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Response of Wheat Crop to Humic Acid and Nitrogen Levels

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Abstract

A field experiment was conducted to study the response of wheat crop to humic acid (HA) and nitrogen levels (N) during rabi 2014-15 at Agronomy Research Farm, The University of Agriculture Peshawar-Pakistan. The experiment was laid out in a randomized complete block design (RCBD) with split plot arrangement having two factors (humic acid and nitrogen levels). Humic acid levels (0, 5, 10 and 15 kg ha^{-1}) were assigned to the main plots, whereas nitrogen levels (0, 90, 120 and 150 kg ha^{-1}) were assigned to sub plots. Plot size of 4.5 m2 having 6 rows of 3 m length, 25 cm apart was used. Urea was applied as a source of nitrogen. All other agronomic practices were applied uniformly. Results showed that humic acid at the rate of 15 kg ha^{-1} and nitrogen at the rate of 150 kg ha^{-1} produced maximum plant height (109 cm), tillers m^{-2} (267), productive tillers m^{-2} (261), 1000 grain weight (46.3 g), grains spike^{-1} (49), grain yield (3316 kg ha^{-1}), biological yield (9641 kg ha^{-1}) and harvest index (36.0 %). Thus it is concluded that wheat yield increased by increasing the application of humic acid and nitrogen levels up to 15 kg ha^{-1} and 150 kg ha^{-1} respectively.

Keywords: *Wheat (Triticum aestivum L.); Humic Acid; Nitrogen; Yield and yield components*

Introduction

Wheat (*Triticum aestivum* L.) is used as a major source of food all over the world and consumed as staple food especially in Pakistan, it meets the major dietary needs. Its straw is used as feed for livestock. The total area of wheat crop in Pakistan is about 8.64 million hectares and the average production was 23.47 million tones. However, in Khyber Pakhtunkhwa (KP) wheat was cultivated on 729.3 million hectares in and is likely to produce 11.3 million tons [1].

Humic acid plays an important role in enhancing wheat production. It is the commercial term often used to refer to the combined humic and fulvic acid content found in naturally occurring deposits. It is known to be among the most bio-chemically active materials found in soil. It increases root vitality, improved nutrient uptake, increase chlorophyll synthesis, improve seed germination, increase fertilizer retention, stimulate beneficial microbial activity and improve yield.

In general Humic acid applied sole or in combination with NP fertilizers were found to be the most economical to obtain optimum production of wheat under the rainfed conditions [2]. Initial growth stages of wheat cultivars significantly affected by humic acid application [3]. It is advisable to apply humic acid fertilizer for organic seed production of wheat especially in cases of drought stress condition after flowering [4]. Humic acid application has limited promoting effect on growth, yield and quality of wheat crop with respect to split soil application of N-fertilizers [5]. 2% humic acid increased the grain and straw yield of wheat by 26% and 23.8% [6].

Inorganic fertilizers have rapid and better effects on crop growth and yield components of wheat crop. Nitrogen is an essential nutrient for plant growth. Healthy plants often contain 3 to 4 percent nitrogen in their above-ground tissues. This is a much higher concentration compared to other nutrients. Nitrogen fertilizer applied to crops in Pakistan to increase its yield and quality. Nitrogen is an essential component of chlorophyll, amino acid, ATP (Adenosine triphosphate) and nucleic acid such as DNA.

Nitrogen (N) nutrition is a critical factor in root uptake into wheat grain and N supply improved root length density [7]. Proper management of nitrogen leads to higher yield. The maximum grain yield of wheat crop (3.48 tones hac^{-1}) obtained by the application of 180 kg N ha^{-1} [8]. Nitrogen is the major element required by plants for their better growth. Adequate nitrogen promotes vigorous growth and dark green color [9]. N utilization efficiency and grain yield increased at the appropriate N rate and topdressing N ratio [10]. One of the positive effect of available N is to increase in root branching [11], which occurs especially in N enriched soil patches for barley. Root survivorship of spring wheat during grain filling is higher by applying 270 kg N ha^{-1} compared with 20 kg N ha^{-1} [12].

Due to the importance of humic acid and nitrogen, the present experiment was conducted to investigate the response of wheat crop to humic acid and nitrogen levels in spring wheat.

