Available online freely at www.isisn.org

Bioscience Research

Print ISSN: 1811-9506 Online ISSN: 2218-3973

Journal by Innovative Scientific Information & Services Network

RESEARCH ARTICLE BIOSCIENCE RESEARCH, 2021 18(4): 3065-3073. **OPEN ACCESS**

Effects of different doses of humic acid and sowing methods on growth and yield of turnip (*Brassica rapa* L.)

Ikram Ullah[1,2]*, Shahid Nadeem[3], Arshad Mahmood[4], Hidayatullah[5], Muhammad Amin[6], Sadia Noureen Zafar[7], Muhammad Zahid Aslam[8], Ibadullah Jan[2], Muhammad Adil[9,10], Ijaz Amin[11], Muhammad Azam[12] and Adnan Ghani[2,12]

[1]College of Landscape and Horticulture, Yunnan Agricultural University, Kunming 650201, **China**
[2]Department of Agriculture, University of Swabi, Khyber Pakhtunkhwa-**Pakistan**
[3]Horticultural Research Institute, National Agricultural Research Center, Islamabad, **Pakistan**
[4]Unit of Soil Science and Plant Nutrients, Brunei Agricultural Research Center, **Brunei Darussalam**
[5]Department of Botany, Shah Abdul Latif University, Khairpur-66022, Sindh, **Pakistan**
[6]Vegetable Research Institute, Ayub Agriculture Research Institute, Faisalabad**, Pakistan**
[7]Department of Botany, Faculty of Sciences, Government College Women University, Faisalabad, **Pakistan**
[8]Cotton Research Station, Bahwalpur-**Pakistan**
[9]Shaanxi key laboratory of earth surface system and environmental carrying capacity, College of Urban and Environmental Science, Northwest University, Xi'an, 710127, **China**
[10]Department of Agricultural Engineering, Khwaja Fareed University of Engineering and information technology, Rahim yar khan, **Pakistan**
[11]Department of Soil and Environmental Sciences, The University of Agriculture, Peshawar, **Pakistan**
[12]Agricultural Research Station Swabi, **KP-Pakistan**

***Correspondence: ikramkhan1800@gmail.com** **Received 26-08-2021, Revised: 22-11-2021, Accepted: 25-11-2021 e-Published: 05-12-2021**

The experiment was performed by following randomized complete block design in three replications at Agricultural Research Station Swabi. The effect of humic acid application at the rate of 6, 12, 18 kg ha^{-1} under ridge, line and broadcast sowing method were analyzed. It was found that humic acid growth and yield attributes were significantly affected under various sowing conditions and different doses of humic acid. Growth parameters such as leaves number (18.22), dry leaves weight (6.10 g), fresh fruit weight (70.62 g), dry fruit weight (7.26 g) were significantly enhanced on 6 kg application of humic acid and by ridge sowing method, while lower on broad cost method. In case of broadcast sowing and 12 kg ha^{-1} of humic acid significantly increased fresh leaves weight by 38.15 g and leaf dry matter percentage by 85.85%. The fresh leaves weight observed lowest (28.62 g) weight when treated with 6 kg of humic acid and seeds sown via broadcasting. The humic acid application of 18 kg ha^{-1} decreased fruit dry matter by 81.80 % by following broadcast method. The efficiency of humic acid application enhanced greatly in the ridge sowing method. Humic acid application and sowing methods significantly affect all the vegetative and growth parameters of *Brassica rapa* whereas broadcasting was least effective. It is concluded that humic acid application in low to high doses significantly enhanced growth and yield components under ridge sowing method.

Keywords: Humic acid (HA), *Brassica rapa*, Hectare (ha), Sowing methods, Growth, Yield

INTRODUCTION

Turnip (*Brassica rapa)* is a cultivated specie belongs to *Brassicaceae* family. It is a root vegetable usually grown in temperate global climates. Brassica species are widely cultivated for their use as feed crops but many plant parts are using for the welfare of human beings i.e., different biological plants product is used for management of diseases world widely. A plant extracts and seed powders are used in cancer treatments (Cochrane et al. 2008). Turnip extract can also be used to reduce uric acid and extract kidney stones. It can increase visual acuity and is used to treat night blindness and enhances memory (El-Sherbeny et al. 2012). A natural insecticide called Allardice is present in turnip peel (Aisha et al. 2014).

