

EFFECT OF INORGANIC AND ORGANIC FERTILIZERS ON GROWTH AND PRODUCTION OF BROCCOLI (*Brassica oleracea L.*).

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ABSTRACT

A field experiment was conducted at the research and production station, El-Nubaria location, National Research Centre, Egypt during winter season, 2008, to study the effect of different solution fertilizers formula and organic manure on vegetative growth, heads yield quantity and quality as well as nutrient composition of broccoli (*Brassica oleracea var. italica*).

The obtained results showed that all mineral solution fertilizers gave a significant synergistic effect for broccoli growth, yield quantity and quality as well as nutrients composition compared with the control (mineral N, P, K recommended fertilizers). The mineral formula 19: 19: 19 gave the highest growth heads, yield and the best quality along with mineral content in broccoli. Using farmyard manure plus inorganic fertilizers enhanced all growth and yield parameters. Applying farmyard manure plus the mineral solution fertilizer formula 19: 19: 19 caused in the superior and optimum figures of broccoli growth, mineral composition as well as heads yield quantity and quality. Organic manure alone recorded the lowest one.

Keywords: organic fertilizers- mineral fertilizers- broccoli- farmyard manure.

INTRODUCTION

Cruciferous vegetables are large and increasingly important vegetables. Broccoli, a member of the crucifer family of vegetables, is a rich source of sulphoraphane, which has been shown to display potent anticarcinogenic properties. However over half of the world population fails to benefit from this because they lack a specific gene (GSTM1) that helps retain the compound in the body (Kirsh *et al.*, 2007). Eating a few portions of broccoli each week may help to reduce the risk of cancer. The cancer-fighting properties of broccoli are not new and previous studies have related these benefits to the high levels of active plant chemicals called glucosinolates (Zhao *et al.*, 2007). Eating more than one serving of broccoli a week reduces the risk of prostate cancer by up to 45 percent. Eating larger portions may also have additional benefits, since broccoli is also a rich source of many vitamins and minerals such as vitamin A and C, carotenoids, fiber, calcium and folic acid (Michaud *et al.*, 2002).

Growing broccoli in the newly reclaimed soils is faced by various problems, such as cultivars, fertilization, low amounts of available nutrients and low organic matter content as well as poor hydrophilic, chemical and biological properties.

Nkoa *et al.*, (2002) found that using mineral fertilizer (N, P, K) increase broccoli vegetative growth, yield and quality.

Organic manure play direct role in plant growth as a source of all necessary macro and micronutrients in available forms during mineralization

and improving physical and chemical properties of soils (Chaterjee *et al.*, 2005).

Anant-Bahadur *et al.*, (2006) pointed that organic matter plays an important role in the chemical behavior of several metals in soils throughout its active groups (Flavonic and humic acids) which have the ability to retain the metals in complex and chelate forms.

The objective of this work is to evaluate the effect of different mineral fertilizers and organic matter on vegetative growth, heads yield, heads quality and chemical content of broccoli plants.

MATERIALS AND METHODS

A field experiment was carried out to study the effect of different sources of mineral fertilizers and organic matter on broccoli.

Soil analysis:-

Some physical and chemical soil properties of El-Nubaria Research and Production station, National Research Centre are shown in Table (1).

Table (1): Some physical and chemical properties of the used soil at El-Nubaria, Research and Production Station, National Research Centre.

Soil property	Particle size distribution %				Soil moisture constant %			
	Sand	Silt	Clay	Texture	Saturation	FC	WP	AW
Physical	68.7	24.5	6.8	S L	%			
					23.0	19.2	6.1	13.1
chemical	pH ^a		EC ^b dS/m		CaCO ₃ %		OM %	
	7.8		0.18		7.07		0.16	
	Soluble cations (meq/l)				Soluble anions (meq/l)			
	Ca ⁺⁺	Mg ⁺⁺	K ⁺	Na ⁺	CO ₃ ⁻	HCO ₃ ⁻	Cl ⁻	SO ₄
	3.00	2.00	0.32	2.09	0.00	1.41	0.70	5.30
	Total		Available		Available micronutrients			
	N		P	K	Fe	Mn	ZN	Cu
	mg/100 g soil				ppm			
	15.0		9.4	16.0	7.8	3.3	1.86	4.0
					Cobalt (ppm)			
				Soluble	Available	Total		
				0.49	4.43	15.00		

a: Soil pH was measured in 1:2.5 soil-water suspension, b: EC was measured as dS^m⁻¹ in soil paste extract,
S L: sandy loam