Materials and Methods

Experimental Site, Design and Agronomic Management

This current study was conducted at Agronomy Research Farm, The University of Agriculture, Peshawar during Rabi 2014-15 season. The site is located at (34° 00' N, 71° 30° E, 510 MASL). The experiment was laid out in Randomized Complete Block Design (RCBD) with split plot arrangement and three replications. Humic acids levels were (0, 5, 10 and 15 kg ha^{-1}) assigned to the main plots while nitrogen levels (0, 90, 120 and 150 kg ha^{-1}) assigned to sub plots. The control treatment having no nitrogen and humic acid were kept in each replication. Sub plot size was 3 × 1.5 m^2 with row to row distance of 25 cm having six rows. Urea was applied as a source for nitrogen. All other agronomic practices were applied uniformly.

Experimental and Data Recording Procedure

Plant height was recorded with the help of meter rod during physiological maturity stage by measuring the height of the plant from the ground to the tip of the ear awns. In each sub plot three rows of one meter length were selected randomly and tillers were counted. Counted tillers were converted to tillers m^{-2} by using the following formula.

$$\text{Tillers } m^{-2} = \frac{\text{No of tillers counted}}{\text{Row} - \text{row distance (m) x Row length (m) x No. of rows}}$$

The data on number of productive tillers m^{-2} recorded by counting the productive tiller in one meter long row at three randomly selected places in each sub plot and were converted into m^{-2} by using the following formula

$$\text{Productive tillers } m^{-2} = \frac{\text{total productive tillers counted}}{\text{Row} - \text{row distance (m) x Row length (m) x No. of rows}} \text{x1}$$

Five spikes were randomly selected in each subplot at maturity and threshed separately. Grains were counted and were averaged. Thousand grains weight was calculated by counting thousand grains taken randomly from each sub plot and then weighed on electronic balance. Biological yield were recorded by harvesting 4 central rows in each sub plot, sun dried for 6 days, having moisture content of grain is less than 15%, weighed and were converted into kg ha^{-1} by using the following formula;

$$\text{Biological yield (kg ha}^{-1}\text{)} = \frac{\text{Biological yield in four central rows}}{\text{Row} - \text{row distance (m) x Row length (m) x No. of rows}} \text{x10000}$$

The harvested material for biological yield in each subplot was threshed using a small wheat thresher. After threshing the grain was weighed by electronic balance and was converted to kg ha^{-1} by using the formula

$$\text{Grain yield (kg ha}^{-1}\text{)} = \frac{\text{Grain yield in four central rows}}{\text{Row} - \text{row distance (m) x Row length (m) x No. of rows}} \text{x10000}$$

Harvest index were calculated by using the following formula.

$$\text{Harvest index (\%)} = \frac{\text{Grain yield (kg ha}^{-1}\text{)}}{\text{Biological yield (kg ha}^{-1}\text{)}} \times 100$$

Statistical Analysis

All data collected were subjected to analysis of variance (ANOVA) with the help of statistical software, Statistics 8.0 USA (2005). Upon significant F-Test, least significant difference (LSD) test was used for mean comparison to identify the significant components of the treatments means.

Results and Discussion

Plant height (cm)

Data showed that plant height was significantly affected by humic acid and different nitrogen levels while their interaction was not significant (Table 1). Higher plant height (109 cm) was recorded in plots which applied 15 kg ha^{-1} humic acid while the shorter plant values (106 cm) were obtained from no humic acid application. Nitrogen application increased, plant height (109 cm) when applied 150 kg N ha^{-1} application while shorter plant values (104 cm) was obtained by no nitrogen application. In the current study it has been observed that plant height significantly affected by humic acid and nitrogen application. The taller plants were produced by humic acid application at the rate of 15 kg ha^{-1}. The increase in plant height might be due to increasing humic acid supply significantly enhanced shoot growth. Our results are in line with [13] who stated that maximum plant height was recorded by 15 kg ha^{-1} humic acid application. Nitrogen application also increased plant height. The taller plants were maintained by 150 kg N ha^{-1}. This increase might be due to balance supply of N need for vegetative growth which leads to increase the cell elongation. Increasing nitrogen supply enhanced both shoot and root growth and the positive effects of N on shoot growth were pronounced than root growth [13,3].

