Research Article

Effect of humic acid and crop residue application on emergence and wheat phenology

Kashif Akhtar, Ahmad Khan, Muhammad Tariq Jan, Muhammad Zahir Afridi, Shahzad Ali and Sajjad Zaheer

Department of Agronomy, The University of Agriculture, KPK Peshawar Pakistan.

*Corresponding author's email: kashtoru@gmail.com

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Abstract

To study the effect of humic acid and crop residues application on wheat, an experiment was conducted at New Development Farm of KPK Agricultural University Peshawar during winter 2011-12. The experiment was laid out in RCB design having four replications. A plot size of 3 x 4m was used. Pirsabak2005 variety was used. Different level of Humic acid @ 1, 1.5, 2 and 2.5 kg ha⁻¹ was applied at sowing time 5 tons ha⁻¹ of mungbean, 10 tons ha⁻¹ of wheat straw and 2^{1/2} and 5 tons ha⁻¹ of mungbean and wheat straw was incorporated 30 days before sowing. Results revealed that higher days to anthesis (125), days to maturity (157) and plant height (84.6 cm), were recorded from those plots where 2.5 kg ha⁻¹ of humic acid was applied, whereas 5 tons ha⁻¹ mungbean incorporation gave us higher anthesis (123.8), days to maturity (157) and plant height (85.7 cm). It is concluded that 5 tons ha⁻¹ of mungbean residues incorporation and 2.5 kg ha⁻¹ of humic acid application will lead to good vegetative growth.

Key words: Humic Acid; Wheat; Phenology, Crop residues

Introduction

Wheat (*Triticum aestivum* L.) belongs to the family Poaceae. It is an annual Rabi self-pollinated and long day plant grown as winter crop in Pakistan. Its requirements in Pakistan are going to increase day by day. The present production of wheat is not sufficient to feed the existing population. The additional requirements will have to be met either by bringing more area under cultivation or increasing yield per unit area. In Pakistan wheat was cultivated on an area of 9.04 million hectares with its total production of 23.86 million tons with an

average yield of 2639 kg ha⁻¹. Whereas in Khyber Pakhtunkhwa (KPK), it was grown on an area of 0.78 m ha with producing 1.2 m tons with average yield of 1856 kg ha⁻¹ during 2009-10 [1].

Wheat is exhaustive crop it not only depletes soil fertility but also degrade soil physical properties. The soil of KPK is deficient in organic matter, nitrogen, phosphorous and zinc [2]. To overcome the problem of nutrient deficiency and increase wheat vegetation and yield, the farmers are applying chemical fertilizers. However, the chemical fertilizers are expensive and small

farmers cannot afford to use these chemical fertilizers in suitable amount and balance proportion which have resulted in low production [3]. Under the above conditions integrated use of chemical and organic fertilizer/manures can play an important role to sustain soil fertility and crop productivity [4]. However, mineral nitrogenous fertilizers are the rich source of nitrogen as plant nutrient but also contribute to environmental hazards in a variety of ways [5]. On the other hand, manures and residues are bulky in nature and generally comprise of cellulose (15-60%), hemi cellulose (10-30%) water soluble fraction (5-30%), alcohol soluble fraction (fats, oil, waxes, resins and pigments) and protein containing N and S mineral constituent.

Crop residues are good sources of plant nutrients and are important components for the stability of agricultural ecosystems. About 400 million tons of crop residues are produced in India alone. In areas where mechanical harvesting is practiced, a large quantity of crop residues are left in the field, which can be recycled for nutrient supply. About 25% of nitrogen (N) and phosphorus (P), 50% of sulfur (S), and 75% of potassium (K) uptake by cereal crops are retained in crop residues, making them valuable nutrient sources. Both rice and wheat are exhaustive feeders, and the double cropping system is heavily depleting the soil of its nutrient content. A rice-wheat sequence that yields 7 tons ha⁻¹ of rice and 4 tons ha⁻¹ of wheat removes more than 300 kg N, 30 kg P, and 300 kg K ha⁻¹ from the soil [6].