Several studies reported that application of organic fertilizer improved soil fertility, beneficial microbial flora structure, reduced soil-borne diseases, which are obstacle in productivity of different crops. Humic acid is a kind of organic matter accumulated by animals and plant remaining parts through transformation and decomposition of microorganisms with a series of geochemistry processes. It affects soil fertility by enhancing beneficial microbial population, improving the soil structure and increased cation exchange capacity in soil and pH buffering. The humic compound directly affects the cell wall, cytoplasm and membrane. It also increased photosynthesis, respiration rates, enhanced protein synthesis in plants and plant hormone activity (Nikbakht et al. 2008). Humic compounds enhanced mineral absorption by stimulating microbial activity (Mayhew, 2004). When sufficient humus is present in the soil, the need for nitrogen, phosphorus, and potassium fertilizers can be reduced (Pettit, 2004). Humic is the main component of organic matter and usually accounts for 70% of total organic matter (Sakellariadou, 2006). Humus stimulation is directly related to increased intake of macronutrients such as nitrogen, phosphorus, and sulfur and micronutrients such as Fe, Zn, Cu, and Mn (Celik et al. 2010). The use of different chemicals in crop production is leading to development of different biotic and abiotic problems (Akram et al. 2018). Humic acid is consistent with nature and humic acids no harm to plants and the environment (Haghighi et al. 2011). The humic acid overcomes the nutrients deficiency by chelating different nutrients, contains hormone ingredients which promote growth, production and quality of plants (Prakash, 2018). Humic acids improved the physical, chemical and biological properties of soil (Pant et al. 2011). The application of humic acid reduce soil borne diseases or increased crop immunity by enhancing nutrient and mineral utilization in an environment friendly manner (Chang, 2012). The application of humic acid increased plants survival rate under unfavorable condition and high yield have been observed in many crops, including *Brassica* (Aisha et al. 2014).

Although organic matter is the foundation of the soil, it is a dynamic component of the soil that affects many chemical, physical, and biological properties that regulate soil productivity (Brown, 2000). However, each seeding method humic acids its own advantages and disadvantages under certain conditions, so research is needed to determine whether different sowing method are suitable for a particular location.

The purpose of this study was to use humic acid in the productivity of turnip under different sowing condition to balance nutrition, vegetative and reproductive growth of the crop. The crop rotation, farming techniques, green and animal fertilizers are commonly used applications to increase organic content in the soil to promote the crop growth. Additionally, the use of organic mineral fertilizers in agriculture humic acids also increased in recent years (Mahdi, 2010). Several reports determined that growth and productivity of turnip under different sowing methods may be different, such planting techniques and practices must be developed to maintain optimal plant populations, promote air circulation, light penetration, regulate soil temperature and save water to increase crop productivity. Therefore, this comprehensive study aims to evaluate the effects of humic acid and different sowing methods on growth, fruit quality and yield of turnip.

MATERIALS AND METHODS

An experiment “Effect of different doses of humic acid and sowing methods on growth and yield of turnip (*Brassica rapa* L.)” was conducted at Agricultural Research Station Swabi during Rabi 2016. The design used in the experiment was randomized complete block design. There were two factors i.e. Humic acid with 4 levels and sowing methods with 3 levels. The humic acids were used in different doses as 0, 6, 12, 18 kg/humic acid, which can be represented as HA_1 (0kg/ha), HA_2 (6Kg/ha), HA_3 (12Kg/ha), HA_4 (18kg/ha) respectively. Different sowing methods including Ridge sowing (M1) line sowing (M2) and broadcast method (M3). The land was prepared

by three dry ploughing, followed by clod crushing and soil leveling for evenly distribution of the water. The rotten farm manure mixed with the soil. The recommended dose of diammonium phosphate (DAP) is transplanted into the soil before seedling transplantation. In October 2016, the seeds of the purple top red globe were sown by using After 15 days, thinning was performed and plant to plant distance was 6 cm. The irrigation was carried after 15 days interval. All necessary cultural practices were used throughout the growing season of the crop. The data were recorded fresh fruit weight, fruit dry weight, fruit dry matter percentage (%), fresh leaf weight, leaf dry weight, leaf dry matter percentage (%) and number of leaves

Statistical Analysis

Statistical analysis was performed on the collected data, using the software Statistics 8.1 (Statistics, 2006) for analysis of variance (ANOVA). All treatment means were compared by using Fisher's Least Significant Difference (LSD) test at the 5% level of probability.

