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Effect of humic acid foliar spraying and nitrogen fertilizers management on wheat yield

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Key words: Foliar humic acid, wheat (*Triticum asetivum* L.), nitrogen fertilizers, nitrogen use efficiency.

Abstract

Foliar feeding has been used as a mean of supplying supplement doses of minor and major nutrients, plant hormone, stimulants and other beneficial substances. It is reported that foliar application of humic acid enhances the nitrogen use efficiency by crops because it is effective at ameliorating the leaf intevenal chlorosis that occurred during early growth of wheat seedlings and hence improves yield. To test this hypothesis an experiment was planned to see the effect of foliar application of humic acid on nitrogen use efficiency on grain and straw yield of wheat in split plot design with three replications at Soil Chemistrty Section, Ayub Agricultural Research Institute, Faisalabad during 2012-13. Experiment included two levels of foliar humic acid spray (H_1: 0 and H_2: 40 mg/L) in main plot and five levels of nitrogen fertilizer (N_1: 0, N_2: 60 kg/ha, N_3: 90 kg/ha, N_4: 120 kg/ha, N_5: 150 kg/ha nitrogen from urea) in subplots. Foliar spray of humic acid was done at two stages i.e. at tillering and at booting stage. At maturity, grain and straw yield was recorded. Interaction effect of foliar humic acid spraying and nitrogen fertilizer management on grain yield and straw yield showed statistically significant results at 5% probability level. The highest grain yield (5.02 t/ha) was obtained from use of 40 mg/L HA+ 150 kg N/ha nitrogen fertilizer. Whereas N_4H_2 and N_5H_1 gave statistically similar yield i.e. 4.58 t/ha. Nitrogen use efficiency was also improved in all treatments where 40 mg/L humic acid foliar spray was used along with nitrogen fertilizer with maximum value of 68 in treatment receiving 60 kgN/ha+ 40ppm HA foliar spray.

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Introduction

Wheat (*Triticum aestivum* L.) is considered one of the most important winter crop in Pakistan. The productivity of wheat is affected by many factors such as seed germination, fertilization and quality of seed bed environment i.e. soil moisture and temperature. To improve the organic content of soil for growing crops, green manuring and animal manure is commonly practiced. In addition to these practices, utilization of organic-mineral fertilizers in agriculture has increased in recent years (Doran *et al.*, 2003). One of the used organic-mineral fertilizer is humic acid. Both soil and foliar application of humic acid is getting popular to enhance crop yield and better soil development. The effects of foliar fertilization have included increase resistance to pest and insect disease, improved drought tolerance and ultimately enhanced crop yield.

Plant growth is influenced directly and indirectly by humic acid foliar spraying. The indirect effects are those factors which provide energy for beneficial organisms within the soil, influence the soil water holding capacity, influence the soil's structure, release of plant nutrients from soft minerals, increased availability of trace minerals and in general improved soil fertility. The direct effects include those changes in plant metabolism that occur following the uptake of organic macromolecules such as, humic acid and fluvic acid. Once these compounds enter in plant cells, several biochemical changes occur in membrane and various cytoplasmic components in plant cell. The foliar application of humic acid and biostimulators led to positive effects on plant growth, fruit set and improvement of cucumber production (El-Nemr *et al.*, 2012). Humic materials may also increase root growth in manner similar to auxin (Donell, 1973), (Tatini *et al.*, 1991). Fernandez-Escobar *et al.* (1999) mentioned that, under field conditions, foliar application of leonardite extracts (humic substances extracted) stimulated shoot growth and promoted the accumulation of K, B, Mg, Ca and Fe in leaves.

Foliar application of humic acid enhances nitrogen use efficieny because it is effective at ameliorating the leaf intervenal chlorosis that occurred during early growth stages of wheat seedlings and thus enhances yield. Bozorgi *et al.*, 2011-12 studied the effect of nitrogen fertilization on seed yield and reported that highest yield was obtained by 80 kgN/ha N fertilizer and 60 mg/L of humic acid foliar spraying which was superior to enhance yield of peanut, cucumber. Therefore, the present study was conducted to see the effect of humic acid foliar spray on nitrogen use efficiency and improvement in wheat yield.

