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Response of Turnip (Brassica *rapa)* Plants to Minerals or Organic Fertilizers Treatments

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ABSTRACT

A greenhouse experiment was conducted in National Research Centre, Dokki, Cairo, Egypt, during two successive seasons to study the effect of various levels for NPK ($N_{100}P_{100}$ K_{50} and $N_{200}P_{200}$ K_{100}), Humic acid (0.02%, 0.04% and 0.06%) or Compost tea (100,200,300 ml /L) on *Brassica rapa* (turnip) plants. The highest growth parameters or biomass represented by leaves and roots were obtained with the second level of NPK or humic acid, but it can recommend to applied humic acid as an organic fertilizer for producing organic products. Humic acid or compost tea increased carbohydrate content while the two levels of NPK fertilizers caused inhibition for its accumulation. Moreover, affect of these treatments on minerals content, total lipids and fatty acids were studied.

Key words : Turnip, *Brassica rapa* , NPK , humic acid , compost tea , fatty acids

Introduction

Turnip (*Brassica rapa*) is a member of the cruciferous family of vegetables. Brassica rapa, commonly known as field mustard or turnip mustard is a plant widely cultivated as a leaf vegetable, a root vegetable, and an oilseed. Plants for a future can not take any responsibility for any adverse effects from the use of plants. Always seek advice from a professional before using a plant medicinally. A decoction of the leaves or stems is used in the treatment of cancer (Duke and Ayensu 1985). The powdered seed is said to be a folk remedy for cancer (Duke 1983). The crushed ripe seeds are used as a poultice on burns (Foster and Duke 1990). The root when boiled with lard is used for breast tumors (Duke 1983). A salve derived from the flowers is said to help skin cancer (Duke 1983). Moreover, turnip extract is also useful for lowering uric acid and extracting renal stones. It increases visual keenness and is used to treat night blindness.Turnip's syrup strengthens the memory (Khashayar, 2007). Turnip root peelings contain a natural insecticide Allardice (1993).

Nutrient supply to plants greatly affects their growth, production and plant constituents. The seed yield, total dry matter and harvested index in some genotypes of *Brassica napus* and *B.juncea* has been found to improve with higher of N (Kumar *et al*, 2001; Cheema *et al*., 2001; Khanna *et al*., 2003 and Miller *et al*., 2003). The application of P also significantly increases the seed yield, leaf area index and total dry matter as well as increases the P uptake in canola and some other *Brassica* species (Thakur and Jgdish, 1998 and Lickfett *et al*., 1999)

Organic products, based on philosophical preferences and conviction or in response to an increasing market opportunity, exclude or prohibit the use of conventional crop inputs common to modern farming. Marculescu *et al*., (2002) revealed that, the soil with its content in macro and microelements, enhanced by the use of organic fertilizers, play an essential role in the plants growing and development, in biosynthesis of the organic substances. Khalid *et al*., (2006) reported that using static compost with tea of static compost increased the production and medicinal properties of *Ocimum basilicum L.* Also it is very cheap and expressed cash money improving the income of farmer, in addition, uses this organic materials are safe for human health.

On the other hand, many commercial products containing humic acid (HA), including K-humate (KH) have been promoted for use on various crops (Liu *et al*., 1998). Benefits ascribed to the use of humic acid, particularly in low organic matter, alkaline soil, include increased nutrient uptake, tolerance to drought and temperature extremes, activity of beneficial soil microorganisms and availability soil nutrients (Russo and Berlyn,1990, Senn and Kingman 1973). Humic materials may also increase root growth in a manner similar to auxins (Senn and Kingman 1973).