Tillers m^{-2}

Tiller m^{-2} are presented in Table 2. Data showed that humic acid, nitrogen and humic acid × nitrogen interaction significantly affected tillers m^{-2} of wheat crop. Humic acid at the rate of 15 kg ha^{-1} gave the maximum numbers of tillers m^{-2} (255) whereas minimum tillers m^{-2} (223) were recorded in plots which have no humic acid application. Similarly, maximum tillers m^{-2} (267) were produced by nitrogen applied at 150 kg ha^{-1} while minimum tillers m^{-2} (206) were produced in control (0 kg N ha^{-1}) plots. For the interaction effect, maximum tillers m^{-2} (280) were obtained by 15 kg ha^{-1} humic acid with 150 kg N ha^{-1} while minimum tillers m^{-2} (188) were recorded in the untreated plots by no HA and N. Tillers m^{-2} significantly affected by humic acid and nitrogen application. Higher tillers m^{-2} was produced by humic acid applied at the rate of 15 kg ha^{-1}. This increase might be due to increasing humic acid supply significantly enhanced shoot growth and development. Same results were reported by [14] that humic acid significantly affects plant growth and development. Nitrogen application also increased tillers m^{-2}. Maximum tillers m^{-2} were maintained by 150 kg N ha^{-1}. Our results are in line with [5], who stated that nitrogen at the rate of 150 kg ha^{-1} improve wheat growth and number of tillers m^{-2}.

Number of productive tillers (m^{-2})

Data statistical analysis showed that productive tillers (m^{-2}) were significantly affected by humic acid and nitrogen levels while their interactions were not significant (Table 3). Maximum productive tillers m^{-2} (250) were recorded in 15 kg ha^{-1} humic acid applied plots while minimum productive tillers m^{-2} (217) were noted for no humic acid application. Also increasing nitrogen till 150 kg ha^{-1} gave the maximum productive tillers m^{-2} (261) while minimum productive tillers m^{-2} (201) were recorded for no nitrogen application.

1000 grain weight (g)

Table 4 indicated that humic acid levels, nitrogen levels and their interaction had significantly affected 1000 grains weight of wheat crop. Maximum 1000 grain weight (43.3 g) was achieved by higher level of humic acid application (15 kg ha^{-1}) which was at par with 10 kg ha^{-1} humic acid application while minimum 1000 grain weight (41.3 g) was recorded by no humic acid application. Similarly in case of nitrogen levels, maximum 1000 grain weight (44.4 g) was obtained by higher level of N (150 kg ha^{-1}) while minimum (37.4 g) for no nitrogen application. However, it has been observed that there are positive interaction between humic acid and nitrogen application while maximum 1000 grains weight (46.3 g) obtained by 15 kg ha^{-1} humic acid with 150 kg N ha^{-1} while minimum 1000 grains weight (36.0 g) was recorded in plots that not treated by humic acid and nitrogen. Humic acid and nitrogen application significantly affected 1000 grains weight in wheat crop. The maximum 1000 grains weight was maintained by humic acid application at the rate of 15 kg ha^{-1}. Similar results were reported by [15] that humic acid application increases 1000 grains weight. Nitrogen application also increases 1000 grains weight. The maximum 1000 grains weight was maintained by 150 kg N ha^{-1}. Current results are in line with [16], who stated that nitrogen application at the rate of 150 kg ha^{-1} significantly increased 1000 grains weight.

Grains $spike^{-1}$

Data indicated that grains $spike^{-1}$ of wheat as affected by different levels of humic acid and nitrogen are presented in Table 5. Statistical analysis of the data revealed that the grains $spike^{-1}$ was significantly affected by different levels of nitrogen and the interaction between humic acid and nitrogen, while humic acid levels were not significant. The application of higher dose of nitrogen (150 kg ha^{-1}) produced more grains $spike^{-1}$ (48) whereas lower numbers of grains $spike^{-1}$ were recorded in plots supplied with no nitrogen. In case of interaction maximum grains $spike^{-1}$ (49) were recorded in plots received 10 kg ha^{-1} humic acid with nitrogen at the rate of 120 kg N ha^{-1}, while minimum grains $spike^{-1}$ (32) were produced by control plots (supplied with no humic acid and nitrogen). Grains $spike^{-1}$ significantly affected by humic acid and nitrogen application. The higher grains $spike^{-1}$ was produced by humic acid applied at the rate of 15 kg ha^{-1}. [15] reported that humic acid produce higher grains $spike^{-1}$. Nitrogen application also increased grains $spike^{-1}$. Maximum grains $spike^{-1}$ was produced by 150 kg N ha^{-1}. Our results are in line with [17], who stated that nitrogen fertilization is a prerequisite to produce high yields of wheat and to increase grain quality.