RESULTS

Number of Leaves

The mean data regarding number of leaves is presented in Table 1 showed that analysis of variance of sowing method had a significant effect but humic acid had non-significant effect on leaf number of turnip. The interactions between sowing methods and humic acid on leaf number were also not significant. It is clear from the data that the maximum number of leaves (17.56) recorded in the turnip plants on ridge sowing, and the least number of leaves (15.07) recorded in plants by broadcast sowing method. The interaction between broadcast sowing methods and humic acid on the number of turnip leaves was not significant. The high number of leaves (18.22) was observed in plants, fertilized with 6 kg ha^{-1} of humic acid by following ridge sowing method, but the minimum number of leaves recorded in plants (14.14), received 0 kg ha^{-1} humic acid with seed broadcasting methods.

Leaves fresh weight

Leaf fresh weight data are listed in Table 2. It can be clearly seen from the analysis of variance that the effect of the sowing method is significant, while humic acid had no significant effect on the fresh weight of turnip leaves. The interaction between sowing method and humic acid was also not significant. The maximum average fresh leaf weight (36.56 g) was recorded in turnip plants sown by ridge method while the minimum average fresh leaf weight (29.86 g) was observed sown by broadcast method .The interaction of humic acid and sowing method on fresh weight of turnip had no significant effect. The maximum fresh leaves weight (38.15 g) was observed in plants sown on the ridges with humic acid fertilization of 12 kg ha^{-1}, but the minimum fresh leaves weight (28.62 g) was observed on application of 6 kg ha^{-1} humic acid by following broadcast method.

Leaves Dry weight

The statistical analysis of the leaf dry weight data is given in Table 3. The analysis of variance showed that the sowing method have a significant effect on leaves dry weight of turnip, while humic acid had no significant effect on the dry weight of fruits. The interaction between sowing method and humic acid on dry weight of turnip leaves was not significant. It is clear from result that the highest dry leaf weight (5.99 g) was set with the ridge sowing method, and the lowest dry weight (4.42 g) of fruits in the plant sown by broadcast method. The effects of sowing methods and humic acid on the dry weight of turnip leaves were not significant. The highest dry leaf weight (6.10 g) was observed on the ridge sowing crop plants with 6 kg ha^{-1} of humic acid application, while by following broadcasting method minimum dry leaf weight (3.76 g) recorded in the plants with application of 0 kg $ha^{-1}$of humic acid respectively.

Leaves dry matter (%)

The mean value of consistent leaf dry matter is given in Table 4. The analysis of variance showed that the sowing method had a significant effect on the dry matter percentage of turnip crop leaves, but the humic acid had no significant effect on the leaf dry matter. The interactions between sowing methods and humic acid on dry matter percentage of leaves were not significant.

It is observed from the data that ridge planting method recorded highest (85.12%) leaf dry matter percentage of turnip while lowest (82.19 %) through broadcast method. The interaction between sowing method and humic acid on dry matter percentage of leaves was not significant.

The highest percentage of leaf dry matter (85.85 %) was observed in plants, with 12 kg ha^{-1} of humic acid application by following ridge sowing method respectively, but the lower percentage of fruit dry matter recorded in plants (81.80%) with 18 kg ha^{-1} humic acid application by

following broadcast method respectively.

Table 1: Effect of humic acid and sowing methods on number of leaves of turnip

Humic acid (kg humic acid^{-1})	Sowing methods			Means
	Ridge	Line	Broadcast	
0	18.21 a	15.99 abcd	14.14 d	**16.11**
6	18.22 a	16.33 abcd	14.50 cd	**16.37**
12	17.12 ab	16.08 abcd	15.64 bcd	**16.28**
18	16.68 abc	16.27 abcd	15.94 abcd	**16.30**
Means	**17.56 a**	**16.17 b**	**15.07 b**	

LSD value at 5% for sowing method =1.2662
LSD value at 5% for humic acid = 1.4620
LSD value at 5% for sowing method × humic acid = 2.5323