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Material and Methods:

A greenhouse experiment was conducted in National Research Centre, Dokki, Cairo, Egypt, during two successive seasons (2007/2008 and 2008/2009) on *Brassica rapa* (turnip) plants. The seeds were secured from experimental station of Agricultural Ministry and sown in seed bed at 10 and 15 November for 1st and 2nd seasons respectively. After three weeks from sowing, seedlings were transplanted to earthenware pots (30 cm in diameter), which was filled with 10 Kg clay loamy soil having pH 7.3, E.C.0.6 ds m^{-1},$CaCo_3$ 1.5% , total N 552 mg Kg^{-1} , available P(P_5O_3) 88 mg Kg^{-1}, available K(K_2O) 265 mg Kg^{-1} and available Mg 2503 mg Kg^{-1}. DTPA extractable Fe, Mn, Zn and Cu were 22.2, 39, 2.1 and 2.6 mg Kg^{-1}, respectively. Mineral fertilizers (NPK) as ammonium nitrate (33.5%) , calcium super phosphate (15% $P_2 O_2$) and potassium sulphate (48% K_2O) were applied at two rates($N_{100}P_{100}$ K_{50} and $N_{200}P_{200}$ K_{100} Kg / Fed. (where Feddan = 4200 m^2) which was divided into two equal parts , the 1st part was added one month after transplanting and the 2nd one after two weeks from the 1st one. Two organic manures were used, compost tea which obtained from Sekam Company (Egypt) which was applied at three levels (100,200,300 m/L) and Humic acid (Humic Total, Soluble Potassium Humat) employed at (0.02%, 0.04% and 0.06%) which obtained from LEJLS Agrochemistry Co.LTD (Origin China).The two organic manures were sprayed two times, the 1st 45 days after plantation and the 2nd one month later. Chemical analysis of used compost tea and humic acid are presented in Tables (1 and 2).

Table 1: The physico-chemical properties and microbial population of organic compost tea

Bacterial Plate Count (CFU/ml)	7.1 X 10^7	EC ds/m	0.923
Bacterial Direct Count (Cell/ml)	6.4 X 10^8	PH	6.56
Spore Forming Bacteria (CFU/ml)	7 X 10^4	Mineral nitrogen ppm	249
		Available phosphorus ppm	7.3
Total Fungi (CFU/ml)	2.8 X 10^5	Available potassium ppm	201
		Ca ppm	88
		Mg ppm	115
		Fe ppm	66
		Zn ppm	7.33

Table 2: Humic Total Analysis

Guaranteed Analysis	
Humic acid	80%
Potassium (K_2O)	10-12%
Zn, Fe, Mn, etc.	100 ppm
Physical Data	
Appearance	Black powder
PH	9 – 10
Water solubility	> 98%

The experimental design was completely randomized, consisting nine groups (each of 20 pots) with three replicates including the following treatments:

1- Control (without fertilizers)
2- $N_{100}P_{100}$ K_{50} (100 Kg ammonium nitrate + 100 Kg super phosphate + 50 Kg potassium sulphate / Fed.), it means 5g / pot
3- $N_{200}P_{200}$ K_{100} (200 Kg ammonium nitrate + 200 Kg super phosphate + 100 Kg potassium sulphate / Fed.) it means 10g / pot
4- Humic acid (HA_1) at 0.02%
5- Humic acid (HA_2) at 0.04%
6- Humic acid (HA_3) at 0.06%
7- Compost tea 100 ml/L
8- Compost tea 200 ml/L
9- Compost tea 300 ml/L

All agriculture practices were done according to plant needs. Plants were harvested on 5 and 10 February in 1st and 2nd season respectively. The vegetative data were recorded including:

- Number of leaves /plant
- Fresh and dry weights of leaves and roots (g/plant)
- Root length (cm)

On the other hand, the chemical analysis for different organs of Brassica *rapa* plants was carried out to determine:

1- Total carbohydrates content (%) for leaves using spectrophotometrically according to Dubois *et al* (1956).

2- Minerals content in leaves, including total nitrogen using the modified micro Kjeldahl methods as Jackson (1973), phosphorus and potassium (%) according to Chapman and Pratt (1978) and Cottonie *et al* (1982) respectively.

3- Total lipids were determined in *Brassica rapa* seeds according to the A.O.A.C. method (1970). The methyl esters of fatty acids were prepared using benzene: methanol: concentrated sulphuric acid (10: 86: 4) and methylation was carried out for one hour at 80 – 90°C according to Stahl (1967).The methyl esters prepared from oil samples and standard materials were analyzed by a Pye Unicum gas chromatograph equipped with a dual flame ionization detector. The separation of fatty acid methyl esters was conducted with a column: SP-2310, 55 % cyanopropyl phenyl silicon (1.5 x 4.0 mm). Column was used with temperatures program of 70° to 190°C at 8°C / min. The injector and detector temperatures were maintained at 250° and 300°C, respectively. The pressure of carrier gas (nitrogen) was 18 kg / cm^2, chart speed 0.35 cm / min. The relative percent of each compound was determined according to the peak area by Varian 4370 integrator. The identification of the different fatty acids was known by matching their retention times (RT) with those the authentic samples under the same conditions.