Materials and methods

An experiment was planned to see the effect of foliar application of humic acid on nitrogen use efficiency on yield and yield components of wheat in split plot design with three replications at Soil Chemistrty Section, Ayub Agricultural Research Institute, Faisalabad during 2012-13. Experiment included two levels of foliar humic acid spray (H_1: 0 and H_2: 40 mg/L) in main plot and five levels of nitrogen fertilizer (N_1: 0, N_2: 60 kg/ha, N_3: 90 kg/ha, N_4: 120 kg/ha, N_5: 150 kg/ha nitrogen from urea) in subplots. Basal dose of nitrogen, phosphorus and potassium was applied at the time of sowing. Foliar spray of humic acid was done at two stages i.e. at tillering and at booting stage. In case of H_1 treatment water was sprayed on the crop. At maturity, grain and straw yield was recorded. Prior to experimentation, composite soil samples were collected to check the fertility status of field. The soil pH was measured in a saturated soil paste and electrical conductivity (EC) of the soil extract by method of Mclean, 1982. Soil organic carbon (SOC) content were estimated following the method described by Ryan *et al.* 2001 and total nitrogen by the method of Bremner and Mulvaney, 1982. Available phosphorus was measured by Olsen's method (Rowell, 1994), for potassium soil extraction was made with ammonium acetate (IN of pH 7.0) and potassium was determined by using PFP-7 Janway Flame photometer (Rowell, 1994). Textural class was determined by using hydrometer method (Bouyoucos, 1962). Statistical analysis data was done by using the M-Stat program. ANOVA test following by least significance difference (LSD) test was used to determine the difference among the treatment means ($p < 0.05$). Soil analysis showed that (Table 1), the soil texture was sandy clay loam with pH, 8.2 and it was free from salinity, sodicity hazards marginal in organic matter and phosphorus while adequate in available potassium.

The grain samples were collected at maturity and then dried at 70 °C till constant weight in an oven and ground in a Wiley micro mill and used for N, P and K analysis using standard protocols. For nitrogen estimation, the dried ground material (0.5 g) was digested in sulphuric acid using digestion mixture ($CuSO_4$, Se and $FeSO_4$), distilled and titrated against 0.1 N H_2SO_4 (Jackson, 1962). Plant samples were wet digested with triacid mixture of HNO_3-H_2SO_4-$HClO_4$. The phosphorus was measured by matavanadate yellow color method (Jackson, 1979) and potassium by following the method of Yoshida *et al*, 1976. The nutrients (N, P, K) uptake and nitrogen use efficiency (NUE) was calculated as under

$$\text{Nutrient uptake kg ha}^{-1} = \frac{\text{Nutrient contents (\%) in plant part (dry matter)} * \text{Yield (kg ha}^{-1})}{100}$$

$$\text{Nitrogen use efficiency (NUE)} = \frac{\text{Wheat grain yield (kg ha}^{-1})}{\text{Fertilizer applied (kg N ha}^{-1})}$$

Results and discussion

Effect of humic acid foliar spraying on grain and straw yield of wheat

The grain yield of wheat is presented in Figure 1. Data showed that interaction effect of humic acid foliar spraying and nitrogen fertilizer management on grain yield of wheat was significant at 5% probability level. Data revealed that highest grain yield (5.00 t/ha) was obtained in treatment H_2N_5 (40 mg/L foliar spraying of humic acid and 150 kg/ha nitrogen application). The H_1N_1 treatment (without foliar spraying of humic acid and without nitrogen fertilizer application) with 2.36 t/ha was minimum. While the treatments H_2N_4 (40 mg/L HA foliar spraying of humic acid and 150 kg/ha nitrogen) and H_1N_5 (with foliar spraying of water and 150 kg/ha nitrogen fertilizer) are statistically at par with 4.58 t/ha wheat grain yield. Similar results were obtained by Moraditochaee (2012) on seed yield of peanut; Bozorgi *et al.*, 2011 and Hafeez and Magda, 2003. Zhang and Ervin, 2004 reported that humic acid contains cytokinins and their application resulted in increasing endogenous cytokinins and auxin levels which probability leads to improve yield.

