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Dry Matter Partitioning and Phenological Traits of Maize as Influenced by Diverse Levels of Humic Acid

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Abstract

Despite the fact that maize productivity is relatively better than other major cereal crops, its current productivity is still far below its potential productivity. An experiment was conducted to asses the influence the effect of humic acid levels on phenology and dry matter partitioning of maize (*Zea mays* L) at New Developmental Research Farm of The University Agricultural Peshawar, during summer 2016. The experiment was condected in randamized complete block design RCBD having three replications. The experiment was consisted of five humic acid levels (0, 5, 10, 15, 20, 25 kg ha^{-1}). The response of humic acid levels was significant to different phenological traits like days to tasseling, silking and days to maturity. Maximum and minimum days were taken by days to tasseling (Control = 65 and 15 kg ha^{-1} = 54), silking (Control = 70 and 15 kg ha^{-1}, 58), maturity (25 kg ha^{-1} 107 and 15 kg ha^{-1}, 98). Humic acid significantly effect dry matter partitioning of maize like number of grains cob^{-1} (574) were taken from the plots which treated with 15 kg ha^{-1}. Higher thousand grain weight (348.5 gm) was taken from the plot which treated with 15 kg ha^{-1}, while minimum (207.5 gm) was taken from the control treatment. Higher biological yield (17338 kg ha^{-1}) was taken from the plot which receive 15 kg ha^{-1} of humic acid, while minimum yield (11375 kg ha$^{-1)}$ was taken from control treatment. The highest net return of grain yield (5054 kg ha^{-1}) was taken from the plot which treated with 15 kg ha^{-1}, while minimum grain yield (3050 kg ha^{-1}) was taken from the plot which treated with 5 kg ha^{-1} of humic acid. It is concluded that overall 15 kg ha^{-1} of humic acid showed best performance.

Keywords: Humic Acid; Phenology; Dry Matter Partitioning; Tasseling; Silking

Introduction

Maize botanically known as *Zea mays* L. belong to the family poaceae. Maize is one of the important cereal crops of the world. It is third in rank after wheat and rice. It is annual cross-pollinated crop having erect, thick and strong culms or stalk with nodes and internodes. The corn leaf consists of the blade, sheath and collar like ligule. It is normally monoecious with staminate and pistillate flowers produce on the tassel and ear.

In Pakistan maize is grown on an area of 1052.1 thousands ha, with production of 3593 thousands tones and average yield is 3415 kg ha^{-1}, while in KPK it is grown on an area of 509 thousand ha, with total production of 957.9 thousand tones and average yield is 1880 kg ha^{-1} [1]. In Pakistan maize is increasingly gaining an important position in crop husbandry because of its higher yield potential and short growth duration. It is rich source of food and fodder. Maize and corn meal constitutes a staple food in many regions of the world. Maize is also used in industries for manufacturing of corn oil, corn flakes, corn syrup etc. Maize is a major source of starch. Starch from maize can also be made into plastics, fabrics, adhesives, and many other chemical products. Maize is also used in the production of ethanol which is a bio-fuel. Maize constitutes 6.4 % of the total grain production in the country, and occupies a special position in the national economy, as it is good source of food, feed and fodder.

Chemical fertilizers are used as major source of nutrients for crops to maintain soil fertility and increase crop productivity. Chemical fertilizers are more concentrated in nutrients and show immediate effect on crops as compared to organic manures. Given the high cost of fertilizers, losses due to fixation and adsorption, leaching and volatilization, use of chemical fertilizers in the required quantity is becoming increasingly difficult for obtaining maximum yield on sustainable basis.

Humic acid (HA) is a natural product, which is present in Pakistan's lignitic coal in reasonable concentration and is used in agriculture and industry but on limited scale [2]. Humic substances are formed through the process of humification of organic materials as by-product of microbial metabolism and are found in soil, coal, sediments water, peat and organic matter [3]. Humic acid contains organic C (51-57%), N (4-6%), and p (0,02%). It is believed that these humic acid elements improve crop yeld due to its capability of supplying N and P to the plant. The beneficial effect of HA addition to soil is associated with the improvement in the physiochemical and biological environment of soils [4]. It is also believed that HA although contains small amount of N, it is in a very stable form which serves as slow releasing N fertilizer [5]. It is also reported that HA reduces phosphate adsorption at low pH values [6-10].

