Effect of NPK –fertilizers and humic acid applications on yield and quality of canola plant (*Brassica napus* L) grown in sandy soil

Yasser, M. Eledfawy

Soil, Water and Environment Research Institute, Agric., Res. Center, Giza, Egypt
Email: Yasser_eledfawy@yahoo.com

Abstract: Two field experiment were carried out at Ismailia agriculture research station. Egypt during the two successive winter seasons of 2013/2014 and 2014/2015 to investigate the effect of NPK- fertilizers rates (50, 75 and 100% of the recommended dose and humic acid at rates of 24kg/ha as soil application and 50mg/L as foliar spraying on growth, yield and quality of canola plant (*Brassica napus L.* serw 4) grown in sandy soil. The experiment were conducted at as factorial format based on randomized complete block design. The obtained results could be concluded that, all growth and yield characters as well as seed quality and chemical composition of canola plant were significantly increased by increasing NPK-fertilizers from 50 up to 100 % of the recommended dose. Also application of 100% NPK recorded the highest values in all characters under study. Foliar spraying followed by soil applications of humic acid led to significant increases in the mean values of plant height, dry weight, No. of pods/plant, No. of branches as well as seed and straw yields than the control. The results clearly demonstrate that the interaction effect between the different levels of NPK-fertilizers and humic acid application resulted in a significant effect in all growth and yield characters as well as seed quality of canola plant. Plants received 100% or 75 % NPK along with foliar spraying or soil application of humic acid produced higher plant height, yield and its components, NPK contents and their uptake than those received 50 % NPK-fertilizers in all cases. Also it can be concluded that 75 % of NPK –fertilizers with foliar application at 50 mg/L could recommended for optimum yield production of canola plant, thus it can be saved 25 % NPK- fertilizers and consequently reduce cost and environmental pollution.
[Yasser, M. Eledfawy. **Effect of NPK –fertilizers and humic acid applications on yield and quality of canola plant (*Brassica napus* L) grown in sandy soil.** *Nat Sci* 2017;15(12):205-211]. ISSN 1545-0740 (print); ISSN 2375-7167 (online). http://www.sciencepub.net/nature. 21. doi:10.7537/marsnsj151217.21.

Keywords: canola plant, humic acid, NPK fertilizers, sandy soil

1. Introduction

Humic substances are generated through matter decomposition and employed as soil fertilizers in order to improve soil structure and soil micro-organisms. Foliar spray of humic acid also promote growth, and increases yield and quality in a number of plant species **(Brownell *et al.*, 1987)**. Likewise, humicsubstances have been shown to stimulate shoot and root growth and nutrient uptake of vegetable crops **(Tattini *et al.,* 1990 and Padem *et al.,* 1997).** Humic acid is a commercial product contains many elements which improved the soil fertility and increase the availability of nutrients and consequently increase plant growth and yield. **(Erik *et al.,* 2000) and Hafez (2003)** reported that humic acid application led to significant increase in soil organic matter which is improves plant growth and crop production.

Mineral fertilizers application is essential for plant growth, development and yield productivity. Nitrogen is essential for synthesis of chlorophyll, enzymes and proteins. Phosphorus is essential for root growth, phosphoproteins, phospholipids and ADP and ATP formation. Potassium plays an important on promotion of enzymes activity and enhancing the translocation of assimilates and protein synthesis **(Saxena *et al.,* 2003 and Souza *et al.,* 2008). EL-Bassiony *et al.* (2010)** reported that spraying snap bean plants by humic acid significantly increased plant growth, yield and yield components (number of pods/plant, pods weight and protein content). **Magdy *et al.* (2011)** showed that combination of chemical fertilizer with application of humic substances improve growth and yield of cowpea. **Seadh *et al.* (2012)** studied that the interaction between NPK rates and humic acid application had a significant effect LAI, total dry weight/plant and all growth characters of Egyptian cotton. **Ibrahim *et al.* (2013)** noted that the interaction effect of soil application or foliar spraying of humic acid in combination with mineral fertilizers significantly increase all growth and yield characters of eggplant (*Solanummel ongena L.*). **Ali *et al.* (2015)** reported that all the vegetative and reproductive attributes significantly influenced by the addition of humic acid and different levels of NPK fertilizers on tulipagesneriana in Faisalabad, Pakistan.

The current study aim to investigate the interaction effect between different rates of NPK fertilizers with the application of humic acid in both forms of soil and foliar sprayingon growth, yield and quality of canola plant (*Brassica napus L.*).

2. Material and Methods

Two field experiments were conducted in sandy soil at Ismailia Agriculture Research station, Egypt during the two successive winter seasons of 2013/2014 and 2014/2015 to study the effect of NPK fertilizers in combinations with applications of humic acid as soil and foliar spraying on growth, yield and quality of canola plant (*Brassica napus L.*) serw 4. The field experiment were conducted in factorial format based on a randomized complete block design (RCBD) with three replications.