Table 1. The result of soil analysis at the experimental sites.

Depth	**0-30 cm**	**Soil texture**	**Sandy clay loam**
Clay (%)	28.6	E.C (dS/m)	1.50
Silt (%)	23.3	Organic matter (%)	0.72
Sand (%)	48.9	P (ppm)	7.23
pH	8.2	K (ppm)	180

Data related to straw yield of wheat is presented in Figure 2. The data showed that maximum straw yield 8.91 t/ha was found where 40 mg/L humic acid foliar spraying was used along with 150 kg/ha nitrogen fertilizer. Similarly the interaction effect of humic acid foliar spraying and nitrogen fertilizer management on straw yield of wheat was significant at 5 % probability level. The results also revealed that straw yield is maximum in all the treatments where humic acid foliar spray was used along with nitrogen fertilizers than treatments without humic acid application. The minimum straw yield of 3.54 t/ha was obtained from H_1N_1 (without humic acid foliar spraying and nitrogen fertilizer application). The results of straw yield of wheat are in consonance with the findings of Hossain *et al.*, 2007; Bozorgie *et al.*, 2011-12 and Moraditochaee (2012).

Nutrients (N, P, K) uptake by grain and straw

The data presented in Table 2. shows the N, P and K uptake by grain and straw. In case of grain the maximum uptake of N, P and K with 93, 22 and 30 kg/ha was found with H_2N_5 (40 mg/L HA foliar spraying of humic acid and 150 kg/ha nitrogen application) treatment. While in case of straw maximum uptake of N, P and K with 105, 16 and 101 kg/ha with similar registered treatment. While the minimum uptake of nutrients were found in H_1N_1 (without foliar spraying of humic acid and without nitrogen fertilizer application). Osman *et al.*, 2013 also reported that foliar spray of humic acid significantly increased uptake of N, P and K contents of wheat grain. Humic acid enhances cell permeability, which in turn made for rapid entry of minerals in leave cells and so resulted in higher uptake of plant nutrients. This effect was associated with the function of hydroxyls and carboxyls in these compounds. These results agree with those obtained by Laila and Elbordiny, 2009 and Habashy and Laila, 2005 who concluded that the uptake of N, P and K by both straw and grain of wheat plant increased due to foliar application of humic acid.

Table 2. Comparison of mean between interaction effects of humic acid spraying & nitrogen fertilizer management on uptake of nutrients in grain and straw.

Treatments	N uptake in grain (kg/ha)	N uptake in straw (kg/ha)	P uptake in grain (kg/ha)	P uptake in straw (kg/ha)	K uptake in grain (kg/ha)	K uptake in straw (kg/ha)
H1N1	21.0^{g}	23.5^{f}	5.9^{g}	4.7^{h}	10.4^{g}	25.9^{h}
H1N2	29.7^{f}	34.8^{e}	8.8^{f}	6.1^{g}	13.5^{f}	36.8^{g}
H1N3	50.9^{e}	54.0^{d}	12.5^{e}	9.3^{f}	18.5^{e}	61.4^{e}
H1N4	60.6^{d}	58.6^{d}	14.1^{cde}	10.2^{e}	20.9^{d}	61.9^{e}
H1N5	71.6^{c}	69.3^{c}	17.9^{b}	12.0^{e}	25.7^{b}	73.3^{cd}
H2N1	29.7^{f}	59.6^{d}	9.69^{f}	9.2^{f}	13.5^{f}	51.6^{f}
H2N2	60.2^{d}	75.4^{c}	12.8^{de}	11.5^{d}	19.3^{e}	71.7^{d}
H2N3	74.2^{c}	83.7^{b}	15.2^{cd}	12.3^{c}	22.1^{d}	77.8^{c}
H2N4	81.3^{b}	103.2^{a}	16.4^{bc}	14.6^{b}	24.3^{c}	92.3^{b}
H2N5	93.2^{a}	105.6^{a}	20.7^{a}	15.9^{a}	30.1^{a}	101.3^{a}

Within each column, means followed by the same letter do not significantly differ at $P < 0.05$.

