high potentiality the natural resources, i. e, sunlight, CO_2, irrigation water, nutrients and other environmental and natural resources. The genetic potentiality of some cultivars enables their plants to absorb and translocate more irrigation water and nutrients. In addition, wider green surfaces allowing better photosynthetic capacity. Consequently, higher levels of carbohydrates, photosynthetic products, net assimilation rate, relative growth rate and dry matter accumulation reflecting higher levels of vegetative growth.

Table 3: Effect of some cultivars on growth, yield and quality of broccoli plants.

Cultivar	Growth		Yield		Quality	
	Plant height (cm)	Leaf number	(ton/ fed.)	Head weight (g)	Head diameter (cm)	Head height (cm)
Southern Star	48.74	15.42	3.42	321.04	13.82	11. 57
Premium Crop	51.30	14.24	3.57	334.44	13.80	11.66
Prominence	48.40	16.74	4.26	399.05	14.14	13.32
Atlantic Local	49.53	17.37	2.78	260.72	13.53	12.69
Atlantic F1.H.	45.09	18.27	3.39	317.95	13.44	11.71
Monotop	40.96	16.12	3.71	347.78	13.48	12.41
LSD at $_{0.05}$	0.24	0.09	0.03	3.24	0.02	0.04

In Egypt, wide variations were recorded among vegetative growth of the different broccoli cultivars (Aboul - Nasr and Ragab, 2000 and Abou El-Magd *et al*., 2006). Hassan(1999) reported that broccoli cultivars differed in their leaves weight of the plant, number of leaves, stem diameter and length as well as dry matter content. Hanaa *et al*. (2010); Hanaa (2011) and Abou El-Magd (2013) Reported that broccoli cultivars differed significantly in their vegetative growth expressed as plant height, leaves number as well as fresh weight of leaves and heads and their dry weight percentage. The latter added that Heraklion hybrid plants were the vigor compared with Centauro, Snowball, Calabrese and Sakura cvs.

2. Vigimax:

Foliar application of Vigimax enhanced vegetative growth of broccoli plants expressed as plant height and leaf numbers per plant up to its highest level, i. e. 4 cm^3/ l. (Table, 4). Linear relationship was noticed between plant height and leaves numbers with Vigimax concentrations. The tallest plants with denser leaves were obtained by foliar application of the highest Vigimax concentration, i. e.

4cm^3/l.. Lower values of plant height and leaf numbers per plant were obtained by the lower concentrations. Spraying broccoli plants by 3, 2 and 1cm^3/ l. Vigimax solution resulted in lower values of plant height and leaves number in a descending order. The shortest plants with the lowest leaf numbers were those of the control. Hanfy *et al*., (2010) came to similar results. They reported that foliar fertilization of snap bean plants with Vigimax (0. 2 ml/ l) increased all their vegetative growth parameters, i.e. plant height, number of leaves and branches/plant, leaf area as well as dry weight of shoots and roots. In addition, plant pigments, i. e. chlorophyll a, total chlorophyll and carotenoids concentrations were significantly increased when the plants treated with Vigimax. In shoots, P, K, Ca, Mg, Zn and Fe concentrations were significantly increased with Vigimax applications. Their results also showed that Vigimax applications significantly increased some organic compounds, i. e. total sugar, total free amino acids and total soluble phenols concentrations at both of shoots and pods as well as protein concentration in pods. On the other hand, application of Vigimax significantly decreased Na and Cl concentrations in both shoots and pods.

Table 4: Effect of foliar application of Vigimax on growth, head yield and quality of broccoli heads.

Vigimax concentration (cm^3/ l)	Growth		Yield	Quality		
	Plant height (cm)	Leaf numbers	(ton / fed.)	Head weight (g)	Head diameter (cm)	Head height (cm)
Control	43.92	15.17	3.16	296.13	12.24	10.94
1	45.35	15.75	3.43	321.48	12.93	11.69
2	47.20	16.33	3.61	338.35	13.68	12.26
3	49.02	16.96	3.81	357.34	14.48	12.78
4	51.20	17.60	3.60	337.51	15.18	13.46
LSD at $_{0.05}$	0.09	0.03	0.01	0.88	0.04	0.03