Table 2: Effect of humic acid and sowing methods on leaves fresh weight of turnip

Humic acid (kg humic acid^{-1})	Sowing Methods			Means
	Ridge	Line	Broad Cost	
0	34.41 ab	32.60 ab	29.36 b	**32.12**
6	37.51 a	32.70 ab	28.62 b	**32.90**
12	38.15 a	33.54 ab	30.42 ab	**34.10**
18	36.16 ab	33.33 ab	31.40 ab	**33.50**
Means	**36.56 a**	**33.50 ab**	**29.86 b**	

LSD value at 5% for sowing method= 4.0675
LSD value at 5% for humic acid = 4.6968
LSD value at 5% for sowing method × humic acid = 8.1351

Table 3: Effect of humic acid and sowing methods on leaves dry weight of turnip

Humic acid (kg humic acid^{-1})	Sowing methods			Means
	Ridge	Line	Broadcast	
0	6.10 a	4.88 bcde	4.58 cde	**5.18**
6	6.10 a	4.88 bcde	3.76 e	**4.91**
12	5.90 ab	4.34 cde	4.20 de	**4.79**
18	5.83 ab	5.22 abcd	5.27 abc	**5.44**
Means	**5.99 a**	**4.83 b**	**4.42 b**	

LSD value at 5% for sowing method = 0.5965
LSD value at 5% for humic acid = 0.6888
LSD value at 5% for sowing method × humic acid = 1.1931

Table 4: Effect of humic acid and sowing methods on leaves dry matter (%) of turnip

Humic acid (kg humic acid^{-1})	Sowing methods			Means
	Ridge	Line	Broadcast	
0	84.66 ab	83.47 ab	83.58 ab	**83.90**
6	84.22 ab	82.59 ab	80.61 b	**82.47**
12	85.85 a	85.20 a	82.78 ab	**84.60**
18	85.75 a	83.20 ab	81.80 ab	**83.58**
Means	**85.12 a**	**83.60 ab**	**82.19 b**	

LSD value at 5% for sowing method = 2.1091
LSD value at 5% for humic acid = 2.4354
LSD value at 5% for sowing method × humic acid = 4.2183

Fruit Fresh weight

The mean data related to fresh fruit weight given in Table 5. It showed that the sowing method had a significant effect on the fresh weight of turnip crop and the effect of humic acid on fresh fruit weight was also found significant. The interaction between sowing method and humic acid was not significant. The mean table showed that the highest fresh fruit weight recorded by ridge sowing (66.19g), followed by the line sowing (63.59g), and the fruit fresh weight (60.15g) was observed in plants with broadcast sowing. The highest fresh fruit weight (70.62g) was observed in plants, and fertilized with 6 kg ha^{-1} of humic acid by following ridges sowing method. However, under 0 kg ha^{-1} of humic acid application, the smallest fresh fruits (53.41g) recorded per plant by following broadcast method. Our results showed that the application of humic acid significantly affects the fresh weight of fruits. However, growth parameters were increased by increasing the rate of humic acid. Statistical analysis also showed that medium and high levels of humic acid significantly improved all growth characteristics as compared to low levels. The widespread use of humic acid in plants is now widely recognized.

Fruit Dry weight

Statistical analysis of the data on fruit dry weight is given in Table 6. The analysis of variance showed that the sowing method had no significant effect on fruit dry weight of turnip crop, and the effect of humic acid had also no significant effect on fruit dry weight of turnip. The interaction between sowing method and humic acid on dry weight of radish fruit was not significant. The maximum dry fruit weight (6.69 g) of turnip plants was a record with the ridge planting method, but the lowest dry fruit weight (5.92 g) was observed in the plants sowed by broadcast method. The interaction between sowing method and humic acid on fruit dry weight of turnip was not significant. The highest dry fruit weight (7.26 g) was observed in the plants fertilized with 6 kg ha^{-1} of humic acid on ridge sowing method, but the minimum dry fruit weight (5.40 g) recorded in the plants fertilized by 0 kg had^{-1} humic acid and sown by broadcast method.