Statistical analysis: the obtained data (the means of two growing seasons) were statistically analyzed for two successive seasons using Duncan test according to the procedure outlined by Snedecor and Cochran (1980).

Results and Discussion

A) Growth characters:

The growth characters of turnip plants as affected by different kinds and levels of fertilization are shown in Table (3). Regarding leaves number, it could be easily noticed that all the used mineral or organic fertilizers had the capacity to increase leaves numbers significantly with one exception with medium compost tea level comparing with control. The chemical fertilizer (NPK) at high level ($N_{200}P_{200}$ K_{100}) exhibited the most promising effect followed by medium humic acid level (HA_2) where the increment values over the control reached 72% and 48% respectively.

Fresh and dry weights of leaves were significantly increased in turnip plants due to utilization of both chemical and organic fertilization. The maximum increment for fresh and dry weights of leaves were recorded with medium humic acid level (HA_2) which reached to 201.8% and 275%over the control treatment , followed by the highest mineral fertilizers ($N_{200}P_{200}$ K_{100}) and medium humic acid level for fresh and dry weight of leaves ,respectively. Meanwhile, the variation in means values of fresh weight for plants treated with chemical and organic fertilizers was significantly, while the opposite was true for dry weight of turnip plants. The roots characters of turnip plants were improved significantly by applying the various levels of chemical or organic fertilizers. The maximum mean values of root length (cm), fresh and dry weight were obtained as a result of the highest chemical fertilizers level ($N_{200}P_{200}$ K_{100}), where the increment values over the control reached to 109.6%, 355.7% and 106.8%, respectively.

Based on the previous finding, one can conclude that the second level of NPK or humic acid was sufficient to obtain the highest growth parameters or biomass represented by leaves and roots, but it can recommended humic acid as an organic fertilizer for producing organic products.

The improvement effects of chemical fertilizer on growth characters can be rendered to the important role of nitrogen in increasing activity of growing apex via increasing cell formation and elongation, as it's needed in the protoplasm formation, in addition to the important role of phosphor and potassium in vital processes of plants. However, several authors recorded the promotion role of chemical fertilizers (NPK) such as Salama *et al* (2003) on *Verbascum Thapsus*, Salem and Awad (2005) on coriander, Kavitha and Vadivel (2006) on *Mucuma pruriens*.

The beneficial stimulation effect of humic acid on growth characters of turnip plants may be explained by several hypotheses, including the formation of complex between HA and mineral ions, catalysis of HA to enzymes in plant, influence of HA on respiration and photosynthesis, stimulation of nucleic acid metabolism and hormone activity (Schmidt, 1990). In this respect Tan and Nopamornbodi (1979) indicated that humic acid was in general beneficial to shoot and roots growth of corn plants. Albayrak and Camas (2005) revealed that the highest root and dry matter yield were obtained from the 1200 ml^- ha^{-1} humic acid level for turnip (*Brassica rapa L.*). Furthermore, the promotion effect of compost tea on growth characters of turnip plants was due to its higher nutritional value in addition to its capacity to improve the hydro-physical properties of the soil.

Table 3: Vegetative growth characters of *Brassica rapa* as affected by minerals and organic fertilizers (Mean values of two successive seasons)