The factors of the experiment included, (1) four levels of NPK fertilizers 0 (control), 50 %, 75% and 100 %of the recommended dose as 240 kg N ha^{-1}, 13kg P ha^{-1} and 45.8 kg K ha^{-1}. (2) three levels of humic acid: $H.A_0$ control, $H.A_1$ soil application at rate of 24 kg $ha^{-1}$and $H.A_2$ foliar spray at rate of 50 mg/L.

Nitrogen fertilizer was added as ammonium nitrate (0.34kg N kg^{-1}) in two equal splits in the first one half after thinning and the second one at flowering stage. Phosphorus was applied in the form of super phosphate (0.068 kg P kg^{-1}) during the final stage of land preparation for planting and potassium was added in the form of potassium sulphate (0.398 kg K kg^{-1}) in two equal doses before planting and after 30 days from sowing.

Table 1. Some physical and chemical properties of the studied soil.

Particle size distribution (%)				Texture class	Calcium carbonate (%)	Organic matter %)
Coarse sand	Fine sand	Silt	Clay			
75.4	11.1	6.3	7.2	Sand	0.23	0.39
pH (1:2.5 soil water suspension)	EC (dSm^{-1})	CEC ($cmol_c$/kg soil)	Soluble cations ($cmol_c$/kg soil)			
			Ca^{++}	Mg^{++}	Na^{+}	K^{+}
7.32	0.49	3.12	1.3	1.95	1.4	0.25
Soluble anions ($cmol_c$/kg soil)				Available macronutrient (mg/kg soil)		
$CO3^{-}$	$HCO3^{-}$	Cl^{-}	$SO4^{-}$	N	P	K
0	2.38	1.49	1.03	19.32	7.87	48.15

Soil application of humic24 kg h^{-1} were also applied along with the basal dose of inorganic fertilizers while, foliar spray of humic acid at a rate of 50 mg/L was done on 30^{th}, 50^{th} and 70^{th} days after planting.

The experimental unit area was 10.5 m^2 with dimensions 3 x 3.5 m, each plot included 4 ridges (3.5 m in length and 30 cm in width). The soil of the experimental field was sandy soil and the physical and chemical analysis were presented in Table 1. Soil particle distribution was carried out by the pipette method as described by **Klute et al. (1982).** Total carbonate content (%) was determined volumetrically using Collin's calcimeter **(Page *et al*. 1982).** Organic matter was determined by the chromic acid method of **Walkely and Black**as **Jackson (1973).** Soil reaction (soil pH) values were measured in 1:2.5 soil water suspension using pH meter **(Page et al. 1982).** Electrical conductivity (EC) was determined in soil paste as **Page *et al.* (1982).** Available nitrogen was determined using KCl extract (1-10 soil: suspension) by using of Kjeldah procedure according **Page et al. (1982).** Available phosphorus extracted by (0.5 N) $NaHCO_3$ solution as described by **Olsen *et al*., (1954)** by using of molybdate and stannous chloride according **Page *et al.* (1982).** Available potassium was extracted by ammonium acetate (**Page *et al.*, 1982).**

Harvesting was carried out after about 170 day after planting. The plants were dried under sunshine for one week. Therefore, the pods trashed and seed were cleaned after separation from pods and seeds, straw yield as well yield components. Samples of plants at harvesting as well as seeds and straw were oven dried and kept for analysis. NPK contents in samples was determined according to **Page *et al.* (1982).** Protein content in seeds was calculated through multiplying nitrogen content by 6.25, while seed protein yield was estimated by multiplying seed yield (kg) by protein percentage. Oil content of seed was determined using Soxclet apparatus according to **A.O.A.C. (1990)** the statistical analysis of the obtained data was performed according to **Senedecor and Cochran (1980)**, and the treatments means were compared using LSD at 0.05 level of probability.

3. Results and Discussions

3.1. Growth characters

Data in Table 2 show the effect of NPK fertilizers in combination with humic acid applications on growth characters of canola plants i.e. plant height and dry weight /plant as well as number of branch/plant. Results clear that all growth characters of canola plant were affected positively insignificant trend by NPK application from 0up to 100 % of the recommended dose. Using NPK – application at 100 % of the recommended dose gave the highest mean values in plant growth characters of canola plant as compared with unfertilized treatment (control). The increment values were 54.05, 71.2 and 63.14 % for plant height, dry weight and number of branch/plant respectively over the control treatment. This discussed trend may be due to the nitrogen role in the stimulation of various physiological processes including cell division and cell elongation resulting in more photosynthetic area, which resulted in more photosynthetic production and consequently increased dry matter accumulation. Also phosphorus is essential for root growth, phosphor-proteins, phospho-lipids and ATP formation and also potassium plays an important role in promotion of assimilates and protein synthesis. These results are in harmony with those reported by **(Malhi 2007; Souze et al., 2008; Singer et al., 2000 and Hussien 2000)** who reported that mineral fertilizer significantly increase vegetative growth characters of plant.

