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Effect of foliar application of indole acetic acid on growth and yield of wheat (*Triticum aestivum* L.)

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Abstract

Wheat is a common food and is widely consumed by people all over Pakistan. Water adds more than 70% to the structure of the plant body and is important for all anabolic and catabolic processes. Abiotic stress is a foremost limitation that affects the growth and yield of wheat crops. Therefore, the objective of this study was to evaluate the effects of the foliar appliance of indole acetic acid on wheat yield components. For this purpose, an experimental trial was conducted during the winter season of 2021 (first week of December 2021) with different concentrations of indole acetic acid 0 ppm, 200 ppm, and 400 ppm. Maximum concentration of indole acetic acid 400ppm resulted maximum in plant height was (106.77 cm), number of tiller (346.22), number of spikelet's spike^{-1} (17.11), number of grains spike^{-1} (55.44), 1000 grain weight (39.19 g), grain yield (5.32 t/ha), biological yield (10.646 t/ha), harvesting index was (37.804%) were obtained respectively. It is determined that irrigations and the application of various levels of indole acetic acid have a favorable impact on grain yield and yield components. Indole acetic acid proven to be a beneficial application.

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Introduction

Agriculture is the main stray of Pakistan's economy and contributes 18.5% to GDP and engages 38.5% labor force. An increase in the production of major cereals is very crucial to assure food security in the country. Wheat (*Triticum aestivum* L.) is a food security item in Pakistan. It was sown on 8.73 m/ha with a production of 25.49 m/tons during 2021-2022 (Government of Pakistan, 2022) [9].

Wheat (*Triticum aestivum* L.) is the supreme significant cereal crop in the world and a staple food for the people of Pakistan (Government of Pakistan, 2017) [8]. Wheat is a self-pollinated crop with determinate type growth. It has great economic importance in food industries all over the world. The plants of wheat are C_3 in the category and it is possible to grow wheat in soils with a clay loam or loam texture, good structure, and a moderate water-holding capacity. Wheat has a wide range of adaptability and may be cultivated in tropical and sub-tropical climates, as well as temperate climates, beyond even 60-degree north altitude. The soil of moderate texture with a pH of 6-7 suites well for wheat (Khan and Hanif, 2007) [11].

Water contributes more than 70% to the composition of the plant body and is important for all anabolic and catabolic processes. Soil and climatic conditions of Pakistan are highly suitable for wheat and cultivars with high yield potential and resistance.

against disease are available but our yield per acre is low when we compare it with developed countries like USA, Egypt, and Canada Indole acetic acid (IAA) is well-known auxin and plays a core role in plant growth regulation. It regulates apical dominance, cell elongation, and the formation of vascular tissues (Wang *et al.*, 2001) [21]. It is proved by research that micronutrients can help in the overall output enhancement (Nazeer *et al*., 2020) [13]. Predominantly IAA is produced in cells of the apex and young leaves. It is a colorless solid having the chemical formula $C_{10}H_9NO_2$. Indole acetic acid may cause a vital role in photosynthesis, plant water relations, stomatal regulation, and growth (Singh *et al.*, 2017) [17]. IAA also involves in enhancing the resistance against pathogens (Pustovoitova *et al.*, 2003) [15]. Foliar application of indole acetic acid may promote the growth of some crops by reducing the water stress that inhibits growth. Therefore, this study aims to determine the impact of foliar-applied indole acetic acid on wheat yield under different water regimes. the improvement of business performance of the enterprise.

Materials and Method

The present research was conducted at the Agronomic Research Area, University of Agriculture, Faisalabad during the winter season of 2021-22. Geographically, it is located at 31°30'N, 73°05' E and 214 meters above mean sea level. The climatic data of the experimental site showed in (Table 1). The trial site was sandy loam and falls in the soil series "Lyallpur", an Arid soil, a fine silty and mixed. The soil property of the experimental site is discussed in (Table 2).

The experiment was repeated three times by using RCBD experimental design. A basal dose for fertilizers was 120:85:60 kg ha^{-1} NPK used. Sources of fertilizers are Urea and DAP. A full dose of DAP was applied at the time of sowing. Half a dose of urea was applied at sowing time and half with 1st irrigation. Sowing was done with a row-to-row distance of 22.5cm and the plant-to-plant distance doesn't maintain. Variety was Ghazi-2019. The net plot size was 5 m x 3 m recommended seed rate 100 kg ha^{-1}. After 17-18 days of first (rouni) irrigation land was prepared by rotavator and two to three cultivations by cultivator followed by planking to prepare a fine seed bed for proper wheat germination. All cultural practices were kept constant. Experimental treatment as indole acetic Acid (C), C_o = 0 ppm (control), C_1 = 200 ppm, C_2 = 400 ppm. At maturity, an equal-sized area from each treatment was harvested for the calculation of different parameters regarding yield and quality. The sample which was collected for experimental observations was evaluated from that sample by using the LSD test at a 5% probability level (Steel *et al*., 1997) [19].