Many investigators recommended foliar fertilization for obtaining better vegetative growth (Fawzy *et al*., 2010 on snap beans; Hassan *et al*., 2013 on broccoli and Mona and Abou El- Magd, (2015) on onion. Foliar fertilization makes transport usually faster through the stomata, but total absorption may be as okosidim, Wuxal amino, Amino acids 70%.Vigimax is a natural plant supplement comprising the essential micro elements in organic form. Vigimax replaces the missing essential micronutrients in all growing plants producing higher yields; healthier plants and more attractive product. Vigimax increased micronutrients in the soil which increase water and food absorbency. Foliar application with Vigimax increased all the vegetative growth parameters of snap bean plants (Hanafy *et al*., 2010).They argued these increases in the vegetative growth to the resulting increases in the pigments content of plant leaves(chlorophyll a, total chlorophyll and carotenoids) and the wider area of the green surface. Consequently, higher photosynthetic activity ,higher levels of photosynthesizes and dry matter accumulation. Increases in vegetative growth might be also due to the increases in the nutrients content (P, K, Ca, Mg, Fe and Zn) and the lower Na and Cl concentration resulting with foliar application of Vigimax. Results of Hanafy *et al*. (2010) also showed that Vigimax applications significantly increased some organic compounds, i. e. total sugar, total free amino acids and total soluble phenols concentrations of shoots .The obtained increases in vegetative growth of broccoli plants might be referred to all the above mentioned results of Hanafy *et al*. (2010).

The requirements of amino acids in essential quantities are well known as a means to increase vegetative growth of crops (Fawzy *et al*., 2010 and Hassan *et al*., 2013). Foliar fertilization of Amino magnical, Amino tec and Root most increased onion growth and fresh weight and bulb yield of onion crop (Mona and Abou El-Magd, 2015).

3. Interaction:

Data in Table (5) show clearly that interaction of cultivars and Vigimax significantly affected vegetative growth of broccoli plants expressed as plant height and leaf numbers. The highest values of plant height were obtained by premium crop plants sprayed with the highest concentration of Vigimax. On the contrary, the shortest plants were the untreated plants of Monotop cv. In general the

tallest plants were obtained by spraying plants of any of the tested cultivars with the highest concentration of Vigimax. Lower values were recorded in all cultivars when sprayed by lower Vigimax concentrations. The shortest plants with the lower number of leaves per plant were obtained in all the tested cultivars by untreated plants. The lowest values of plant height were obtained by the unsprayed monotop plants. Leaves number per plant recorded the lowest values by the unsprayed premium crop plants. It was noticed that all the interaction treatments reflected significant increases in the vegetative growth of broccoli plants.

B. Head yield

1. Cultivars:

Broccoli cultivars varied widely in their yield of heads (Table 5). Prominence cv. yielded the highest head yield per feddan. The lowest yield was recorded by Atlantic local. Monotop, premium crop, Southern star and Atlantic hybrid cvs. yielded in-between these two cultivars in a descending order. Variations of head yield within cultivars may be mainly due to their genetic variations. Cultivars varied in their vegetative growth and their chemical content. Their photosynthetic activity, photosynthesizes and dry matter accumulation would be also differed. Since head yield is the summation of these products, it might be differed between cultivars. Many investigators reported variations within broccoli cultivars (Abou El-Magd, 2005 and Hanaa *et al*., 2010 and Hanaa, 2011). It was clear from these results that head yield results followed the same trend of the vegetative growth to more extent. Since prominence is superior in its vegetative growth, plant height and leaf number, Consequently, leaf area and fresh weight which allows plants to benefit more of the natural resources, more light energy, CO_2 photosynthetic activity and photosynthetic metabolites which translocate and stored in the main yield as a sink. In the addition, potentiality of prominence cv. plants for absorption and translocation of soil nutrients might be also of the high yield attributes. Many investigators studied wide range of broccoli cultivars. Aboul- Nasr and Ragab, 2000; Abou El-Magd *et al*., 2005 & 2006; Hanaa *et al*., 2010 and Hanaa, 2011). Abou El- Magd *et al*., (2015) found differences in head yield within the tested cvs. Hanaa *et al*.,2010 and Hanaa (2011) found that Decathlon cv. was superior in head yield compared with Premium crop and Green Comet . Abou El-Magd (2013) working on broccoli in western Egypt reported that cultivars differed significantly in their total head yield. Heraklion hybrid recorded the highest values of total head yield compared with Centauro, Sakura, snowball and Calabrese. The lowest head yield was recorded by Calabrese cv.