Fruit dry matter (%)

The means consistent with fruit dry matter is given in Table 7. The analysis of variance showed that the sowing method had a significant effect on the dry matter percentage of the fruit of the turnip crop, but the humic acid had no significant effect on the dry matter of the fruit. The interactions between sowing methods and humic acid on dry matter were not significant. It can be clearly seen from the table that the highest percentage of dried fruits (87.63%) in turnip plants humic acids set a record by using ridge sowing, and the lowest dry matter percentage (80.57%) of turnip fruits were observed when line sowing method was practiced. The interaction between sowing method and humic acid on dry matter percentage of turnip fruit was not significant.

Table 5: Effect of humic acid and sowing methods on fruit fresh weight of turnip

Humic acid (kg humic $acid^{-1}$)	Sowing method			Means
	Ridge	Line	Broadcast	
0	58.13bcde	55.94 de	53.41 e	55.83 b
6	70.62 a	65.31 abcd	56.41 de	64.11 a
12	70.15 a	66.52 abc	63.13 abcde	66.60 a
18	65.86 abcd	66.59 ab	67.10 ab	66.52 a
Means	66.19 a	63.59 ab	60.15 b	

LSD value at 5% for sowing method = 5.0758 ,LSD value at 5% for humic acid = 5.8611
LSD value at 5% for sowing method × humic acid = 10.152

Table 6: Effect of humic acid and sowing methods on fruit dry weight of turnip

Humic acid (kg humic $acid^{-1}$)	Sowing methods			Means
	Ridge	**Line**	**Broadcast**	
0	6.36 ab	6.08 ab	5.40 b	5.95
6	7.26 a	6.17 ab	5.40 b	6.27
12	6.79 ab	6.43 ab	6.15 ab	6.46
18	6.34 ab	6.76 ab	6.74 ab	6.61
Means	6.69 a	6.36 a	5.92 a	

LSD value at 5% for sowing method = 0.8122 ,LSD value at 5% for humic acid = 0.9378

LSD value at 5% for sowing method × humic acid = 1.6243.

Table 7: Effect of humic acid and sowing methods on fruit dry matter (%) of turnip

Humic acid (kg humic acid^{-1})	Sowing Methods			Means
	Ridge	Line	Broadcast	
0	88.50 ab	84.30 abc	80.57 bc	84.31
6	89.49 a	85.98abc	79.62 c	85.20
12	88.94 a	84.86 abc	81.28 bc	85.80
18	84.30 abc	82.78 abc	81.05 bc	82.62
Means	87.63 a	80.57 bc	80.63 b	

LSD value at 5% for sowing method = 3.8043,LSD value at 5% for humic acid = 4.3928
LSD value at 5% for sowing method × humic acid = 7.6085

Table 8: Mean square values for various morphological parameters of Turnip regarding sowing methods and humic acid application

Mean squares						
Traits	**Reps**	**Sowing methods**	**Humic acid**	**Sowing dates x Humic acid**	**Error**	**CV**
Number of Leaves	0.8648	18.6098*	0.1068	1.9942	2.184	9.0
Leaves fresh weight	24.743	134.643**	6.027	3.172	18.815	13.08
Leaves dry weight	2.94691	7.96066**	0.7558	0.4948	0.496	13.85
Leaves dry matter (%)	12.0659	25.8351**	7.1055	1.7574	5.252	2.74
Fruit fresh weight	31.245	115.544*	233.270**	31.386	34.966	9.35
Fruit dry weight	1.96830	1.75650	0.72983	0.9684	0.869	14.74
Fruit dry matter (%)	97.379	147.275 **	1.6530	6.8310	17.327	4.90

* = Significant at 5% probability level; ** = Significant at 1% probability level

The highest percentage of fruit dry matter (89.49%) was observed in plants, fertilized by 6 kg ha^{-1} of humic acid on the ridges, but the lowest percentage of fruit dry matter (79.62%) recorded in plants fertilized with 6 kg of ha^{-1} humic acid by following broadcast sowing method.