Particle size distributions along with soil moisture were determined as described by Blackmore (1972). Soil organic matter, CaCO₃, EC, pH, cation and anions, soluble and available micronutrients were determined according to Black *et al.*, (1982).

Experimental work:-

A field experiment was conducted during successive season, 2008 at El-Nubaria farm, National Research Centre, El-Beheara governorate, Egypt to evaluate vegetative growth, heads yield, heads quality and chemical

constituents of broccoli plants as affected by different mineral fertilizers and organic matter.

Seeds of broccoli (*Brassica oleraceae L.var. italica*), Family crucifer were sown in the nursery in foam trays filled with a mixture of peat moss and sand (1:1 volume) on 1st of September of 2008 season. Seedlings were transplanted in the open field at 45 days age. The experiment contains 9 plots. Each plot was 5 X 3 meter, consisting of three rows. Ten plants in each row (50 cm a part) were planted under drip irrigation system.

◆ **Fertilizers treatments:-**

- 1- Recommended fertilizers (ammonium nitrate (33.5% N) at a rate 100 kg N /fed.; ordinary super phosphate (15.5% P₂O₅) at a rate 60 kg P₂O₅/fed. and potassium sulphate (48% K₂O) at a rate of 50 kg K₂O/fed.).
- 2- Solution fertilizer formula (10: 19: 40). 1 ml / Liter.
- 3- Solution fertilizer formula (19: 19: 10). 1 ml / Liter.
- 4- Solution fertilizer formula (19: 19: 19). 1 ml / Liter.
- 5- Farmacyard manure. 10 m³ /fed.
- 6- Recommended fertilizers + farmyard manure.
- 7- Solution fertilizer formula (10: 19: 40) + farmyard manure.
- 8- Solution fertilizer formula (19: 19: 10) + farmyard manure.
- 9- Solution fertilizer formula (19: 19: 19) + farmyard manure.

Table (2): Some chemical properties of farmyard manure.

O.M %	Total N %	C/N ratio	pH (1:2.5)	EC dSm ⁻¹	Available nutrients %		DTPA- extractable (ppm)			
					P	K	Fe	Mn	Zn	Cu
36.00	1.8	17.07	7.5	3.3	1.20	1.6	840	30.0	15.0	3.0

The quantities of the chemical fertilizers were split into three equal doses (3, 6 and 9 weeks) after transplanting. All the plants received natural agricultural practices whenever they needed.

Measurement of plant growth:-

After 60 days from transplanting, growth parameters were recorded i.e. plant height, pranches and leaves number per plant, leaf area as well as fresh and dry weight of both shoots and roots (3 plants from each treatment) were determined according to Gabal *et al.*, (1984).

Measurement of heads yield:-

At mature stage, after 90 days from transplanting, all broccoli heads were harvested to record:- Head weight (g/plant), head height, head diameter, total heads yield (ton/fed) according to Gabal *et al.*, (1984).

Measurement of heads quality:-

Chemical contents i.e. TSS, protein, total carbohydrates, vitamin (C), vitamin (A) were determined according to the method described by A.O.A.C. (1980) as well as nutrients content were determined according to Cottenie *et al.* (1982).

Statistical analysis of the obtained data was subjected to standard analysis of variance procedure. The values of LSD were calculated at 5% level according to Snedecor and Cochran (1982).

RESULTS AND DISCUSSION

Vegetative growth characters:-

Results in Table (3) show that broccoli growth characters were significantly influenced by different mineral fertilizers. The highest plant height branches and leaves number/plant and leaves area were recorded for plants supplied with formula (19: 19: 19) fertilizer. All mineral fertilizers can be arranged in decreasing order as follows: formula (19: 19: 19) > formula (19: 19: 10) > formula (10: 19: 40) > N, P, K as recommended.