Also in the same Table 2, data indicate that all growth characters generally, were affected significantly, in increasing trend by soil or by foliar application of humic acid compared with the control. In addition, there were significant difference between soil and foliar application in all cases. The highest mean values of growth characters were achieved by spraying canola plants by humic acid at 50mg/L followed by soil application at 24 kg/ha. However, the lowest mean values were recorded without humic application (control). Thistrend may be due to that humic acid contains many elements which improve the plant growth. These results are in accordance with those obtained by **(David 1991; Emara and Hamada 2012 and El-Bassiony et al. 2010)** who showed that the vegetative growth characters were improved by using of humic acid spraying.

Table 2. Effect of different rates of NPK fertilizers and humic acid applications on plant growth characters of canola plant.

NPK treatments	Humic acid application											
	$H.A_0$	$H.A_{soil}$	$H.A_{foliar}$	Mean	$H.A_0$	$H.A_{soil}$	$H.A_{foliar}$	Mean	$H.A_0$	$H.A_{soil}$	$H.A_{foliar}$	Mean
	Plant height (cm)				Dry weight g/plant				No. of branch/plant			
NPK_0	112.72	117.24	121.46	117.14	98.10	103.20	108.12	103.14	10.90	11.50	13.10	11.83
$NPK_{50\%}$	148.31	156.83	160.15	155.10	122.63	128.65	131.37	127.55	12.94	14.28	15.06	14.09
$NPK_{75\%}$	176.72	178.93	180.86	178.84	170.34	176.55	178.92	175.44	16.91	18.52	20.14	18.52
$NPK_{100\%}$	179.26	180.68	181.44	180.46	172.43	177.05	180.80	176.59	18.33	19.15	20.42	19.30
Mean	154.25	158.42	160.98	157.88	134.66	139.77	142.55	138.99	14.07	15.25	16.44	15.25
L.S.D$_{0.05}$	***NPK= 1.91, H.A=6.87, NPK*H.A= 2.61***				***NPK= 1.17, H.A=9.96, NPK*H.A= 2.05***				***NPK= 1.03, H.A=1.45, NPK*H.A= 2.59***			

NPK_0, NPK_{50}, NPK_{75}, NPK_{100}: 0, 50, 75 and 100 % from recommended dose. $H.A_0$, $H.A_{soil}$, $H.A_{foliar}$: without, soil and foliar humic acid applications

Table 3. Effect of different rates of NPK fertilizers and humic acid applications on yield and yield components of canola plant.

NPK treatments	Humic acid application															
	$H.A_0$	$H.A_{soil}$	$H.A_{foliar}$	Mean	$H.A_0$	$H.A_{soil}$	$H.A_{foliar}$	Mean	$H.A_0$	$H.A_{soil}$	$H.A_{foliar}$	Mean	$H.A_0$	$H.A_{soil}$	$H.A_{foliar}$	Mean
	No. of pods/plant				1000 seed weight (g)				Seed yield kgha^{-1}				Straw yield kg/ha			
NPK_0	174.42	202.54	224.83	200.60	1.90	1.96	2.05	1.97	769.22	786.31	806.02	787.18	979.75	998.04	1013.09	996.96
$NPK_{50\%}$	323.33	331.62	338.81	331.25	2.45	2.51	2.60	2.52	1172.04	1195.97	1217.06	1195.02	1385.90	1404.17	1435.99	1408.69
$NPK_{75\%}$	348.40	355.34	361.91	355.22	3.72	3.80	3.88	3.80	1305.26	1335.29	1355.04	1331.86	1586.71	1628.52	1655.66	1623.63
$NPK_{100\%}$	355.34	366.51	370.35	364.07	3.77	3.84	3.91	3.84	1349.57	1371.38	1381.99	1367.65	1659.53	1677.48	1690.37	1675.79
Mean	300.37	314.00	323.98	312.78	2.91	2.98	3.06	2.98	1149.02	1172.24	1190.03	1170.43	1402.97	1427.05	1448.78	1426.27
L.S.D$_{0.05}$	***NPK=10.12, H.A=26.96, NPK*H.A= 12.76***				***NPK= 0.05, H.A=0.17, NPK*H.A= 0.06***				***NPK=31.03, H.A=42.26, NPK*H.A=37.81***				***NPK=, 33.18 H.A=48.86, NPK*H.A= 49.48***			

NPK_0, NPK_{50}, NPK_{75}, NPK_{100}: 0, 50, 75 and 100 % from recommended dose. $H.A_0$, $H.A_{soil}$, $H.A_{foliar}$: without, soil and foliar humic acid applications.