Humic acid (HA) is a natural product, which is abundant in our lignitic coal and is applied in agricultural and industry [7]. Humic acid contain organic carbon C (51-57%), N (4-6%) and P (0.2-1.0%) is thought to improve crops yields due to its capability of supplying N and P to the plants. But the total amount of HA added as fertilizer is

generally one or two kg ha⁻¹, which will hardly supply 0.04 to 0.08 kg N and 0.001 kg P ha⁻¹ to the soil. This amount is far below the overall nutrients requirement of agricultural crops [8]. Obviously the beneficial effect of HA addition to the soil must be associated with the improvement in the physiochemical and biological environment of the soils [9]. It is believed that HA contains although small amount of N but in a very stable form, which serves as slow releasing N fertilizer [10] and it is reported to reduce phosphate adsorption at low pH values [11].

Literature is available on the uses of humic acid and crop residues, however information on combine use of humic acid and crop residues are not available. Therefore the present research was designed to study the effect of crop residues and humic acid application on improving wheat phenology.

Materials and Methods

An experiment on 'the effect of humic acid and crop residues application on wheat' was conducted at New Developmental Farm of Agricultural University, Peshawar during winter 2011-12. The experiment was carried out in randomized complete block (RCB) design having four replications. The seed of wheat cultivar pirsabak-2005 was sown in a plot size of 5m by 3 m, having 10 rows 30 cm apart. The crop was sown at proper moisture/vatter condition. Different level of humic acid was applied with different combinations of crop residues (Mungbean residues= stem and leaves, wheat straw= stem, leaves and spike) with the following details.

T1=Control, T2=1 kg ha⁻¹ humic acid with 5 tons of legumes, T3= 1 kg ha⁻¹ humic acid with 10 tons of cereals, T4=1 kg ha⁻¹ humic acid with 2 ½ and 5 tons of legumes and cereals, T5=1.5 kg ha⁻¹ humic acid with 5 tons of legumes, T6= 1.5 kg ha⁻¹ humic acid with 10 tons of cereals, T7 = 1.5 kg ha⁻¹ humic acid with 2 ½ and 5 tons of legumes

and cereals, T8= 2.0 kg ha⁻¹ humic acid with 5 tons of legumes, T9= 2.0 kg ha⁻¹ humic acid with 10 tons of cereals, T10 = 2.0 kg ha⁻¹ humic acid with 2 ¹/₂ and 5 tons of legumes and cereals, T11= 2.5 kg ha⁻¹ humic acid with 5 tons of legumes, T12= 2.5 kg ha⁻¹ humic acid with 10 tons of cereals, T13= 2.5 kg ha⁻¹ humic acid with 2 ¹/₂ and 5 tons of legumes and cereals.

Days to emergence was recorded from the date of sowing till 80% plants emerge in each plot. Data on emergence m⁻² was recorded in one meter row length in each plot at random at three places and then their average was calculated. Days to anthesis data was recorded from the date of sowing till when 80% spikes emerged in each plot and then averaged. Days to maturity data was recorded from the date of sowing till when all the plants get physiological maturity in each plot. Plant height data was recorded at maturity by measuring the height of ten representative plants in each plot randomly selected and was then averaged.

Statistical Analysis

The data was statistically analyzed using analysis of variance (ANOVA) techniques appropriate for randomized complete block design (RCBD). Means was compared using LSD test at 0.05 level of probability, when the F-values are significant [12].

Results and discussion

Days to Emergence

Perusal of the data (Table 1) indicated that days to emergence were non-significantly ($P \leq 0.05$) affected by humic acid and crop residues and control vs. rest. The interactive effect was also found as non-significant. Delayed emergence (11.4) was recorded from those plots where 1.5 kg ha⁻¹ of humic acid was applied whereas early emergence (10.8) days were from 2.5 kg ha⁻¹ of humic acid application. Emergence was delayed of (11.3) days where 2¹/₂ tons ha⁻¹ mungbean and 5 tons ha⁻¹ wheat straw were incorporated. Similarly (10.8) days of early

emergence were recorded from 5 tons ha⁻¹ of mungbean residues. Days to emergence were delayed of (11.1) days where rest of the treatments were applied and early emergence of (10.0) days were from control plots.