2.Vigimax:

Data in Table (5) shows clearly that foliar application of Vigimax significantly increased broccoli yield per feddan. The highest total yield of broccoli heads was obtained by spraying plants with the high concentrations (3 and 4 cm^3/ l) Vigimax solution. On the other hand, the lowest head yield was recorded by the untreated plants. The other treatments ranged in-between these two treatments with respect to their head yields. Foliar application of 400, 200 and100 ppm recorded increases in head yield in a descending order. Increases in head yield due to 4, 2 and1cm^3/ l Vigimax treatments amounted to 0.45, 0.44 and 0.27 ton/ fed. These increases equal 14.0, 13.9 and 2 %, respectively. These increases in head yield might be owing to the resulting increases in the vegetative growth by Vigimax foliar fertilization. Since Vigimax amended plants with amino acids and trace elements in the organic form, increased water and nutrients absorption and increased the nutrients content (N, K, Ca, Mg, Fe and Zn) and lowered Na and Cl concentration (Hanafy *et al*., 2010). These amendments may also increase the vegetative growth. Increases in vegetative growth allowed plants more benefits of the natural resources. Vigor plants with denser leaves and wider green surface which capture more sunlight energy, absorb more water and soil nutrients. The abundant light energy, water and nutrients absorption allows favorable conditions for higher photosynthetic activity accumulating higher amounts of photosynthetic products and dry matter accumulation. Since these components are the yield promoters, higher head yields were obtained by foliar application of Vigimax. Hanafy *et al*., (2010) recommended these findings. They reported that foliar application with Vigimax increased all the vegetative growth parameters of snap bean plants, pigments content of plant leaves (chlorophyll a,

total chlorophyll and carotenoids) and the wider area of green surface. Consequently, higher photosynthetic activity, higher levels of photosynthesizes and dry matter accumulation. Increases in vegetative growth might also be due to the increases in the nutrients content(N, K, Ca, Mg, Fe and Zn) and the lower Na and Cl concentration with foliar application of Vigimax (Hanafy *et al*., 2010). Foliar application with Vigimax created all these favorable conditions. The resulting increases in the vegetative growth, pigments content, mineral content, organic compound resulted in higher yields. Many investigators came to similar results by foliar fertilization. Abou El-Magd and Mona (2015) on onion; Tamer (2013) on broccoli; Mona and Abou El-Magd(2015) on onion; Abou El-Magd *et al*., (2015) on broccoli and *Zaki et al.,* (2016) on broccoli.

Table 5: Effect interaction of broccoli cultivars and Vigimax on the growth, head yield and quality of heads of broccoli plants.

Cultivars	Vigimax Concentration (cm^3/ l)	Growth		Yield		Quality	
		Plant height (cm)	Leaf numbers	Ton / feddan	Head weight (g)	Head diameter (cm)	Head height (cm)
Southern Star	Control	44.95	14.24	2.860	268.09	12.57	10.00
	1	47.17	15.28	3.220	301.60	13.06	11.12
	2	49.15	15.28	3.720	348.52	13.65	11.71
	3	50.16	15.98	3.950	370.30	14.52	12.16
	4	52.28	16.33	3.380	316.68	15.28	12.85
Premium Crop	Control	49.26	13.20	3.270	306.63	11.95	10.53
	1	49.33	13.89	3.480	326.73	12.99	10.91
	2	50.99	14.24	3.630	340.14	13.62	11.67
	3	52.49	14.59	3.790	355.22	14.83	12.16
	4	54.43	15.28	3.660	343.49	15.60	13.06
Prominence	Control	44.71	15.63	3.950	369.96	12.57	11.53
	1	46.55	15.98	4.220	395.43	13.37	13.06
	2	48.18	16.67	4.410	413.86	14.38	13.48
	3	50.30	17.37	4.560	427.27	14.87	14.07
	4	52.28	18.06	4.150	388.73	15.53	14.48
Atlantic Local	Control	46.79	15.98	2.250	211.12	12.51	11.74
	1	48.32	16.33	2.750	258.04	12.78	12.16
	2	49.53	17.37	2.840	266.41	13.27	12.71
	3	51.34	18.40	3.040	284.84	14.31	13.27
	4	51.65	18.76	3.020	283.17	14.76	13.58
Atlantic F1 H.	Control	39.84	17.02	3.120	292.22	11.64	10.70
	1	41.44	17.37	3.230	303.28	12.44	11.05
	2	44.36	18.06	3.320	311.65	13.58	11.57
	3	47.62	18.76	3.660	343.49	14.28	12.02
	4	52.17	20.15	3.620	339.13	15.25	13.20
Monotop	Control	37.97	14.94	3.510	328.74	12.19	11.12
	1	39.29	15.63	3.670	343.82	12.92	11.88
	2	40.99	16.33	3.730	349.52	13.58	12.44
	3	42.20	16.67	3.870	362.93	14.07	13.03
	4	44.36	17.02	3.770	353.88	14.66	13.58
L.S.D. at $_{0.05}$		0.75	0.59	0.080	7.27	0.27	0.20