DISCUSSION

Humic acid tested in our study have shown a greater effect on growth and yield characteristics including fresh weight of fruit, dry weight of fruit, fresh weight of leaves, dry weight of leaves, Dry matter (%) and number of leaves, which is in agreement with the results of Paksoy et al. (2010) and Atiyeh et al. (2002).The different doses of Humic acid increased growth and yield attributes (Karakurt et al. 2009).The medium and high levels of humic acid application showed significant effect on crop growth in the presence of different soil condition as compared to low doses (Tahir et al. 2011). The higher number of leaves and weights may be due to positive effect of humic acid on chlorophyll amount indirectly. The adequate amount of chlorophyll content increased the photosynthetic activities which in turn, shift more photo assimilations towards the high number of fresh leaves and leaves weight (Meganid et al. 2015). The similar finding were recorded for humic acid, reported by some scientists that application of humic acid significantly enhanced the growth and yield parameters of *Brassica rapa* under different sowing methods (Türkmen et al. 2004). The prevalent use of humic acid in different crops plants is now generally accepted. Similar findings were reported for humic acid, which reveals that humic acid mainly affect the yield components of *Brassica rapa* (Albayrak and Camas, 2005). The application of humic acid has an important beneficial effect on yield and the growth of mustard (David and Samuel, 2002). The similar

results have been reported that humic acid application increased the dry matter of mustard (Rao et al. 2009). The significant effect was found in most of crop species such as rice, wheat and *Brassica raya* (Tahir et al. 2011).The humic acid application showed it beneficial effect on weight of fresh or dry fruits including dry matter percentage as compared to control in different growing condition and crop gained high grain filled percentage by application of humic acid under subsurface irrigation (Vanithumic acid and Mohumic acidndass, 2014).The experiments showed that only humic acid added to given water increased the growth of roots up to 58%. Our research results are also in lined with previous work that the organic fertilizer KOMIX containing humic acid significantly improves the production of spring soybean crops (Shuixiu and Ruizhen, 2001). The humic acid alteration in soil enhanced the water retention capacity and humic acid addition to plants growing in the nutrient solution promotes the root growth. This may be related to species, growth methods and different doses of humic acid application (Waqas et al. 2014). Our results are also in conformity with previous research that application of humic acid to soil increased the number of spike in maize and wheat as compared to control (Shumic acidrif et al. 2004).The maximum growth and yield parameters in *Brassica rapa* gained by humic acid application corroborates with previous findings (Khan et al. 2010). These authors recommended the use of humic acid because of its beneficial effect on the growth and yield parameters in several crop species like, wheat, aerobic rice, *brassica raya*, groundnut, mustered and barley. Moreover, as compared to the control, since humic acid was applied on the same plot, the maximum growth and yield per plant was obtained on different seeding methods due to the application of humic acid. The further results confirmed and reported that humic acid alone enhanced grain yield over the control (Shumic acidrif et al. 2004). Many researchers recorded greater effects of humic acid on growth and crop establishment (Tahir et al. 2011). It also cleared from previous findings that humic acid application improved the absorption of many elements including N, P, K, Mg, Ca, Fe, and Zn (Nikbakht et al. 2008), but some reports reveals that humic acid may reduce the uptake of some elements particularly in high concentrations. In our study dry weight of fruit in grams and percentage, fresh weight of leaves, dry weight of leaves and Dry matter (%), number of leaves or fresh leaves per plant significantly affected by humic acid application by following different sowing method.

Similar results have also been reported that application of humic acid significantly increased biological yield by up to 25% (Waqas et al. 2014). It was observed that application of humic acid to soil had a significant effect on total dry matter of mung beans (Ashraf et al. 2005). In this study growth and yield parameters enhanced by different application of humic acid concentration under different soil condition. It might be due to some macro and micro elements uptake (Paksoy et al. 2010). Statistical analysis of the data showed that, under different field conditions, all agronomic traits have variability due to interactions when used in combination with humic acid. Results of the present study showed that humic acid plays a positive role in the growth of *Brassica rapa,* without negative impacts from vegetative to reproductive growth period. Humic acid is applied to plants at medium to high doses of 6 to 18 kg ha^{-1}, which enhanced plant growth and yield parameters (Fahramand *et al*., 2014). However, high levels of humic acid prevent or reduced plant growth and yield, respectively (Khaled and Fawy, 2011).

CONCLUSION

In conclusion, the data presented in this paper indicated that humic acid is a promising compound for the growth of *Brassica rapa* in different soil condition specially to benefit from improving growth and yield parameters. Further studies may, however be required to determine humic acid application rates for optimal response of both nutrients uptake and postharvest life.