Table 1: Metrological conditions of the experimental site

Month (2018-19)	Temperature ^0C		Relative Humidity %	Rainfall (mm)	ET_0 (mm)
	Max.	Min.			
November	27.0	11.8	75.6	0.6	01.4
December	22.7	6.7	82.7	0.7	00.9
January	20.2	7.4	79.3	48.0	00.8
February	20.3	09.1	79.0	10.2	01.1
March	25.5	14.1	64.7	5.7	02.1
April	35.4	19.3	42.5	5.2	03.8

Table 2: Soil analysis result for physical and chemical characteristics (Normal soil)

Physiochemical characteristics	Values
Texture	Loamy soil
pH	7.8
Electrical Conductivity	1.72 d S m^{-1}
Sodium Absorption Ratio	1.6 (mmol L^{-1})
Organic matter	0.71%
Phosphorus	6.85 ppm
Potassium	119 ppm

Results and Discussion

Plant height (cm)

The highest value of yield and yield components biological yield and harvest index are as under in Table 3. Data for plant height (cm**)** reveals that concentration of indole acetic acid significantly affect plant height. Maximum plant height (106.77 cm) was obtained at the level of C_2 (400 ppm) as followed by (106.77 cm) was recorded at the level of C_1 (200ppm), and minimum height (105.07 cm) was obtained at C_0 (control). Previous studies supported our findings, according to Khan *et al*., (2020) [10] showed that Indole acetic acid was more effective for improving plant height. On the other hand, plant height is an important parameter of any crop, in case of wheat plant height effects the straw yield. It has great importance in dry matter production. Plant height directly affects biological yield and ultimately economic yield of any crop.

Total number of tillers m^{-2}

Total number of tillers (m^{-2}) data shows that indole acetic acid concentration has a considerable impact on several tillers. The maximum number of tiller (346.22) was obtained at the level of C_2 (400 ppm) as followed by (344.52) was recorded at the level of C_1 (200ppm), and the minimum number of tiller (340.89) was obtained at C_0 (control). Elhani *et al.*, (2007), Qadir *et al*., (2013) [16] supporting our findings that tillering may affect wheat yield positively or negatively depending on the availability of natural resources such as water, light and indole acetic acid. The number of fertile tillers has a great influence on the biological and straw yield of wheat crops. Productive tillers are key contributors to wheat yield (Tahir *et al*., 2009) [20].

No. of spikelet's spike^{-1}

According to data indole acetic acid concentration has significant impact on the number of the spikelet that produces spike^{-1} (Table 3). The maximum number of spikelet's spike^{-1} (17.11) was obtained at the level of C_2 (400 ppm) as followed by (16.55) was recorded at the level of C_1 (200ppm), and minimum number of spikelet's spike^{-1} (15.44) was obtained at C_0 (control). Spike length had a positive relationship with the number of spikelet spike^{-1} at both genotypic and phenotypic levels (Akram *et al*., 2008) [1]. The increase in spikelets may have been caused by indole acetic acid, which supported our findings (Alvaro *et al*., 2008) [2].

No. of grains spike^{-1}

According to the data, indole acetic acid concentration have a significant impact on the number of grains spike^{-1}. Maximum number of grains spike^{-1} (55.44) was obtained at the level of C_2 (400 ppm) as followed by (54.33) was recorded at the level of C_1 (200ppm), and minimum number of grains spike^{-1} (52.44) was obtained at C_0 (control). Most studies have attributed the increased wheat yields in past decades to increases in grain number per spike (Zhang *et al*., 2012) [22]. Number of grains per spike is an important indicator of yield in wheat. They are directly linked to grain production and final yield of the crop. Grain numbers and weights differ between and within spikelet. Spikelet number, grain weight and grain number per spikelet have a significant effect on thousand-grain weight and grain number per spike (Tahir *et al*., 2009) [20].