3. Interaction:

Interaction of cultivars and Vigimax concentration affected significantly head yield of broccoli (Table 5).The highest values of head yield were obtained by the combined effect of foliar application of 300 ppm Vigimax solution with prominence cv. plants. In general, foliar application of 3 cm^3/ l. Vigimax solution with all the tested cultivars resulted in higher head yield compared with the other interactions. The lowest head yield was the result of interaction between the control treatment and Atlantic local cv. plants. The other interaction treatments ranged in-between these two values.

C. Head quality

1. Cultivars:

Quality of broccoli expressed as head weight, diameter and height was widely influenced within cultivars (Table 3).The superior heads in their weight, diameter and height were those of prominence cv. Atlantic local heads recorded the lowest mean weight, Atlantic hybrid the lowest head diameter but southern star the lowest head height. Monotop, Premium crop, Southern star and Atlantic hybrid recorded lower head weight compared with Prominence in a descending order. Head diameter of Southern star, Premium crop, Atlantic local and Monotop recorded lower diameter than prominence in a descending order. Atlantic local, Monotop, Atlantic hybrid and premium crop recorded lower values of head height than prominence in a descending order. Many investigators reported variations in the quality of broccoli heads due to cultivars. Abou El-Magd, (2013) ; Abou El-Magd *et al*., (2003, 2010, 2015, 2016 and 2017).

2. Vigimax:

Foliar application of Vigimax affected significantly the quality of broccoli heads expressed as weight, diameter and height (Table 4). Head weight recorded its highest value when the plants were sprayed by 300 ppm Vigimax. The lowest head weight was recorded by the untreated plants. Plants sprayed with 2,4 and1 cm^3/ l. of Vigimax followed 3 cm^3/l. treatment in their head weight with a descending order. Head diameter and height recorded their highest values by plants treated with the highest Vigimax concentration (4 cm^3/ l.). Lower values of head diameter and height were obtained by 3, 2and 1 cm^3/l. Vigimax solution, respectively. The untreated plants recorded the lowest diameter and height of broccoli heads. It is clear from the data of Table (4) that foliar fertilization of broccoli plants enhanced head quality in all Vigimax concentrations. The high tested concentrations were more effective than the low ones. Hanafy *et al*., (2010) reported that foliar fertilization with 0.2 ml/ l Vigimax solution enhanced yield quality and nutritive value of snap bean plants. Their results also showed that foliar application with Vigimax significantly improved N, K, Mg, Zn, Mn and Fe concentrations at both pickings as well as some organic compounds, i.e. total sugar, total free amino acids and total soluble phenols concentrations as well as protein concentration in pods.

3. Interaction:

Data in (Table 5) showed that the combined effect of cultivars and Vigimax concentrations affected significantly the quality of broccoli heads expressed as weight, diameter and height. The highest values of head weight, diameter and height were obtained by prominence plants which sprayed with 3 and 4 cm^3/ l. Vigimax concentration. The high concentrations of Vigimax were more effective in the quality of heads combined with all cultivars. Lower values of head weight, diameter and height were obtained by the other interactions. The lowest values of head quality were obtained by all cultivars untreated.

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