Humic acid contains many trace elements in its structure and various micronutrients are further complexed with HA to form chelates [7]. These chelates can regulate the supply of micronutrients needed for plant growth and development [8]. HA may serve as a catalyst in promoting the activity of microorganisms in soil [9]. Humic acid exerts a stimulatory, conditioning and growth promoting effect on soil when applied in combination with chemical fertilizers due to its chelation properties to hold nutrients ions and released them as and when required by the plants [4,10]. A commercial humate consisted of 58% organic matter, 32% ash and 10% moisture. The humic fraction was mostly humic acid (76%), with some fulvic acid (18%). The organic elemental composition (59% C, 5% H, and 36% O) also suggest a humic acid nature.

The present study was therefore conducted to investigate the effect of levels of humic acid on yield and yield component of maize crop and to find out the optimum level of humic acid for potential yield.

Materials and Methods

A field experiment entitled "Effect of humic acid levels on yield and yield components of maize" was conducted at Agricultural Research Farm of Agricultural University Peshawar during summer 2016. The experiment was laid out in RCB design having three replications. Each plot consisted of 6 rows 7 m long, and row to row spacing of 75 cm. A basal dose of 100 and 60 kg ha^{-1} of nitrogen and phosphorus was applied respectively. All phosphorus was applied at time of sowing while nitrogen was applied in two split, half at sowing time and remaining half at time of silking. Different treatments of humic acid levels were investigated during the study. Humic acid levels are (Control, H_1= 5, H_2= 10, H_3 =15, H_4 = 20, H_5 = 25 Kg/ha). All agronomic practices were carried out during the experiment. Throughout the crop stand irrigation were applied according to the needs of crop.

Statistical Analysis

Data was statistically analyzed according to Jan MT, et al. [11] and means was computed using LSD test ($P < 0.05$).

Results and Discussion

Days to Tasseling

Data regarding days to tasselling is presented in the Table 1 Statistical analysis of the data revealed that humic acid effect days to tasselling significantly. Higher days to tasseling (65) were recorded in control plots while minimum (54) days were recorded in plot treated with 15 kg ha^{-1} of humic acid. Humic acid levels 15 kg ha^{-1} took less days to tasseling. Its might be availability of all nutrients. Similar results were also found with Stevenson FJ, et al.; Li X, et al. [3,12] who applied different ratios of humic acid to maize crop.

Humic acid levels kg ha^{-1}	Days to Tasseling	Days silking	Days Maturity
0	65	70	104
5	59	63	104
10	55	60	102
15	54	58	98
20	58	62	103
25	63	65	107
LSD (0.05)	3.409	3.306	0.308

Table 1: Days to Tasseling, Days silking, Days Maturity, as affected by Humic acid levels.

Days to Silking

Data regarding days to silking is given in the Table 1. Statistical analysis of the data showed that humic acid significantly effected days to silking. Maximum days to silking (70) were taken by control treatment while minimum (58) days were recorded in plots treated with 15 kg ha^{-1} humic acid. 15 kg ha^{-1} gave good result and take less days to silking. It may be all condition was favorable for plant growth at this level. Our results was also in line with Sibanda HM, et al.; Mohammadi SA, et al. [6,13] who used humic acid for maize crop to find different phenological parameters.

Days to Maturity

Data presented in Table 1 reveals that days to maturity influenced by humic acid significantly. Maximum days (107) were taken by plot in which 25 kg ha^{-1} was applied while minimum days (98) were taken by plot which 15 kg ha^{-1} of humic acid was applied. From the result it's clear that 15 kg ha^{-1} gave best result and take less days to maturity. Our results are supported with Gu Z, et al.; Jan MT, et al. [9,11]. It may be easily decomposed and provide early availability of nutrients, results quick vegetative growth, ultimately early maturity of the crops and take less days to maturity while high dose delay maturity. It may be high humic acid level did not encourage early maturity.