Nitrogen use efficiency (NUE)

The nitrogen use efficiency was calculated and presented in Figure 3. The results showed that HA foliar spray treatments were significantly better than without humic acis application. This was due to better availability of nutrients throughout the growth stages leading to better uptake of nutrients. NUE was significantly higher (68) in N_2H_2 (40mg/L foliar spraying of humic acid and 60 kg/ha nitrogen fertilizer) treatment which is 39% more over N_2H_5 treatment (40mg/L foliar spraying of humic acid and 150 kg/ha nitrogen fertilizer). The principal physiological function of humic acid may be that the reduce oxygen deficiency in plants, which result in better uptake of nutrients (Chen and Avaid, 1990). Leaf nitrogen status is often well correlated with chlorophyll content and leaf vienal chlorosis is corrected through foliar spray. Foliar use of humic acid derivatives is reported to be very effective because the humic molecules can get into the cellular nutrient stream and make cellular membrane more permeable allowing the improvement of nutrient flow and cell division (Jackson, 1993).

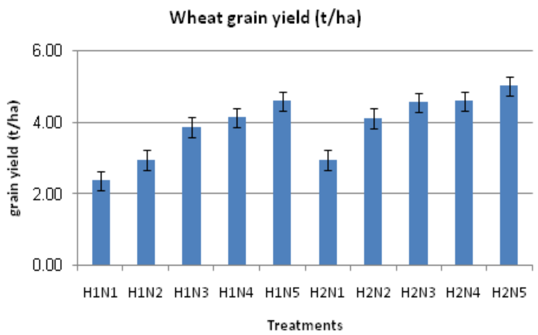

Fig. 1. Effect of humic acid foliar spraying on wheat grain yield.

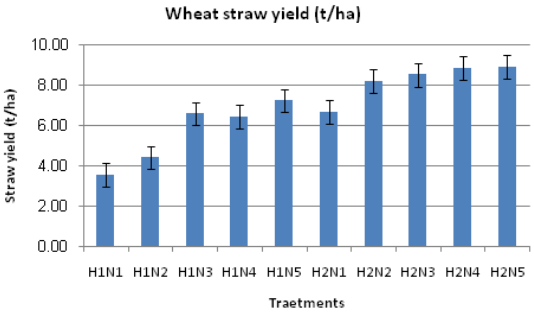

Fig. 2. Effect of humic acid foliar spraying on wheat straw yield.

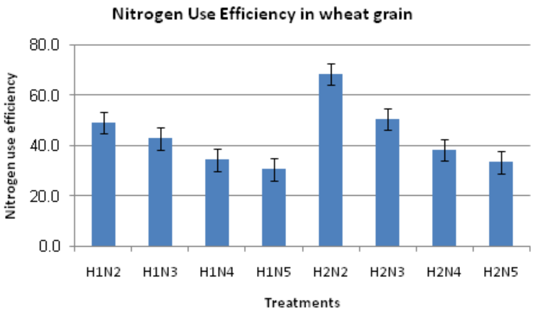

Fig. 3. Effect of humic acid foliar spraying on nitrogen use efficiency in wheat grain.

Conclusion

The study concludes that combined application of humic acid foliar spraying and nitrogen fertilizer had significant effect on grain and straw yield of wheat. It also improves the nutrient uptake and nitrogen use efficiency of wheat crop.

Refrences

Bouyoucos GJ. 1962. Hydrometer method improved for making particle size analysis of soils. Journal of Agriculture **53,** 464-465.

Bozorgi HR, Pendashteh M, Tarighi F, Doustan HZ, Keshavarz AK, Azarpour E, Moraditochaee M. 2011. Effect of foliar zinc spraying and nitrogen fertilization on seed yield and several attributes of groundnut (Arachis hypogaea L.). World applied Scientific Journal **13,** 1209-1217.

Bozorgi HR, Bidarigh S, Azarpour E, Danesh RK, Moraditochaee M. 2012. Effects of natural zeolite application under foliar spraying with humic acid on yield and yield components of cucumber (*Cucumis sativus L.*). International Journal of Agriculture & Crop Sciences **4,** 1485-1488.