Table 4. Effect of different rates of NPK fertilizers and humic acid applications on seed quality of canola plant.

NPK treatments	Humic acid application															
	$H.A_0$	$H.A_{soil}$	$H.A_{foliar}$	Mean	$H.A_0$	$H.A_{soil}$	$H.A_{foliar}$	Mean	$H.A_0$	$H.A_{soil}$	$H.A_{foliar}$	Mean	$H.A_0$	$H.A_{soil}$	$H.A_{foliar}$	Mean
	Oil (%)				Oil yield (kg/ha)				Protein (%)				Protein yield (kg/ha)			
NPK_0	42.33	45.63	44.60	44.19	325.61	358.79	359.48	347.96	12.41	12.62	12.83	12.62	94.46	99.23	103.51	98.94
$NPK_{50\%}$	46.00	46.60	46.70	46.43	539.14	557.32	568.37	554.94	15.64	15.85	16.02	15.84	183.31	189.56	192.53	188.34
$NPK_{75\%}$	46.10	46.00	46.30	46.13	601.73	614.23	627.38	614.45	19.83	19.58	19.71	19.71	258.83	261.45	267.48	259.99
$NPK_{100\%}$	45.20	45.30	45.50	45.33	610.00	621.24	628.81	620.02	22.29	22.37	22.47	22.38	300.82	306.78	310.53	305.15
Mean	44.91	45.88	45.78	45.52	519.12	537.90	546.01	534.34	17.54	17.61	17.76	17.64	209.61	214.26	219.00	214.29
L.S.D$_{0.05}$	***NPK= 0.91, H.A=1.24, NPK*H.A= 1.06***				***NPK=6.91, H.A=21.07, NPK*H.A=2.88***				***NPK= 2.76, H.A=0.18, NPK*H.A=2.89***				***NPK= 39.15, H.A=14.29, NPK*H.A= 46.79***			

NPK_0, NPK_{50}, NPK_{75}, NPK_{100}: 0, 50, 75 and 100 % from recommended dose. $H.A_0$, $H.A_{soil}$, $H.A_{foliar}$: without, soil and foliar humic acid applications

Regarding to the interaction effect between NPK-fertilizers with soil or foliar application of humic acid on plant growth characters of canola plant, results in Table 2showed a significant and positive effect in all plant growth characters with plants received 100 % of recommended dose of NPK-fertilizers with foliar application of humic acid. The percentages were 60.9, 84.3 and 87.3 % for plant height, dry weight and No. of branches/plant respectively as compared with the control treatment. In addition results clear that the combined treatment of NPK-fertilizers at 75 % of the recommended dose with humic acid soil or with foliar application in all the studied plant growth characters gave values similar to or better than the treatment received full dose (100 % NPK) with humic acid soil or with foliar application with non-significant effect.

These results are in harmony with those obtained by **Magdy *et al.* (2011)** and **Ibrahim *et al.* (2013).**

Yield and yield components

Results in Table 3show the effects of different doses of NPK-fertilizers on yield and yield components of canola plant, the results revealed that number of pods/plant, 1000-seed weight, seed and straw yields were significantly responded to increasing application of NPK-soil fertilizers from 0 up to 100 % of the recommended dose. It looks to be true that the application of 100 % of the recommended dose of NPK-fertilizers being much more effective and gave higher values in all yield characters of canola plant. The increment values were 81.49, 94.9, 73.7 and 68.08 % for No. of pods/plant, 1000-seed weight, seed and straw yield, respectively over the control. These increases in yield and yield components may be attributed to that the mineral NPK-fertilizers increased physiological activities which enhanced growth and leading to better yield. Similar results were reported by **Seadh *et al.* (2012) and Ali *et al.* (2015).**

With respect to the effect of humic acid applications on yield and yield components of canola plant, results obtained in Table 3 show that the foliar H.A application at 50 mg/L and soil HA application at 24 kg/ha gave significant increase in No. of pods/plant, 1000 seed weight, seed and straw yields compared with control. The highest seed and straw yields were obtained by using of 50mg/L foliar spraying of humic acid followed by the soil application of humic at 24 kg/ha. The increment values were 3.56 and 2.02 %, 3.27 and 1.72% for seed and straw yields in foliar and soil applications of humic acid respectively compared to the control treatments. The results could be due to the reported enhancement in the growth of canola to the incorporation of HA into plant growth media. These are in complete harmony with recorded by **(Serenella *et al.,* 2002; Halime *et al.,* 2011 and Ibrahim *et al.,* 2013).**