CONFLICT OF INTEREST

The authors declared that present study was performed in absence of any conflict of interest.

ACKNOWLEGEMENT

Authors are thumic acidnkful to the department of Agricultural Research Station (ARS) Swabi for providing all the facilities to conduct this experiment..

AUTHOR CONTRIBUTIONS

IU and IJ designed the experiments. IU, SN and AM performed the experiments. MA, SNZ, MZA conceptualized and analyzed the manuscript. IU wrote the initial manuscript. SN, IJ, MA, IA, MA and AG revised the manuscript and polished the expression of English. All of the authors have read and approved the final

manuscript.

REFERENCES

Aisha HA, Shafeek MR, Mahmoud R A, El-Desuki M,2014. Effect of various levels of organic fertilizer and humic acid on the growth and roots quality of turnip plants (Brassica rapa). *Current Science International*, *3*(1): 7-14.

Akram, S, Atiq R. Tariq A, Mahmood, MA, 2018. Emerging Resistance in *Alternaria solani* Against Different Fungicides in Southern Punjab, Pakistan. Pakistan Journal of Life & Social Sciences 16.

Albayrak S, Camas N, 2005. Effects of different levels and application times of humic acid on root and leaf yield and yield components of forage turnip (*Brassica rapa L*.). Journal of Agronomy 4: 130-133.

Ashraf M, Saqib N, Sarfraz T, 2005. Biological effect of biofertilizer humic acid on Mung beans (*Vigna radiate L*.). Journal of Biology and Biotechnology 2: 737-739.

Atak M, Kaya M, 2004. Effects of zinc and humic acid applications on yield and yield components of durum wheat. Anadolu 14: 49-66.

Atiyeh R, Lee S, Edwards C, Arancon N, Metzger J, 2002. The influence of humic acids derived from earthworm-processed organic wastes on plant growth. Bioresource technology 84: 7-14.

Celik H, Katkat AV, Asik BB, Turan MA, 2010. Effects of humus on growth and nutrient uptake of maize under saline and calcareous soil conditions. Žemdirbystė (Agriculture) 97: 15-22.

Chohumic acidn S, Akram S, Tariq A, Shumic acidh RM., Binyameen M, Shumic acidd SA, Abid M, 2018. Influence of Frequently Used Chemical Insecticides on Mycoflora Carried by Common Housefly, Musca domestica L. International Microbiology 21: 121-128.

Cochrane CB, Nair PR, Melnick SJ, Resek AP, Ramachumic acidndran C, 2008. Anticancer effects of *Annona glabra* plant extracts in human leukemia cell lines. Anticancer research 28: 965-971.

David R, Samuel M, 2002. Plant growth stimulation of lignite humic acid. Part-II. Effect of lignite derived ammonium humate on mustard (*Brassica juncea L*.) using different levels of phosphumic acidte fertilizer. Pakistan Council of Scientific and Industrial Research 45: 273-276.

El-Sherbeny SE, Hendawy S, Youssef A, Naguib N, Hussein M, 2012. Response of turnip (*Brassica rapa*) plants to minerals or organic fertilizers treatments. Journal of Applied Sciences Research 8: 628-634.

Fahramand M, Moradi H, Noori M, Sobhkhizi A, Adibian M, Abdollahi S, Rigi K, 2014. Influence of humic acid on increase yield of plants and soil properties. International Journal of Farming and Allied Sciences 3: 339-341.

Haghighi S, Saki Nejad T, Lack S, 2011. Effect of biological fertilizer of humic acid on metabolic process of biological nitrogen fixation. *Life Sci. J*, *8*(3), 43-48.

Karakurt Y, Unlu H, Unlu H, Padem H, 2009. The influence of foliar and soil fertilization of humic acid on yield and quality of pepper. Acta Agriculturae Scandinavica Section B–Soil and Plant Science 59: 233-237.

Khaled, H., & Fawy, H. A. (2011). Effect of different levels of humic acids on the nutrient content, plant growth, and soil properties under conditions of salinity. *Soil and Water Research*, *6*(1), 21-29.

Khan, RU, Rashid A, Khan MS, Ozturk E, 2010. Impact of humic acid and chemical fertilizer application on growth and grain yield of rainfed wheat (*Triticum aestivum L*.). Pakistan Journal of Agricultural Research 23.