Biological yield (kg ha^{-1})

Table 6 showed that biological yield of wheat crop significantly affected by humic acid levels, nitrogen levels and also by the interaction of humic acid × nitrogen. Maximum biological yield (8552 kg ha^{-1}) was achieved at higher level of humic acid application (15 kg HA ha^{-1}), while lower biological yield (8008 kg ha^{-1}) was produced by no humic acid application. Regarding nitrogen levels, highest biological yield (9291 kg ha^{-1}) was obtained using higher level of N (150 kg ha^{-1}) while lower (6717 kg ha^{-1}) was recorded for no nitrogen application. For the interaction between humic acid and nitrogen application, data revealed that the maximum biological yield (9641 kg ha^{-1}) was observed for 15 kg ha^{-1} humic acid with 150 kg N ha^{-1} while minimum (6677 kg ha^{-1}) was recorded for no applied humic acid and nitrogen. Application of humic acid and nitrogen cause significant increase in biological yield. Maximum biological yield was observed at the rate of 15 kg HA ha^{-1}. Humic acid significantly increase biological yield, reported by [15]. Nitrogen application also causes significant increase in biological yield. Maximum biological yield was maintained by 150 kg N ha^{-1}. Our results are in line with [18], who reported that nitrogen fertilizer management on grain yield and straw yield showed statistically significant results.

Grain yield (kg ha^{-1})

Data analysis revealed that grain yield was significantly affected by humic acid and nitrogen levels while their interaction had no significant (Table 7). Higher grain yield (2819 kg ha^{-1}) was recorded for 15 kg ha^{-1} humic acid which was at par with 10 kg ha^{-1} humic acid application while lower grain yield (2567 kg ha^{-1}) was noted for no humic acid application. In case of nitrogen application, maximum grain yield (3316 kg ha^{-1}) was recorded for 150 kg N ha^{-1} while minimum (1776 kg ha^{-1}) was recorded for no nitrogen. Grain yield also showed significant increase by the application of humic acid and nitrogen. Highest grain yield was recorded for 15 kg ha^{-1} humic acid which was at par with 10 kg ha^{-1} humic acid. Our results are in line with [19], who stated that humic acid application increase grain yield. Nitrogen application has significant increase in grain yield. Higher grain yield was observed at the rate of 150 kg N ha^{-1}. Similar result was also reported by [18] that nitrogen at the rate of 150 kg ha^{-1} produce higher grain yield.

Harvest index (%)

Regarding to harvest index of wheat crop as affected by different levels of humic acid and nitrogen are presented in Table 8. Data analysis revealed that harvest index was significantly affected by different levels of nitrogen and the interaction of humic acid and nitrogen, while humic acid levels were not significant. Maximum harvest index (35.7 %) was achieved by higher level of nitrogen (150 kg ha^{-1}) which was at par with level 120 kg N ha^{-1}, while minimum (26.6 %) was recorded by no nitrogen application. For interaction between humic acid and nitrogen level, the maximum harvest index (36.0 %) was observed for 15 kg ha^{-1} humic acid with 150 kg N ha^{-1} while lowest (23.0 %) was obtained in control plots which have no humic acid and no nitrogen. Harvest index significantly affected by humic acid and nitrogen application. Higher harvest index was observed by humic acid at the rate of 15 kg ha^{-1}. Nitrogen application also has significant increase in harvest index. Maximum harvest was maintained by 150 kg N ha^{-1}. The results of current study are in line with [20], who obtained higher harvest index by the application of humic acid combined with nitrogen at the rate of 150 kg N ha^{-1} [21].

Nitrogen (kg ha^{-1})	Humic Acid (kg ha^{-1})				Mean
	HA 1	HA 2	HA 3	HA 4	
N 1	103.3	104.2	104.7	105.7	104 c
N 2	105.0	107.0	107.3	108.9	107 b
N 3	106.7	107.8	108.3	110.6	108 b
N 4	107.7	108.7	110.3	110.9	109 a
	106d	107c	108b	109a	

LSD at P ≤ 0.05 for HA = 0.39788

LSD at P ≤ 0.05 for N = 0.550094

Table 1: *Plant height (cm) of wheat crop as affected by different humic acid and nitrogen levels during rabi 2014-15 season.*

Nitrogen (kg ha^{-1})	Humic Acid (kg ha^{-1})				Mean
	HA 1	HA 2	HA 3	HA 4	
N 1	188	202	212	220	206 d
N 2	213	225	237	255	233 c
N 3	237	248	247	264	249 b
N 4	252	264	270	280	267 a
	223c	235bc	242ab	255a	

LSD at P ≤ 0.05 for HA = 17.36305

LSD at P ≤ 0.05 for N = 7.136786

LSD at P ≤ 0.05 for HA × N = 14.27357

Table 2: *Tillers m^{-2} of wheat crop as affected by different humic acid and nitrogen levels during rabi 2014-15 season.*