Concerning the interaction effects between foliar and soil applications of humic acid and NPK-fertilizers treatments on yield and yield components of canola plant results in the same Table 3 indicate that NPK-fertilizers at 100 % of the recommended dose as combined with humic acid foliar spraying or soil application revealed a significant increases in all yield characters and yield components of canola plant comparing with control treatment. It's clear that the highest values of yield characters were detected at the combined treatment of NPK-fertilizers at 100 % of the recommended dose with foliar spraying of humic acid. These values were increased than control with 79.66 and 72.53 % for seed and straw yield of canola plant respectively. Moreover, application of NPK-fertilizers at 75 % of the recommended dose with foliar spraying of humic acid recorded values of yield and yield component, mostly, nearest from the values under NPK-fertilizers at 100 % of the recommended dose alone. This stimulatory effect may have also been related to increased uptake of mineral nutrients by plant and consequently improve the growth and yield for canola plant. In addition there was non-significant difference between the two treatments of 75 % NPK-fertilizers and 100% NPK-fertilizers of the recommended dosein all yield characters of canola plant. These results in the same lines with those obtained by **Yildirim (2007) and Karakurt *et al.* (2009).**

Seed quality

Regarding to the effect of NPK-fertilizers in absence of humic acid application, data in Table 4 clearly showed that the different levels of NPK-fertilizers produced significant increases in seed quality of canola plant i.e. oil and protein contents and yield particularly in the treatment of NPK-fertilizers100 % of the recommended dose which gave the highest mean values in all characters of seed quality of canola plant. The increments were 2.58 and 77.33 % for oil and protein contents respectively as compared with the control treatment. This results can be explained on the basis that mineral fertilizers plays and important role in plant metabolism, i.e. energy transfer reactions and nucleoproteins which leading to increase in seed yield and thus increase the oil and protein yields. Similar findings were observed by **Cheema *et al.* (2001): Magdi *et al.* (2011) and Morditochaee (2012).**

Data in Table 4 clear that humic acid application (soil or foliar spraying) showed a positive and significant effect in all seed quality of canola plant. Compare with the control generally, it worthy to noted that, the highest mean values of all characters of seed quality under studied were recorded by using of foliar spraying of humic acid followed by the soil application of humic acid. This effect is in harmony with of humic acid application on seed yield. These results are in agreement with those obtained by **Magdi *et al.* (2011) and Fahmy *et al.* (2016).**

Regarding to the interaction effect between different levels of NPK-fertilizers as combined with humic acid application on seed quality of canola plant, data in Table 4 indicated that the combined application gave positive and significant increase in oil and protein contents and yields. The highest oil and protein yields of canola plant were recorded from the treatment of 100 % recommended dose of NPK-fertilizers + 50 mg/L foliar spraying of humic acid with 7.5 and 81.06 % for oil and protein contents respectively as compared with of $NPK_0 + HA_0$ without fertilizers which recorded the lowest oil and protein yields of canola plant. The treatment of 75% of the recommended dose of NPK + foliar spraying of humic acid application in most cases gave values in canola seed quality higher than the individual application of NPK-fertilizers at 100% of the recommended dose. Also the treatments of NPK-fertilizers at 75 % and 100% along with foliar application of humic acid in some cases under study showed no significant differences between them. These results are in harmony with those obtained by **Ali, *etal.* Seadh *et al.* (2012) and Fahmy *et al.* (2016).**

Nutrient contents and uptake

The main effect of inorganic NPK-fertilizers on NPK contents and their uptake in both seed and straw of canola plant are given in Tables 5 and 6. Generally, the obtained results showed a significant increase of NPK contents and their uptake in both seed and straw as result of addition of any doses of NPK-fertilizers from 0 up to 100 % of the recommended does as compared with the unfertilized plant (control). The highest NPK contents and their uptake were recorded by using of 100 % recommended dose of NPK-fertilizers.

Also data recorded in the same Tables (5 and 6) also indicated that the foliar spraying and soil application of humic acid show a significant effect in NPK contents and their uptake in seed and straw of canola plant. The highest mean values in all cases were recorded by using foliar spraying of humic application as compared with unfertilized plants. The stimulation of NPK contents and their uptake by soil application and foliar spraying of humic acid material may be attributed the effect on the membrane permeability and the better –developed root system. Such effect of humic acid application studied by **Malhi *et al.* (2007) Celik *et al.* (2008) and Karakurt *et al.* (2009) and Fahmy *et al.* (2016).**

As regard to the interaction effect between recommended dose of NPK-fertilizers and humic acid application on NPK contents and their uptake in both seed and straw of canola plant, obtained data supported the previous discussion which showed the effects of either mineral fertilizers or humic acid application significantly increased NPK contents and their uptake in seeds and straw of canola plant (Table 5 and 6). The highest values in all cases were recorded at the treatment of NPK- 100 % of the recommended dose + foliar spraying of humic acid. But it worthy to note that, the plants received 75 % NPK along with foliar spraying or soil application of humic acid produced higher values in NPK contents and uptake than those received 100 % NPK-fertilizers as solo. Also, in most studied parameters there were no significant differences among the combination of 100 % or 75 % NPK-fertilizers + foliar application of humic acid. These finding are in concern with (**Magdi *et al.*, 2011; and Fahmy *et al.*, 2016).**

Table 5. Effect of different rates of NPK fertilizers and humic acid applications on NPK contents and theiruptake in seeds of canola plant.