Emergence m⁻²

Data collected on emergence m⁻² are placed in Table 2 which Showed that emergence m⁻² was significantly ($P \leq 0.05$) affected by crop residues and control vs. rest and non-significantly ($P \leq 0.05$) affected by humic acid and interaction. Higher emergence (120) m⁻² was reported from those plots where 2¹/₂ tons ha⁻¹ mungbean and 5 tons ha⁻¹ wheat straw was incorporated. Whereas lower emergence (107 m⁻²) were recorded from 10 tons ha⁻¹ of wheat straw incorporation. Highest emergence (113 m⁻²) was observed from rest of the treatments and lowest (97.3 m⁻²) was from control. Higher emergence m⁻² was recorded from rest while lower were from control. Plots having residues can hold more moisture at root zone and provide more conducive environment for more emergences that sole plots [13].

Days to Anthesis

Humic acid, crop residues and control vs rest had significant effect on days to anthesis is presented in Table 3. Analysis of the data showed that days to anthesis were non-significantly ($P \leq 0.05$) affected by interaction. Days to anthesis was delayed of (125) days was recorded on the application of 2.5kg ha⁻¹ of humic acid similarly enhanced of (120) was observed from 1kg ha⁻¹ of humic acid whereas delay days to anthesis (123.8) were reported from 5 tons ha⁻¹ mungbean incorporation. This is followed by (122.4) of 2¹/₂ tons ha⁻¹ mungbean and 5 tons ha⁻¹ wheat straw incorporation. Early (121.1) days to anthesis were observed from 10 tons ha⁻¹ of wheat straw. Delayed days to anthesis (122) were reported from rest of the treatments and early (118) days were from control.

Decomposition of the mungbean residues produced essential nutrients for plant growth. Legumes residues have improved soil organic matter and N level of the soil. Retention of residues over a long term can improve soil fertility and nutrient cycling. Control vs. rest of the treatments also significantly affected days to anthesis. Humic acid application increases the spike fertility and took more days than the sole plots [14].

Days to Maturity

The effect of humic acid and crop residues application on days to maturity is indicated in Table 4. Statistical analysis of the data revealed that days to maturity was significantly ($P \leq 0.05$) affected by humic acid, crop residues, and control vs. rest of the treatments. While interactive response was non-significant. Maturity was delayed (157) days when 2.5 kg ha⁻¹ of humic acid was applied. This is followed by (157) days where 2 kg ha⁻¹ of humic acid was used. Early maturity of (153) days was recorded when 1 kg ha⁻¹ of humic acid was applied. Maturity was delayed of (157) days were reported where 5 tons ha⁻¹ of mungbean residues was incorporated, whereas enhanced of (153) days was recorded from those plots where 10 tons ha⁻¹ of wheat straw was incorporated. Delay maturity of (155) days were observed by those plots where rest of the treatments was applied and enhanced (150) days were recorded from those plots which were controlled. Incorporated residues particularly legume crop decomposed readily and had improved soil fertility and mineral N content which interim prolonged the life cycle of the residues incorporated plots than the sole [15] and mineralization of the N rich residues [16].

Plant Height (cm)

Data regarding plant height of wheat as affected by humic acid and crop residues is presented in Table 5. Statistical analysis of the data showed that humic acid, crop residues, interaction and control vs. rest had a significant ($P \leq 0.05$) effect on plant height. Higher plant height (84.6 cm) was attained by applying 2.5 kg ha⁻¹ of humic acid similarly lower plant height (75.3 cm) was from 1 kg ha⁻¹ of humic acid. Higher plant height (85.7 cm) was observed on 5 tons ha⁻¹ of mungbean incorporation, whereas lower (74.6 cm) was from 10 tons ha⁻¹ of wheat straw. Highest plant height (79.9 cm) was observed from the rest of the treatments and lowest (62.3 cm) was from control. Crop residues indicated increasing trend line on humic acid levels. Decomposition of mungbean residues gives more nitrogen to the wheat crop than the wheat straw. Residues incorporation increased the mineral N content of the soil by 22.40% [17]. The addition of HA to soil reportedly increases the rate of adsorption of mineral ions on root surfaces and their penetration into the cells of the plant tissue and increase plant height. Plants show more active metabolism and increased respiratory activity and attained higher plant height [18].