Bremner JM, Mulvaney CS. 1982. Nitrogen total. P. 595-624. *In* A.L. Page (ed.), *Methods of soil analysis*. Agron. No. 9, Part 2: *Chemical and microbiological properties*, 2nd ed., American Society of Agronomy, Madison, WI, USA.

Chen Y, Aviad T. 1990. Effects of humic substances on plant growth. p. 161-186 In P. MacCarthy, C.E., R.L. Clapp, and P.R. Bloom (Eds.). Humic substances in soil and crop sciences. Soil Science Society of America, Madison, USA.

Donnell RW. 1973. The auxin-like effects of humic preparations from leonardite. Soil Science **116**, 106-112.

Doran I, Akinci C, Yildrim M. 2003. Effects of delta humate applied with different doses and methods on yield and yield components of Diyabakir-81 wheat cultivar. 5th Field Crop Congress. Turkey. **2**, 530-534. (In Turkish with English abstracts).

El-Nemr MA, El-Desuki M, El-Bassiony AM, Fawzy ZF. 2012. Response of growth and yield of cucumber Plants (*Cucumis sativus* L.) to different foliar applications of humic acid and Biostimulators. Australian Journal of Basic & Applied Sciences **6**, 630-637.

Fernandez-Escober R, Benlloch M, Barranco D, Dueñas A, Gutérrez gañán JA. 1996. Response of olive trees to foliar application of humic substances extracted from leonardite. Scientific Horticulture **66,** 191-200.

Habashy NR, Laila MA. 2005. Effects of organic growth promoting substances as Humic acids and Indole acetic acid on wheat crop with special refrences to some chemical composition. Minufiya Journal of Agricultural Research **30,** 1607-1624.

Hossain MA, Hamid A, Nasreen S. 2007. Effect of nitrogen and phosphorus fertilizer on N/P uptake and yield performance of groundnut (*Arachis hypogaea L.*) Journal of Agricultural Research **45,** 119-127.

Jackson ML. 1962. Soil Chemical Analysis. Prentice Hall: Inc. Englewood Cliffs, New Jersey. United States of America.

Jackson WR. 1993. Organic Soil Conditioning, "Humic, Fulvic and Microbial Balance "isbn#0-9635741-0-8.

Jackson ML. 1979. Soil Chemical Analysis: Advanced course. 2nd ed. Department of Soil Science, University of Wisconsin, Madison, USA.

Laila KMA, Elbordiny MM. 2009. Response of wheat plants to potassium humate application. Journal of Applied Sciences Research **5**, 1202-1209.

Mclean EO. 1982. Soil pH and lime requirement. P. 199-209. *In:* Method of Soil Analysis Part 2: Chemical and Microbiological Properties. A. L. Page, R. H. Miller and D. R. Keeney (eds). American Society of Agronomy. **9**. Madison, WI, USA.

Moraditochaee M. 2012. Effects of humic acid foliar spraying and nitrogen fertilizer management on yield of peanut (*Arachis hypogeae L.*) in Iran. ARPN Journal of Agriculture & Biological Sciences **7,** 289-293.

Osman EAM, EL- Masry AA, Khatab KK. 2013. Effect of nitrogen fertilizer sources and foliar spray of humic and/or fulvic acids on yield and quality of rice plants. Pelagia Research Library. Advances in Applied Sciences Research. **4,** 174-183.

Rayan J, Estefan G, Rashid A. 2001. Soil and Plant Analysis Laboratory Manual. 2nd ed. International center of Agricultural Research in Dry Areas, Alleppo, Syria.

Rowell DL. 1994. Soil Science. Methods and application Longman Scientific & Technical, UK.

Tatini M, Bertoni P, Landi A, Traversi ML. 1991. Effect of humic acids on growth and biomass portioning of container-grown olive plants. Acta Hort, **294,** 75-80.

Yoshida AS, Fornno DO, Cock JL, Gomez KA. 1976. Laboratory manual for physiological studies on rice. IRRI, Manila, Philphines.

Zhang X, Ervin EH. 2004. Cytokinin-containing seaweed and humic acid extracts associated with creeping bentgrass leaf cytokinins and drought resistance. Crop Sciences **44,** 1737-1745.