NPK treatments	Humic acid applications											
	$H.A_0$	$H.A_{soil}$	$H.A_{foliar}$	Mean	$H.A_0$	$H.A_{soil}$	$H.A_{foliar}$	Mean	$H.A_0$	$H.A_{soil}$	$H.A_{foliar}$	Mean
	NPK contents (%)											
	N				P				K			
NPK_0	1.96	2.01	2.05	2.01	0.21	0.23	0.24	0.23	0.98	0.99	1.01	0.99
$NPK_{50\%}$	2.50	2.53	2.54	2.52	0.39	0.41	0.44	0.41	1.33	1.34	1.36	1.34
$NPK_{75\%}$	3.09	3.17	3.15	3.14	0.50	0.51	0.53	0.51	2.21	2.25	2.26	2.24
$NPK_{100\%}$	3.56	3.57	3.59	3.57	0.61	0.62	0.64	0.62	2.48	2.49	2.51	2.49
Mean	2.78	2.82	2.83	2.81	0.43	0.44	0.46	0.44	1.75	1.77	1.79	1.77
$L.S.D_{0.05}$	NPK= 0.49, H.A=0.02, NPK*H.A= 0..51				NPK= 0.12, H.A=0.01 , NPK*H.A=0.14				NPK= 0.25, H.A=0.02, NPK*H.A=0.28			
NPK treatments	NPK uptake (kg/ha)											
	N				P				K			
NPK_0	15.08	15.80	16.52	15.80	1.62	1.81	1.93	1.79	7.54	7.78	8.14	7.82
$NPK_{50\%}$	29.30	30.26	30.91	30.16	4.57	4.90	5.36	4.94	15.59	16.03	16.55	16.06
$NPK_{75\%}$	40.33	42.37	42.68	41.80	6.53	6.81	7.18	6.84	28.85	30.04	30.62	29.84
$NPK_{100\%}$	48.04	48.96	49.61	48.87	8.23	8.50	8.84	8.53	33.47	34.15	34.69	34.10
Mean	33.19	34.35	34.93	34.16	5.24	5.51	5.83	5.52	21.36	22.00	22.50	21.95
$L.S.D_{0.05}$	**NPK=11.02, H.A=1.20, NPK*H.A= 7.50**				**NPK= 2.12, H.A=0.89, NPK*H.A= 1.98**				**NPK=6.32, H.A=0.85 , NPK*H.A= 5.50.**			

NPK_0, NPK_{50}, NPK_{75}, NPK_{100}: 0, 50, 75 and 100 % from recommended dose. $H.A_0$, $H.A_{soil}$, $H.A_{foliar}$: without, soil and foliar humic acid applications

Table 6. Effect of different rates of NPK fertilizers and humic acid applications on NPK contents and their uptake in straw of canola plant

NPK treatments	Humic acid application											
	$H.A_0$	$H.A_{soil}$	$H.A_{foliar}$	Mean	$H.A_0$	$H.A_{soil}$	$H.A_{foliar}$	Mean	$H.A_0$	$H.A_{soil}$	$H.A_{foliar}$	Mean
	NPK content (%)											
	N				P				K			
NPK_0	1.30	1.31	1.33	1.31	0.11	0.12	0.14	0.12	1.28	1.29	1.31	1.29
$NPK_{50\%}$	1.36	1.36	1.38	1.37	0.17	0.19	0.21	0.19	1.34	1.34	1.35	1.34
$NPK_{75\%}$	1.39	1.41	1.44	1.41	0.23	0.24	0.26	0.24	1.38	1.40	1.41	1.40
$NPK_{100\%}$	1.43	1.44	1.46	1.44	0.27	0.28	0.30	0.28	1.42	1.43	1.45	1.43
Mean	1.37	1.38	1.40	1.38	0.20	0.21	0.23	0.21	1.36	1.37	1.38	1.37
$L.S.D_{0.05}$	**NPK=0.05, H.A=0.02, NPK*H.A=0.04**				**NPK= 0.05, H.A=0.01, NPK*H.A= 0.05**				**NPK= 0.05, H.A=0.03, NPK*H.A=0.05**			
NPK treatments	NPK uptake (kg/ha)											
	N				P				K			
NPK_0	12.74	13.07	13.47	13.10	1.08	1.20	1.42	1.23	12.54	12.87	13.27	12.90
$NPK_{50\%}$	18.85	19.10	19.82	19.25	2.36	2.67	3.02	2.68	18.57	18.82	19.39	18.92
$NPK_{75\%}$	22.06	22.96	23.84	22.95	3.65	3.91	4.30	3.95	21.90	22.80	23.34	22.68
$NPK_{100\%}$	23.73	24.16	24.68	24.19	4.48	4.70	5.07	4.75	23.57	23.99	24.51	24.02
Mean	19.34	19.82	20.45	19.87	2.89	3.12	3.45	3.15	19.14	19.62	20.13	19.63
$L.S.D_{0.05}$	**NPK=0.56, H.A=0.30, NPK*H.A=0.90**				**NPK= 0.33, H.A=0.15, NPK*H.A=0.98**				**NPK= 0.58, H.A=0.29, NPK*H.A=1.69**			