Conclusion and Recommendation

The results obtained from the present study indicated that among the crop residues 5 tons ha⁻¹ of mungbean residues and 2.5kg ha⁻¹ of humic acid delayed days to anthesis, days to maturity and improved plant height. Therefore I recommend to the farmers of Peshawar region that use mungbean residues 5 tons ha⁻¹ and humic acid 2.5 kg ha⁻¹ for improved phenology of wheat in agro-climatic condition of Peshawar valley.

Table 1. Days to emergence of wheat as affected by humic acid and crop residues application.

Crop Residue (t ha ⁻¹)	Humic Acid (kg ha ⁻¹)				Mean
	1	1.5	2	2.5	
5 Mungbean	11.0	11.0	10.8	10.3	10.8
10 Wheat Straw	11.0	11.0	11.3	11.3	11.1
2 ^{1/2} Mungbean + 5 wheat straw	10.8	12.3	11.3	11.0	11.3
Mean	10.9	11.4	11.1	10.8	
Control	Control vs. rest				10.0
Rest					11.1

Table 2. Emergence m⁻² of wheat as affected by humic acid and crop residues application.

Crop Residue (t ha ⁻¹)	Humic Acid (kg ha ⁻¹)				Mean
	1	1.5	2	2.5	
5 Mungbean	114	113	112	111	113 b
10 Wheat Straw	106	107	108	107	107 c
2 ^{1/2} Mungbean + 5 wheat straw	120	120	120	120	120 a
Mean	114	113	113	113	
Control	Control vs. rest				97.3 b
Rest					113 a

LSD value at $P \leq 0.05$ for crop residues =5.23

Humic acid and crop residues interaction = ns

Table 3. Days to anthesis of wheat as affected by humic acid and crop residues application

Crop Residue (t ha ⁻¹)	Humic Acid (kg ha ⁻¹)				Mean
	1	1.5	2	2.5	
5 Mungbean	120	124	125	127	123.8 a
10 Wheat Straw	120	120	122	124	121.1 b
2 ^{1/2} Mungbean + 5 wheat straw	121	122	123	124	122.4 a
Mean	120 d	122 c	123 b	125 a	
Control	Control vs. rest				118 b
Rest					122 a

LSD value at $P \leq 0.05$ for humic acid =1.20LSD value at $P \leq 0.05$ for humic acid =1.04

Humic acid and crop residues interaction = ns

Table 4. Days to maturity of wheat as affected by humic acid and crop residues application.

Crop Residue (t ha ⁻¹)	Humic Acid (kg ha ⁻¹)				Mean
	1	1.5	2	2.5	
5 Mungbean	154	154	159	161	157 a
10 Wheat Straw	152	152	155	154	153 b
2 ^{1/2} Mungbean + 5 wheat straw	152	154	157	158	155 ab
Mean	153 b	153 b	157 a	157 a	
Control	Control vs. rest				150 b
Rest					155 a

LSD value at $P \leq 0.05$ for humic acid =2.34LSD value at $P \leq 0.05$ for crop residues =2.03

Humic acid and crop residues interaction = ns

Table 5. Plant height (cm) of wheat as affected by humic acid and crop residues application

Crop Residue (t ha ⁻¹)	Humic Acid (kg ha ⁻¹)				Mean
	1	1.5	2	2.5	
5 Mungbean	74.5	85.0	89.0	94.3	85.7 a
10 Wheat Straw	69.0	74.3	76.3	79.0	74.6 c
2^{1/2} mungbean + 5 wheat straw	82.3	76.8	78.3	80.5	79.4 b
Mean	75.3 c	78.7 b	81.2 b	84.6 a	
Control	Control vs. rest				62.3 b
Rest					79.9 a

LSD value at $P \leq 0.05$ for humic acid =2.53LSD value at $P \leq 0.05$ for crop residues =2.19

Humic acid and crop residues interaction = **

Mean values followed by different letters are statistically significant at 5 % level of significance using LSD test.

Figure 1. Mean monthly temperature and rainfall data from May 2011 to April 2013

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