Table (3): Vegetative growth of broccoli plants as affected by inorganic and organic fertilizer.

Fertilizers addition	Plant height (cm)	Branches No./plant	Leaves No./plant	Leaves area (cm ²)	Fresh weight (gm)		Dry weight (gm)	
					Shoot	Root	Shoot	Root
With inorganic fertilizer:								
(control) N, P, K Recommended	48.20	6	12	169	271	23.8	24.9	5.95
10: 19: 40	52.66	7	13	197	280	25.0	26.7	6.24
19: 19: 10	58.50	8	16	229	289	26.2	27.5	6.66
19: 19: 19	63.00	10	19	253	297	27.3	28.9	6.85
With organic fertilizers								
Farmyard manure	45.60	6	12	181	258	22.5	20.8	5.57
(control) N, P, K Recommended	53.81	7	14	212	291	27.7	25.2	6.92
10: 19: 40	57.52	8	17	247	302	30.1	26.5	7.53
19: 19: 10	64.66	10	20	279	313	31.7	27.4	7.89
19: 19: 19	67.55	12	25	294	322	32.6	28.7	8.18
LSD 5%	0.30	0.35	0.45	2.80	1.62	0.31	0.28	0.07

Data also indicate the positive effect of organic manure fertilizer. It is obvious that farmyard manure, when added with mineral fertilizers, had a promotive effect on all growth parameters including fresh and dry weights of broccoli shoots and roots.

Data in Table (3) indicate also, that the great differences in plant height were due to applied treatments. The values of plant height ranged from 48.20 cm for control to 63.00 cm for formula (19: 19: 19) treatment. On the other hand, the number of branches and leaves/plant slightly differed among treatments.

The same trend took place for both fresh and dry weights of shoots and roots. Control plants had the lowest value while the highest one for formula (19: 19: 19) fertilizer. The values of fresh shoots and roots were 271 and 23.8 g/plant under control treatment versus 297 and 27.3 g/plant under the formula (19: 19: 19) fertilizer. Regarding dry weights of shoots and roots, the data showed a similar trend. The values reached 24.9 and 5.95 g/plant for control and 28.9 and 6.85 g/plant for formula (19: 19: 19) fertilizer. It is clear that mineral solution fertilizers gave values lower than that of combined with farmyard manure (FYM).

Data in Table (3) clearly indicate the vital role of organic fertilizer (FYM) as a source for organic nitrogen besides. The obtained the plant nutrients results are in agreement with those obtained by Rakesh *et al.*, (2006) who showed that organic manure plus mineral fertilizer increase vegetative growth of broccoli plants.

Head yield of broccoli:-

The data in Table (4) and Fig (1) represent the yield parameters of broccoli as affected by different solution fertilizers of mineral and organic manure either alone or in combination. All mineral solution fertilizers gave a significant synergistic effect for the yield parameters i.e. head height; head diameter, heads weight (g/plant) and yield (ton/fed.) of broccoli compared to control. The best treatment of broccoli yield components i.e. first, second and third harvests were recorded by using mineral solution fertilizers, formula (19: 19: 19) followed by formula (19: 19: 10) followed by formula (10: 19: 40).

Table (4): The heads yield of broccoli as affected by inorganic and organic fertilizer.

Fertilizers addition	Head height (gm)	Head diameter (cm)	Head Weight (g/plant)	Head Weight (ton/fed.)			
				First	Second	Third	Total
With inorganic fertilizers							
(control) N, P, K Recommended	13.38	14.56	191.22	1.67	1.72	1.53	4.92
10: 19: 40	13.84	15.80	198.60	1.92	1.80	1.59	5.31
19: 19: 10	14.56	16.04	211.00	2.06	1.98	1.69	5.73
19: 19: 19	15.20	16.21	229.72	2.93	2.07	1.84	6.84
With organic fertilizers							
Farmyard manure	11.68	13.51	133.50	1.49	1.27	1.07	3.83
(control) N, P, K Recommended	14.91	15.06	198.80	2.42	1.95	1.59	5.96
10: 19: 40	15.26	16.14	223.50	2.66	1.92	1.79	6.77
19: 19: 10	15.93	17.61	257.80	2.95	2.34	2.06	7.35
19: 19: 19	16.14	18.32	278.60	3.56	2.66	2.22	8.44
LSD 5%	0.16	0.18	0.27	0.06	0.02	0.04	0.09