Nitrogen (kg ha^{-1})	Humic Acid (kg ha^{-1})				Mean
	HA 1	HA 2	HA 3	HA 4	
N 1	182	197	207	216	201 d
N 2	205	221	231	250	227 c
N 3	232	242	240	258	243 b
N 4	247	259	264	274	261 a
	217c	230bc	236ab	250a	

LSD at P ≤ 0.05 for HA = 16.2521

LSD at P ≤ 0.05 for N = 7.374942

Table 3: *Productive tillers as affected by different humic acid and nitrogen levels during rabi 2014-15 season.*

Nitrogen (kg ha^{-1})	Humic Acid (kg ha^{-1})				Mean
	HA 1	HA 2	HA 3	HA 4	
N 1	36.0	37.0	38.3	38.3	37.4 c
N 2	41.3	43.3	45.0	42.3	43.0 b
N 3	45.0	44.3	43.0	46.0	44.6 a
N 4	42.0	44.0	45.3	46.3	44.4 a
	41.3b	41.9ab	42.9a	43.3a	42.4

LSD at P ≤ 0.05 for HA = 1.395451

LSD at P ≤ 0.05 for N = 1.220211

LSD at P ≤ 0.05 for HA × N = 2.440422

Table 4: *1000 grains weight (g) of wheat as affected by different humic acid and nitrogen levels during rabi 2014-15 season.*

Nitrogen (kg ha^{-1})	Humic Acid (kg ha^{-1})				Mean
	HA 1	HA 2	HA 3	HA 4	
N 1	32	35	34	32	33 c
N 2	44	46	47	47	46 b
N 3	46	46	49	46	47 b
N 4	50	47	47	48	48 a
	44	43	44	43	

LSD at P ≤ 0.05 for N = 1.007778

LSD at P ≤ 0.05 for HA × N = 2.015557

Table 5: *Grains spike^{-1} of wheat crop as affected by different humic acid and nitrogen levels during rabi 2014-15 season.*

Nitrogen (kg ha^{-1})	Humic Acid (kg ha^{-1})				Mean
	HA 1	HA 2	HA 3	HA 4	
N 1	6677	7237	6248	6706	6717 d
N 2	7631	7936	8764	8729	8265 c
N 3	8782	8847	9181	9133	8986 b
N 4	8942	9125	9456	9641	9291 a
	8008d	8286c	8412b	8552a	

LSD at P ≤ 0.05 for HA = 115.5918

LSD at P ≤ 0.05 for N = 68.77328

LSD at P ≤ 0.05 for HA × N = 137.5466

Table 6: *Biological yield (kg ha^{-1}) of wheat crop as effected by different humic acid and nitrogen levels during rabi 2014-15 season.*

Nitrogen (kg ha^{-1})	Humic Acid (kg ha^{-1})				Mean
	HA 1	HA 2	HA 3	HA 4	
N 1	1658	1662	2038	1747	1776 d
N 2	2619	2734	2605	2859	2704 c
N 3	2925	3088	3164	3203	3095 b
N 4	3067	3304	3424	3468	3316 a
	2567b	2697ab	2808a	2819a	

LSD at P ≤ 0.05 for HA =158.8364

LSD at P ≤ 0.05 for N =110.063

Table 7: *Grain yield (kg ha^{-1}) of wheat crop as affected by different humic acid and nitrogen levels during rabi 2014-15 season.*

Nitrogen (kg ha^{-1})	Humic Acid (kg ha^{-1})				Mean
	HA 1	HA 2	HA 3	HA 4	
N 1	23.0	24.8	32.6	26.0	26.6 c
N 2	34.3	34.5	29.7	32.7	32.8 b
N 3	33.3	34.9	34.5	35.1	34.4 a
N 4	34.3	36.2	36.2	36.0	35.7 a
	31.3	32.3	33.4	34.5	

LSD at P ≤ 0.05 for N = 1.486151

LSD at P ≤ 0.05 for HA × N = 2.972303

Table 8: *Harvest index (%) of wheat crop as affected by different humic acid and nitrogen levels during rabi 2014-15 season.*

Conclusions

From the obtained results we conclude that application of humic acid at the rate of 15 kg ha^{-1} and nitrogen fertilizer at the rate of 150 kg ha^{-1} showed significant increase in yield and yield components of wheat crop. Therefore, we can recommend the application of humic acid at the rate of 15 kg ha^{-1} and nitrogen at the rate of 150 kg ha^{-1} to increase yield and yield components of wheat crop in Peshawar, Pakistan.

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