Grains Cob^{-1}

The data regarding grains cob^{-1} as affected by humic acid levels is given in Table 2 Statistical analysis of the data revealed that humic acid level significantly effected grains cob^{-1}. Highest number of grains cob^{-1} (574) were obtained from the plot which treated 15 kg ha^{-1}, while the lowest number of grains cob^{-1} (445) were taken from control treatment. Same results were also found with Yiengei W, et al.; Khan MB, et al. [8,14]. Number of grains cob^{-1} contribute to the economic yield as well as represents the reproductive efficiency of any cereal crop. The plot which receive 15 kg ha^{-1} gave good grains cob^{-1}. It may be 15 kg ha^{-1} provide an excellent environment for the plants to grow and develop properly and express their maximum genetic potential for grain formation.

Humic acid levels kg ha^{-1}	Grain cob^{-1}	1000 grain wt	Biological yield	Grain yield
0	445	207.5	11375	3425
5	488	224.6	13733	3050
10	532	266.3	14454	3153
15	574	348.5	17338	5054
20	534	321.3	14230	4654
25	506	316.4	11975	4064
LSD (0.05)	34.701	18.406	1381.87	372.07

Table 2: Grain Cob^{-1}, 1000 Grain wt, Biological yield, Grain yield as affected by different humic acid. levels.

1000 Grain Weight

Data regarding 1000 grain weight is shown in Table 2. Statistical analysis of the data showed that humic acid was significantly affected on 1000 grain weight. The highest 1000 grain weight (348.5 gm) was recorded from the plot which treated 15 kg ha^{-1}, while the lowest 1000 grain weight (207.5 gm) was obtained from the control treatment. Grain weight is an important trait that contributes to overall yield of maize. Our results are also supported with Stevenson FJ, et al. Qamar R, et al. [3,15]. Grains become dominant sink at maturity and all the photo assimilates deposited in the grains give them weight. The plot which treated 15 kg ha^{-1} of humic acid gave higher 1000 grain weight. It may be humic acid work with the combination of chemical fertilizer and produced heavier grain weight.

Biological Yield

Biological yield is the sum of grain yield and stover yield. Statistical analysis of the data showed that humic acid had significant effect on biological yield which is presented in table 2. The highest biological yield (17338 kg ha^{-1}) were obtained from the plot which treated 15 kg ha^{-1}, while the lowest biological yield (11375 kg ha^{-1}) were taken from control plot. Higher biological yield take from the plot which receive 15 kg ha^{-1} of humic acid. Same result was found with Stevenson FJ, et al. [3] and Sibanda HM, et al. [6]. It may be humic acid improved endurance to high stands allowed intercept and use solar radiation more effectively, contributing increase in crop growth and yield. Increasing in crop growth rate thus resulting in higher biological yield.

Grain Yield

The data grain yield as affected by humic levels is given in table 2. Statistical analysis of the data showed that humic acid had significant effect on grain yield. The highest grain yield (5054 kg ha^{-1}) were obtained from the plot which treated with 15 kg ha^{-1}, while the lowest grain yield (3050 kg ha^{-1}) were taken from the plot which treated with 5 kg ha^{-1}. Grain yield is one the most important goal and ultimate objective of any cereal. Our results are also supported with Sibanda HM, et al. [6] and Gu Z, et al. [9]. Humic acid applied at the rate of 15 kg ha^{-1} with the combination of chemical fertilizer gave greater grain yield. Increase in grain yield may be humic acid because it improved physiochemical and biological environment of soil, work as chelates. These chelates can regulate supply of micronutrients needed for plant growth and development.

Conclusion and Recommendation

Improper fertilizer management particularly with continued soil nutrient mining is a major factor contributing to low maize yield in Khyber Pakhtunkhwa. Application of humic acid with the combination of chemical fertilizers increases yield and yield component of maize crop. From the experiment it is concluded that humic acid effect positively on days to tasseling, days to silking, days to maturity, grains cob^{-1}, thousand grain weight, biological yield, grain yield.

It is suggested to the government provide humic acid at low price to the farmer. It is suggested to the farmer to use humic acid with the combination of chemical fertilizers for sustainable yield. Farmer have suggested to use 15 kg ha^{-1} of humic acid for best yield. More precise studies of this nature however recommended to be carried out for further confirmations.

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