NPK_0, NPK_{50}, NPK_{75}, NPK_{100}: 0, 50, 75 and 100 % from recommended dose. $H.A_0$, $H.A_{soil}$, $H.A_{foliar}$: without, soil and foliar humic acid applications

Conclusion

From the previous discussion it can be concluded that application of humic acid substance has positive effect on growth, yield and quality of canola plant. Humic acid application can be decreased for mineral fertilizers and consequently reduced the environmental pollution.

Also the application on NPK-fertilizers at a rate of 75 % of the recommended dose as combined with foliar spraying at a rate of 50mg/L or soil application at 24 kg/ha of humic acid could be recommended for optimum growth of canola plant and can be approximately saved 25 % NPK-fertilizers without reduced the growth and yield of canola plant. Finally it can be said, application of humic acid can be play a significant role in achieving of sustainable agriculture in a sandy soils.

References

1. A.O.A.C. 1990. Official methods of analysis of the association of official analytical chemists. 12ed Washington.
2. Ali, A. Ramadan; S.U; Sami, U. A. and Raza, S. 2015. Combined effect of humic acid and NPK on growth Saskatchewan. J. of plant nutrition 30: 641 – 685.
3. Ali, Vahap Katkat; Hakan, C.; Murat, A. T. and Bakry, B. A. 2009. Effect of soil and foliar application of humic substances on dry weight and mineral nutrients uptake of wheat under calcareous soil conditions. Aust. J. Basic and Appl. Sci. 3 (2): 1266 – 1273.
4. Brownell, J.R.; Nordstrom, G.; Marihart, J. and Jorgensen, G. 1987. Crop responses from two new leonardite extracts. Sci. total environ. 62: 491-499.
5. Celik, H.; Katkat, A. V.; Ayk, B. B. and Turan, M. A. 2008. Effect of soil application of humus on dry weight and mineral nutrients uptake of maize under calcareous soil conditions. Archives of Agron. and Soil Sci., 54 (6): 605 – 614.
6. Cheema, M.A.; Saleem, M. and Malik, H. A.2001. Effect of row spacing and nitrogen management of agronomic traits and oil quality of canola (Brassica napus L.) J. Agric. 38: 15 – 18.
7. David, P.P. 1991. Effect of applied humic acid on yield, growth, nutrient accumulation content in selected vegetable crops and soil interactions that reduced their effectiveness. Dissertation Abstractacts international –B, SCI. and Engineering 52(3): 1136 – 1137B.
8. El-Bassiony, A. M.; Fawzy Z. F.; Abd El-Baky M. M. H. and Mahmoud A. R. 2010. Response of snap bean plants to mineral fertilizers and humic acid application. Res. J. of Agric. and Biol. Sci. 6 (2): 169 – 175.
9. Emara, H. A. And Hamada S. F. 2012. Effect of humax on growth, yield and quality of cotton under calcareous soil conditions. Fac. Of Alex. Saba Basha, alex. Univ. 17th -18th 2012.
10. Erik, B.G.; Feiber, Shock, C. G. and Lament, Sanders, D. 2000. Evaluation of humic acid and other nonconventional fertilizer additions for onion production. Malheur Experiment station University. Ontario, O.R.
11. Fahmy, M.F; Thalooth, A.T.; Amal, G.; Mohammed, H. and Elewa, T.A. 2016. Evaluation of the effect of chemical fertilizer and

humic acid on yield and yield component of wheat plants (*Triticum aestivum*) grown under newly reclaimed sandy soil. Inter. J. of Chemetic Res. 9(8): 154-161.