Data in Table (4) show that using FYM alone gave the lowest broccoli heads yield. Addition of organic manure plus mineral fertilizer (NPK recommended) increased the heads total yield and its components from 4.92 to 5.96 ton/fed. Using the formula (10: 19: 40) with organic manure increased the total head yield from 5.31 to 6.77 ton/fed, with the formula (19: 19: 10) increased it from 5.73 to 7.35 ton/fed. It worth to be mentioned that the hinged increase in head yield n case of using the formula (19: 19: 19) since it reached 8.44 ton/fed. These results agree with that mentioned by chaterjee *et al.*, (2005).

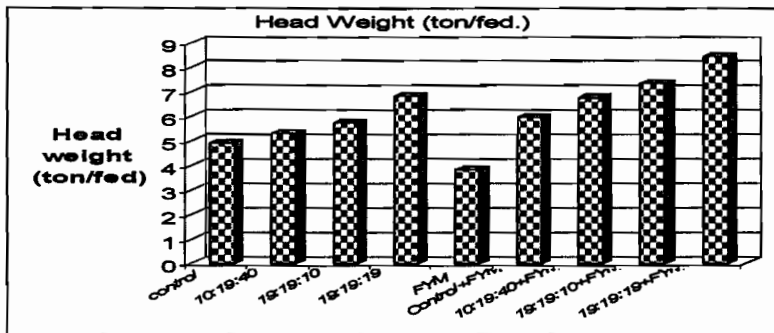


Fig (1): Heads yield of broccoli as affected by inorganic and organic fertilizer.

Table (5): Chemical constituents of broccoli heads as affected by inorganic and organic fertilizer.

Fertilizers addition	TSS	Protein	Phenols	Vitamin "A"	Vitamin "C"
	(%)			mg/ 100 gm fresh tissue	
With inorganic fertilizers					
(control) N, P, K Recommended	7.18	21.40	6.86	15.35	77.80
10: 19: 40	7.67	22.96	7.54	15.90	81.92
19: 19: 10	7.96	23.84	7.98	16.72	85.61
19: 19: 19	8.21	25.52	8.35	17.06	92.35
With organic fertilizers					
Farmyard manure	6.13	19.47	6.24	14.86	72.60
(control) N, P, K Recommended	7.56	24.77	7.94	16.11	93.89
10: 19: 40	8.97	25.08	8.30	17.19	99.78
19: 19: 10	8.53	26.77	8.87	17.78	104.09
19: 19: 19	8.89	27.77	9.33	18.00	108.20
LSD 5%	0.09	0.29	0.06	0.17	0.38

Chemical constitute:-

Data presented in Table (5) point that the highest TSS, protein, Phenols, vitamin "A" and vitamin "C" in broccoli heads was obtained by formula (19: 19: 19) mineral solution fertilizer. The effect of different mineral fertilizers on broccoli heads chemical contents (%) can be arranged in the following order: formula (19: 19: 19) > formula (19: 19: 10) > formula (10: 19: 40) > NPK recommended (control). Application of FYM combined with mineral solution fertilizer formula (19: 19: 19) were the superior. It is worthy to notice that the combination between mineral solution fertilizer formula (19: 19: 19) and FYM, caused the highest increase in all chemical constituents (TSS, protein, Phenols, vitamin "A" and vitamin "C").

The combination between FYM and mineral solution fertilizer formula (19: 19: 10) occupied the second order. While the combination between FYM and mineral solution fertilizer formula (10: 19: 40) occupied the third order. Finally, the recommended N, P, K fertilizers with FYM occupied the fourth

order. The lowest values of chemical constituents were recorded by organic manure alone.