Treatments	Number of leaves/ plant	Fresh Wt. of leaves (g/plant)	Dry Wt. of leaves (g/plant)	Length of roots (cm)	Fresh Wt. of Roots (g/plant)	Dry Wt. of Roots (g/plant)
Control	10.0[a]	38.2[a]	1.6[a]	10.4[a]	25.3[a]	2.9[a]
NPK_1	12.6[bcd]	74.1[d]	4.9[bc]	15.4[b]	53.9[c]	3.3[ab]
NPK_2	17.2[f]	106.4[f]	6.0[c]	21.8[d]	115.3[h]	6.0[c]
$Humic_1$	11.6[bc]	87.5[e]	4.2[b]	19.4[c]	90.3[f]	4.5[b]
$Humic_2$	14.8[e]	115.3[g]	5.7[bc]	21.5[d]	93.6[g]	4.6[bc]
$Humic_3$	14.2[de]	86.2[e]	4.6[bc]	19.2[c]	76.2[e]	4.4[ab]
Compost tea $_1$	13.0[cd]	75.2[d]	4.4[bc]	18.2[c]	55.4[c]	3.2[ab]
Compost tea $_2$	11.3[ab]	67.7[c]	401[b]	15.8[b]	61.1[d]	4.0[ab]
Compost tea $_3$	13.5[de]	65.7[b]	4.4[bc]	16.3[b]	31.0[b]	3.2[ab]

NPK1 = $N_{100}P_{100}K_{50}$, NPK2= $N_{200}P_{200}K_{100}$, Humic 1 = 0.02, Humic 2 = 0.04 , Humic 3 = 0.06
Compost tea 1= 100ml/L. , Compost tea 2= 200ml/L. Compost tea 3= 300ml/L.

B) Nutrient Content:

Data presented in Table (4) revealed that fertilizers treatments had no clear trend for their effects on macronutrients (N, P, K and Ca). In this respect, it can be noticed that compost tea treatments had a pronounced effect comparing with other treatments. The maximum mean values of N, K and Ca (%) were obtained as a result of the third level of compost while the 1st level of compost tea gave the maximum mean value of P (%). On the other hand, different fertilizers treatments increased micronutrients content comparing with control. The maximum mean values of Fe, Mn and Zn ppm were obtained as a result of the 3rd level of compost tea while the 1st level of compost gave the highest mean value of Cu. In this respect, Khalil and El-Sherbeny (2003) on three *Mentha sp* found that the highest compost level resulted in maximum micro and macronutrients content except Zn content. Also, Khalil *et al*. (2006) concluded that the content of P of Ocimum *basilicum* plants significantly increased by either increasing static compost or tea of static compost ($10m^3$ to $20m^3$ /Fed.) while N content significantly.

Table 4: Nutrient content of *Brassica rapa* as affected by minerals and organic fertilizers (Mean values of two successive seasons)

Treatments	%				ppm			
	N	P	K	Ca	Fe	Mn	Zn	Cu
Control	1.94 0	0.102	7.363	3.65	2540	92	105	95
NPK_1	1.80 0	0.084	8.788	4.375	2860	115	130	125
NPK_2	1.95 0	0.090	8.450	4.231	2850	95	125	110
$Humic_1$	1.90 5	0.096	7.864	4.155	2846	94	120	125
$Humic_2$	1.90 0	0.076	8.313	4.250	2720	95	140	130
$Humic_3$	2.00 0	0.112	7.363	3.875	3095	115	115	110
Compost tea $_1$	2.06 0	0.114	8.124	4.365	2917	117	125	140
Compost tea $_2$	2.10 0	0.110	8.075	4.750	2940	115	135	105
Compost tea $_3$	2.50 0	0.085	8.650	4.780	3140	120	145	135

NPK1 = $N_{100}P_{100}K_{50}$, NPK2= $N_{200}P_{200}K_{100}$, Humic 1 = 0.02, Humic 2 = 0.04 , Humic 3 = 0.06
Compost tea 1= 100ml/L. , Compost tea 2= 200ml/L. Compost tea 3= 300ml/L.

C) Total Carbohydrate Content (%):

Data presented in Table (5) illustrated that the two levels of NPK fertilizers caused inhibition in the total carbohydrate accumulation which reached to 2.98 % and 6.56 % for the 1st and 2nd levels, respectively comparing with control treatment. In contrast the application of various humic acid levels produced a promotion effect in the accumulation of total carbohydrate percentage. Moreover, the highest humic acid level caused the maximum significant level for total carbohydrate content which reached to 29.02% in corresponding to 27.11% for control, while the two other levels gave 27.33% and 27.50% for the 1st and 2nd level respectively.