12. Hafez, M.M. 2003. Effect of some sources of nitrogen fertilizer and concentration of humic acid on the productivity of squash plant. Egypt J. Appl. Sci. 19 (10): 293 – 309.
13. Halime, O. U.; Husnu, U.; Yasar, K. and Huseyin, P. 2011. Changes in fruity yield and quality in response to foliar and soil humic acid application in cucumber. Scientific Res. and essays 6 (13): 2500 – 2803.
14. Hussien, A.M. I. 2000. Evaluation of some mung bean varieties under agricultural treatments MS.C. Thesis, Fac. Of Ain Shams Univ., Egypt.
15. Ibrahim, A.; Mohammed, K. M., Moral M.and Hamid, R. B. 2013. Effect of bio mineral nitrogen fertilizer management, under humic acid foliar spraying on fruid yield and several traits of eggplant (solanummelongena L.) African J. of Agric. Res. 7(7): 1104 - 1109.
16. Jackson, M.L. 1973. Soil chemical analysis. Prentice – Hall of India, private and LTD. New Delhy. 2nd indian Rep.
17. Karakurty, Y.; Unlu H. and Padem, H. 2009. The influence and soil fertilization of humic on yield and quality of pepper. Acta agriculturae Scandinavica Section B Plant Soil Sci. 59(3): 233 – 237.
18. Klute, A. 1982. Methods of analysis. Part – 1 physical and mineralogical methods (2nd ed.) Amer. Soc. Of Agron. Madison, Wisconsin, USA.
19. Magdy, T. A.; Selim, E.M. and El-ghamry, A. M. 2011. Interaction effects on bio and mineral fertilizers and humic substances on growth yield and nutrient contents fertigated cowpea (vignaunguiculata L.) J. of Agron. 10(1): 34-39.
20. Mlahi, S.S.; Johnston, A. M.; Schoenau, J.J.; Wang, Z. H. and Vera, C.L. 2007. Seasonal biomass accumulation and nutrient uptake of canola, mustard and black chernozem soil in SasKatchewan. J. of plant nuration 30: 641- 658.
21. Moraditochaee, M.2012. Effect of humic acid foliar spraying and nitrogen fertilizer management on yield of peanut (Arochishypogaea L.) in Iran ARPN J. of Agric and Biol. Sci. 7 (4): 289 -293.
22. Olsen, S. R.; Cole, C.V.; Watanabe, F.S. and Dean, L. A. 1954. Estimation of available phosphorous in soil by extraction with sodium bicarbonate. U.S. dept. Agric. Cir. 939.
23. Padem, H., Ocal, A. and Alan, R. 1997. Effect of humic acid added foliar fertilizeron seedling quality and nutrient content of eggplant and pepper. ISHS symposium on greenhouse management for better yields and quality in mild winter climate. 2-5 November. Acta Horticulture 491: 241- 246.
24. Page, A. L.; Miller, H. and Keeny, D. R. 1982. Nethods of soil analysis. Part -2: chemical and microbiological properties (2nd ed.) Amer. Soc. Of Agron., Madison, Wisconsin, USA.
25. Saxena, K.; Arun – Srivastava, K. and Singh, R. B. 2003. Response of french bean to nutrient application (NPK) in relation to physiological traits and their consequent effect on yield. Farm Sci. J. 12(2): 150 – 152.
26. Seadh, S.E.; El-Hendy; M. H. Abd El-Aal, H. A. and Shaimaa, and El-Sayed, O.2012. Effect of NPK rates and humic application on growth of Egyptian cotton. J. Plant Prod. Mansoura Uni., 3(8): 2287-2299.
27. Serenella, N.; Pizzeghelloe D. A.; Muscolob N. and Vianello A. 2002. Physiological effects of humic substances on higher plants. Soil Biol. Biochem. 34: 1527 – 1536.
28. Singer, S.M.; Ali, A. H.; Eldesuki, M.; Gomaa, A.M. and Khalfalla, M. A. 2000. Synergistic effect of bio and shemical fertilizers to improve quality and yield of snap bean grown in sandy soil. Acta Horticulturae, 513: 213 – 220.
29. Snedecor, G. W. and W. G. Cochran 1980. Statistical methods, 6th Iowa Stat. univ. Press, America.
30. Souza, A. B.; Andrade, M.J.B. De.; Vierra, N.M.B. and Albuquerque, B. 2008. Sowing densities and NPK and liming levels on common bean yield, in conventional cropping system, in Ponta Grossa state, Brazil. Pesquisa Agropecu-aria Tropical, 38(1): 39 – 43.
31. Tottini, M.; Chiarini A.; Tofani, R.; Castagneto, M. 1990. Effect of humic acid on growth and nitrogen uptake of container-grown olive (oleaearopaea L., Maurina) Internat. Symp. On olive growing, proceeding Wageningen (Netherlands), PP. 125: 128.
32. Yldirim, E. 2007. Foliar and soil fertilization of humic acid affect productivity and quality of tomato. Acta Agriculturae Scandinavica Section B Plant Soil Sci. 75: 182 – 186.

12/20/2017