These data are in harmony with those obtained by Nanwai et al., (1998) who found that, the supplying wheat crop with organic and inorganic fertilizers was proved to be essential for producing higher yield and better quality.

Table (6): Minerals composition of broccoli heads as affected by inorganic and organic fertilizer.

Fertilizers addition	Macronutrients (%)			Micronutrients (ppm)			
	N	P	K	Fe	Mn	Zn	Cu
With inorganic fertilizers							
(control) N, P, K Recommended	3.43	0.28	1.89	129	48.92	33.55	28.50
10: 19: 40	3.68	0.31	1.97	132	51.03	35.20	31.02
19: 19: 10	3.82	0.36	2.14	137	53.61	37.14	34.50
19: 19: 19	4.09	0.42	2.23	141	55.52	39.66	36.72
With organic fertilizers							
Farmyard manure	3.12	0.26	1.80	126	44.60	30.41	26.0
(control) N, P, K Recommended	3.97	0.39	2.39	139	48.91	39.51	32.81
10: 19: 40	4.02	0.45	2.45	144	51.78	42.37	34.60
19: 19: 10	4.29	0.49	2.51	151	54.21	45.13	37.00
19: 19: 19	4.45	0.54	2.59	156	57.34	47.50	39.44
LSD 5%	0.134	0.085	0.033	1.715	0.990	0.281	0.462

Mineral composition:-

Data in Table (6) demonstrate the influence of different mineral fertilizers and organic manure on minerals content in broccoli heads. It is clear that mineral solution fertilizer formula (19: 19: 19) exerted the highest values of all nutrients i.e. N, P, K, Mn, Zn, Cu. Control treatment which received the recommended doses of mineral fertilizers of N, P and K only showed the minimum content of all elements. On the other hand, using organic manure with mineral fertilizers achieved the best level either for macronutrients or micronutrients. These results agree with those obtained by El-Shakry (2005) who found that organic manure enhances nutrients absorption by sweet fennel plants.

CONCLUSION

Mineral nitrogen from mineral solution fertilizers represent the easier available form of nitrogen compared to recommended mineral fertilizers.

Using organic manure plus inorganic solution fertilizers gave a significant increase in plant growth, heads yield, chemical constituents and mineral composition of broccoli. Organic manure enhances soil aggregation, aeration, water holding capacity and amended the root system by slow flow of nutrients which in combination creates favorable conditions for root respiration, nutrients absorption, root and upper parts growth and yield

quantity and quality. Organic manure increasing the fertility and productivity of sandy soils.

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"تأثير الاسمدة المعدنية و العضوية على نمو ومحصول البروكلى"
هالة أحمد قنديل و نادية جاد الرب شحاته
قسم تغذية النبات- المركز القومي للبحوث الدقى - مصر

أقيمت تجربة حقلية فى محطة البحوث و الانتاج بالنوبارية - المركز القومى للبحوث خلال الموسم الشتوى ٢٠٠٨ لدراسة تأثير نسب مختلفة من الاسمدة المعدنية المركبة السائلة على النمو الخضرى و كمية المحصول و صفات الجودة بالإضافة الى المحتوى المعدنى لرؤوس البروكلى. أظهرت النتائج أن كل الاسمدة المعدنية المركبة السائلة أعطت تأثير منشط للنمو و كمية وجودة محصول البروكلى و كذلك التركيب المعدنى للرؤوس مقارنة بالكنترول (الاسمدة المعدنية N, P, K الموصى بها من وزارة الزراعة) اعطى السماد المركب السائل ١٩:١٩:١٩ أفضل النتائج للنمو و كمية و جودة المحصول. إضافة السماد العضوى مع الاسمدة المعدنية بصورها المختلفة رفع من كفاءتها و انعكس هذا على كمية وجودة المحصول بينما أعطت إضافة السماد العضوى بمفرده أقل كمية محصول.

قام بتحكيم البحث

كلية الزراعة - جامعة المنصورة
خارجى

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