1000 grain weight (g)

The 1000 grain weight is significantly impacted by indole acetic acid concentration, according to data. Maximum 1000 grain weight (39.19 g) was obtained at the level of C_2 (400 ppm) as followed by (37.59 g) was recorded at the level of C_1 (200ppm), and minimum 1000 grain weight (36.24 g) was obtained at C_0 (control). Doncic *et al*. (2003) supported our study that grain weight (TGW) is found to be closely associated with kernel size traits as well, such as kernel length (KL), kernel width (KW), kernel thickness (KT), and the kernel length/width ratio (L/W). As a result, TGW is frequently used in crop research as a measurement indicator. Indole acetic acid concentration have a considerable impact on grain yield. Thousand grain weight (TGW) is an important parameter for the evaluation of variety breeding. TGW is not only directly related to the grain yield and milling quality of grain, but also has an impact on the seedling vigor and growth indirectly affecting the yield (Botwright *et al*., 2002) [4].

Grain yield (t ha^{-1})

Maximum grain yield (5.32 t ha^{-1}) was obtained at the level of C_2 (400 ppm) as followed by (4.81 t ha^{-1}) was recorded at the level of C_1 (200ppm), and minimum grain yield (4.46 t ha^{-1}) was obtained at C_0 (control). According to the Noorka *et al*. (2009) [14] supported our study which shows that under stress conditions, protein content, gluten quality, and content show substantial negative associations with grain yield and thousand-grain weight in wheat. Indole acetic may increase grain yield of wheat by increasing assimilates in wheat grains. Hence, better hereditary of wheat genotype is inevitable for higher yields under favorable and non-favorable agro-ecological conditions (Baranski, 2015) [3].

Biological yield (t ha^{-1})

It was observed that statistically maximum biological yield by indole acetic acid shown in (Table 3). Maximum biological yield (10.646 t ha^{-1}) was obtained at the level of C_2 (400ppm), followed by (10.06 t ha^{-1}) was recorded at the level of C_1 (200ppm) and minimum biological yield (9.512 t ha^{-1}) was obtained at C_0 (control). It was reported in previous studies also that seed inoculation with PGRs maybe increase the plant height and yield by phytohormones synthesizing, the plant in nutrients uptake and reducing the heavy metal toxicity in the plants antagonizing plant pathogens (Burd *et al*., 2000) [5]. Singh *et al*., (2019) [18] illustrate in their studies that biological yield of wheat crop directly effects by drought stress at different growth stages of wheat. Biological yield is the total biomass accumulated by the crop by using available resources during growing season. The results pertaining to effect of indole acetic acid on biological yield under water stress of wheat.

Harvest index (%)

Maximum harvesting index (37.80%) was obtained at the level of C_2 (400ppm), followed by (37.08%) was recorded at the level of C_1 (200ppm) and minimum harvesting index (35.89%) was obtained at C_0 (control). Studies revealed that drought and heat stresses during anthesis and grain filling caused reduction in kernel number and size, grain yield and harvest index (Veisz *et al*., 2005). Harvest index (HI) shows the physiological productivity of plants to variation in the fraction of photo-assimilates to grain yield (Mubeen *et al*., 2021) [12].

Table 3: The highest value of yield and yield components with biological yield and harvest Index

Treatments	Plant height (cm)	Total No. of tillers (m^{-2})	No. of productive tillers (m^{-2})	No. of spikelet's spike^{-1}	No. of grains spike^{-1}	1000 grain weight (g)	Grain yield (t ha^{-1})	Biological yield (t ha^{-1})	Harvest index (%)
C_0 (control)	105.07 C	340.89 C	340.89 C	15.444 C	52.444 C	36.249 C	4.4600 C	9.512 C	35.898 C
C_1(200ppm)	106.67 B	344.56 B	344.56 B	16.556 B	54.333 B	37.599 B	4.8144 B	10.062 B	37.086 B
C_2(400ppm)	106.77 A	346.22 A	346.22 A	17.111 A	55.444 A	39.198 A	5.3211 A	10.646 A	37.804 A

Conclusion

Indole acetic acid during grain filling and booting had a detrimental effect on wheat output. It is determined that application of various levels of indole acetic acid have a favorable impact on grain yield and yield components. The lowest values for yield and yield components were obtained from control from which have not applied any level of indole acetic acid. Wheat yield and yield component were maximum when indole acetic acid was applied at 400 ppm. Indole acetic acid proven to be a beneficial application, and plant growth can be boosted without the use of typical irrigations.

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