Similarly, applied various levels of compost tea improve the percentage of total carbohydrate content in turnip seeds (Table5). The highest significant accumulation was recorded with medium level of compost tea which produced an increment over the control reached to 8.19%, while the minimum increment was observed by applying low level comparing with other levels of tea compost which recorded 4.9 % over the control.

Tracing the literature nothing was found concerning the effect of NPK fertilizer on total carbohydrate content for turnip seeds. However,Ahmed *et al*., (1994) working on *Lupinus termis*, found that the maximum carbohydrate content of seeds were obtained as a result of the highest level of NP. On the other hand, the pronounced increment of total carbohydrate percentage with applied various compost tea levels was observed. This increment may be explained by the promising role of compost to supply the growing plants with required micro and macro nutrients which play important role in metabolic process as photosynthesis, respiration and carbohydrate synthesis. In this regard, many researchers obtained similar stimulative effect such as Khalil and El-Sherbeny (2003) on three *Mentha sp*, El-Sherbeny *et al*. (2005) and abd El-Razek (2007) on *Sideretes montana.*

D) Total Lipids Content (%):

The total lipids percentage in turnip seeds induced no significant decreased with applied two levels of NPK fertilizer Table (5). This decrement on accumulation reached to 2.7 % and 4.4 % for the 1st and 2nd level respectively,comparing with control treatment. In this respect, Al-Barrok (2006), Brennan and Bolland (2007) indicated that application of nitrogen always decreased the concentration of seed oil of *Brassica napus L.* Similarly, Li-Zhi Yu *et al*. (2005) added that application of N, P or NP decreased the oil seeds of canola hybrid Zhongyouza.

On the other hand, humic acid caused a remarkable increment in total lipids especially with applied the highest level, followed by medium level while the low level caused the reverse trend. However, the increment caused by medium and highest levels reached to 6.7% and 12.1%, respectively above the control.

Concerning of fertilization with various levels of compost tea, the data tabulated in Table (5) revealed that the three levels caused marked and significant accumulation for total lipids (%) of turnip seeds. The highest percentage was produced with low level which gave 13.5 over the control followed by the 3rd and 2nd levels which account about 12.61% and 11.86 % above the control respectively. So, it can be concluded that the 1st level of compost tea gave the maximum mean value of total lipids comparing with other treatments and control. On this regard, Khalil (2006) working on *Plantago afra* revealed that applied compost fertilizer caused insignificant effect on total lipids content (%) while total lipids /plant and Kg/Fed. increased significantly.

Table 5: Total lipids (%) and total carbohydrate (%) in seeds of Brassica *rapa* as affected by minerals and organic fertilizers (Mean values of two successive seasons)

Treatments	Total carbohydrate (%)	Total lipids (%)
Control	27.11^{bc}	22.59^{b}
NPK_1	26.30^{ab}	21.98^{b}
NPK_2	25.33^{a}	21.63^{b}
$Humic_1$	27.33^{bc}	20.01^{a}
$Humic_2$	27.50^{bc}	24.11^{c}
$Humic_3$	29.02^{d}	25.32^{cd}
Compost tea $_1$	28.44^{cd}	25.64^{d}
Compost tea $_2$	29.33^{d}	25.27^{cd}
Compost tea $_3$	29.00^{d}	25.44^{cd}

NPK1 = $N_{100}P_{100}K_{50}$, NPK2= $N_{200}P_{200}K_{100}$, Humic 1 = 0.02, Humic 2 = 0.04, Humic 3 = 0.06
Compost tea 1= 100ml/L., Compost tea 2= 200ml/L. Compost tea 3= 300ml/L.

E) The relative percentages of fatty acids:

The relative percentages of fatty acids extracted from *Brassica rapa* seeds treated with different levels of fertilizers (NPK, Humic acid and Compost tea) are presented in Table (6). Four saturated fatty acids and five unsaturated ones were markedly identified and grouped into three classes, i.e., major fatty acids (more than 10 %), minor fatty acids (less than 10 %) and traces one (less than 1 %) were identified.