Mayhew L, 2004. Humic substances in biological agriculture. Rev ACRES 34: 80-88.

Meganid AS, Al-Zahrani HS, El-Metwally M, 2015. Effect of humic acid application on growth and chlorophyll contents of common bean plants (*Phumic acidseolus vulgaris L*.) under salinity stress conditions. International Journal of Innovative Research in Science, Engineering and Technology 4: 2651-2660.

Motaghi S, Nejad TS, 2014. The effect of different levels of humic acid and potassium fertilizer on physiological indices of growth.

International Journal of Biosciences 5: 99-105.

Nikbakht A, Kafi M, Babalar M, Xia YP, Luo A, Etemadi N, 2008. Effect of humic acid on plant growth, nutrient uptake, and posthumic acidrvest life of gerbera. Journal of Plant Nutrition 31: 2155-2167.

Paksoy M, Türkmen Ö, Dursun A, 2010. Effects of potassium and humic acid on emergence, growth and nutrient contents of okra (*Abelmoschus esculentus L*.) seedling under saline soil conditions. African Journal of Biotechnology 9.

Pant A, Radovich T, Hue N, Arancon N, 2011. Effects of vermicompost tea (aqueous extract) on pak choi yield, quality, and on soil biological properties. Compost Science & Utilization 19: 279-292.

Pettit RE, 2004. Organic matter, humus, humate, humic acid, fulvic acid and humin: their importance in soil fertility and plant health. CTI Research, 1-17.

Prakash P, Mitra A, Nag R, Sunkar S, 2018. Effect of seaweed liquid fertilizer and humic acid formulation on the growth and nutritional quality of *Abelmoschus esculentus*. Asian Journal of Crop Science 10: 48-52.

Rao P, Mak MS, Liu T, Lai KC, Lo IM, 2009. Effects of humic acid on arsenic (V) removal by zero-valent iron from groundwater with special references to corrosion products analyses. Chemosphere 75: 156-162.

Rasheed Khumic acidn A, MIR S, 2002. Plant growth stimulation of lignite humic acid. Part-II. Effect of lignite derived ammonium humate on wheat (Triticum aestivum-v) crop using differentlevels of phosphumic acidte fertilizer. Pakistan Journal of Scientific and Industrial Research 45: 273-276.

Sakellariadou F, 2006. Spectroscopic studies of humic acids from subsurface sediment samples collected across the Aegean Sea. Mediterranean Marine Science 7, 11-18.

Saruhan V, Kusvuran A, Kokten K, 2011. The effect of different replications of humic acid fertilization on yield performances of common vetch (Vicia sativa L.). African Journal of Biotechnology 10: 5587-5592.

Sharif M, Ahmad M, Sarir MS, Khattak RA, 2004. Effect of organic and inorganic fertilizers on the yield and yield componentsof maize. *Pakistan Journal of Agriculture, Agricultural Engineering Veterinary Sciences (Pakistan)*.

Shuixiu H, Ruizhen W, 2001. Studies on the effect of KOMIX humic acids containing organic fertilizer on spring soybean. Jiangxi Nongye Daxue Xuebao (China).

Tahir M, Khurshid M, Abbasi M, Kazmi, M., 2011. Lignite-derived humic acid effect on growth of wheat plants in different soils. Pedosphere 21: 124-131.

Thenmozhi S, Natarajan S, Selvakumari G, 2004. Effect of humic acid on quality parameters of groundnut. Crop Research 27: 210-213.

Türkmen Ö, Dursun A, Turan M, Erdinç Ç, 2004. Calcium and humic acid affect seed germination, growth, and nutrient content of tomato (Lycopersicon esculentum L.) seedlings under saline soil conditions. Acta Agriculturae Scandinavica, Section B-Soil & Plant Science 54: 168-174.

Vanitha K, Mohandass S, 2014. Effect of humic acid on plant growth characters and grain yield of drip fertigated aerobic rice (Oryza sativa L.). *The bioscan*, *9*(1): 45-50.

Waqas M, Ahmad B, Arif M, Munsif F, AL Amin M, Kang SM, Kim YH, Lee IJ, 2014. Evaluation of humic acid application methods for yield and yield components of mungbean. American Journal of Plant Sciences 2014.