Accordingly, in most treatments the major saturated fatty acids were Stearic acid ($C_{18:0}$) (Ranged from 10.98 % in low level of compost tea 1 treatment to 28.08% in the seed oil of plants treated with the highest level of humic acid, except in plants treated with NPK levels and the first level of humic acid that recorded minor values. On the contrary, Arachidic acid ($C_{20:0}$) was found as a major constituent (10.15%) in the seeds of plants treated with Humic 2 treatment, while it was found as minor in the seeds of plants of the other treatments. Myrstic acid($C_{14:0}$) were detected as minor constituents in most treatments except in the seed oils of plants treated with humic 3, compost tea 1 and compost tea 2 that recorded as trace fatty acid, while it was completely disappeared in the seeds of plants of control and compost tea 3 treatments. While, Palmitic ($C_{16:0}$) was present in all treatments as minor component nearly equal amounts, it ranged from 2.94 % to 5.46%.

In all treatments Gadoleic acid ($C_{20:1}$) unsaturated fatty acid were found as major components (ranged from 19.55% in NPK 1 treatment to 43.95 % in the seed oil of plants treated with Compost tea 2. while, Oleic acid

($C_{18:1}$) was found as a minor constituent in the seeds of all treatments (ranged from 1.08% in Humic 3 treatment to 2.84% in compost tea 2 treatment), Linolenic acid ($C_{18:3}$) was found as a minor constituent in all treatments except in control plant that recorded as trace fatty acid (0.74%). Linoleic acid ($C_{18:2}$) were found to be minor in most treatments except in plants treated with Humic 3, compost tea 1, Compost tea 2 and control in which it was found as trace component. On the other hand, Erucic acid ($C_{22:1}$) were detected as minor fatty acid in NPK 1, Compost 1, compost 2 and control treatments, Whereas it was found as trace one in NPK 2, Humic 1, Humic 3 and compost 3 treatments, while it was not found in the seeds of plants of Humic 2 treatments.

Data in Table (6) also indicate that application of compost tea at 2, 1 and 3 levels caused the highest values of total unsaturated fatty acids (59.39, 55.98 and 49.04%, respectively) compared with untreated plants (45.05). While application of NPK 1 produced the lowest value (25.77%). On the other hand, the highest values of total saturated fatty acids (41.46%) was observed in plants treated with the high level of Humic acid, while the lowest values of saturated fatty acids (17.54 and 17.58%) were resulted from treatments of Humic 1 and compost 1, respectively.

Application of Humic acid at high level resulted in the lowest total unsaturated / total saturated ratio of fatty acids (1.01), while Compost tea 1 (3.18) caused the highest increases in total unsaturated/total saturated fatty acids ratio compared to control (1.24).

Table 6: The relative percentages of fatty acids as affected by minerals and organic fertilizers

Treatment	Control	NPK 1	NPK 2	Humic 1	Humic 2	Humic 3	Compost Tea 1	Compost Tea 2	Compost tea 3
C14:0	0	1.82	1.04	1.4	3.24	0.11	0.06	0.04	0
C16:0	3.04	2.94	3.83	3.95	5.05	4.88	4.21	4.5	5.46
C18:0	26.3	8.16	7.71	7.25	12.59	28.08	10.98	14.34	22.44
C18:1	2.29	1.46	2.36	2.82	1.23	1.08	2.8	2.84	3.49
C18:2	0.67	1.66	1.4	1.32	1.15	0.86	0.85	0.45	5.29
C18:3	0.74	1.68	1.29	1.26	1.39	1.47	6.5	7.9	1.1
C20:0	6.91	6.71	9.14	4.94	10.15	8.39	2.33	8.52	6.88
C20:1	40.31	19.55	25.5	25.35	33.39	37.74	42.22	43.95	38.15
C22:1	1.04	1.42	0.27	0.33	0	0.54	3.61	4.25	0.99
Total. S.F.	36.25	19.63	21.72	17.54	31.03	41.46	17.58	27.4	34.78
Total. Uns.F.	45.05	25.77	30.82	31.08	37.16	41.69	55.98	59.39	49.02
T.Uns./T.S	1.24	1.31	1.42	1.77	1.20	1.01	3.18	2.17	1.41

NPK1 = $N_{100}P_{100}K_{50}$, NPK2= $N_{200}P_{200}K_{100}$, Humic 1 = 0.02, Humic 2 = 0.04, Humic 3 = 0.06
Compost tea 1= 100ml/L., Compost tea 2= 200ml/L. Compost tea 3= 300ml/L.

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