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To Study the Effect of Ascorbic Acid as a Foliar Spray on the Growth of *Triticum Aestivum* L.

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ABSTRACT: *Wheat is the foremost nutritional crop in West Pakistan, where it is grown in abundance. There is a larger need for better plant growth solutions to suit the growing need for wheat output for an ever-increasing population. Organic fertilizer and growth regulators are necessary to improve plant growth. We wanted to see how helpful ascorbic acid (AsA) is for wheat growth and yield in our study. Ascorbic acid was utilized as a growth regulator and two wheat cultivars, CK-50 and UJ-16, were used as test crops. This experiment was conducted under Randomized Complete Block Design (RCBD) which was divided into two blocks (B1and B2). Each block was divided into 6 subplots. Each plot has two replications which were further divided into three treatments; control, 100mg/L & 200mg/L treatment of ascorbic acid. Studied parameters were taken at growth and reproductive stages to record the effect of ascorbic acid treatments on wheat cultivars. After the threshing of wheat in each subplot, total yield data was collected. Results revealed that growing parameters such as Plant height, leaf length, shoot length, no. of grains/ plant, yield/ plant, yield/ plot, no of spikes, and chlorophyll content were all considerably increased when ascorbic acid was treated at 200mg/L. Growth parameters such as the number of tillers, no. of spikes, chlorophyll content, and thousand grains weight were significantly increased at the 100mg/L treatment of ascorbic acid. So, ascorbic treatment could be recommended for the farming community from an economic point of view and for enhanced production.*

KEY WORDS: *Triticum aestivum*; ascorbic Acid (AsA); complete randomized design (CRD); ujala-16 (UJ); chakwal-50 (CH); plant growth.

INTRODUCTION

Pakistan lies within the agro-ecological zone. Wheat agriculture covers 9 million hectares in Pakistan, accounting for 66 percent of the entire area under food grain cultivation and 37 percent of total arable land. Pakistan has 23 million hectares of arable land, 17 million of which are irrigated and the remainder is rainfed (Rashid *et al*., 2003). Agriculture, which accounts for 19.5% of Pakistan's GDP, is vital. Agriculture employs 42.3% of the workforce and supplies raw materials for a variety of value-added and agro-based industries. So, it's vital for national growth, food security, and poverty reduction (Ijaz *et al.*, 2013). Food security and poverty alleviation are dependent on the agriculture sector for cereals, fruits, and vegetables. Pakistan's GDP grew by 4% in 2013-2014 and 4% in 2014-2015.While agriculture's 2.7% growth rate in 2013-2014 rose to 2.9% in 2014-2015 (Chandio *et al*., 2016).

Production of wheat

70% to 30% of the wheat crop is grown in rain-fed areas. Pakistan is an agrarian nation. 4 million farmers plant 8.5 million acres of wheat each year to feed 100 million people, or 37% of total cropland (Hussain & Routray, 2012). In terms of area (8.5 million hectors), Pakistan ranks 10th and in terms of vintage 59th (21.0 million ton). Pakistan's wheat-growing land is in Punjab, then Sindh. Sindh has a little higher yield per hectare than Punjab. While cropland area expanded by 2% in Punjab and 9.4% in NWFP, it decreased by up to 30% in Sindh and 60% in Baluchistan (Badar & Mohyundin, 2005).

Factors of yield crop depressed

It will be noted that our farmers are getting only one-fourth of the technically possible yield because of a number of deficiencies. The potential yields of crops are depressed by a number of factors, which have been given weight by an informal group of experts (Kirchmann *et al*., 2009) Some of the factors are: Poor seed bed preparation, late sowing, poor quality of seed, inadequate and ill-timed irrigation, fertilizer, weed competition, insect and disease control, cultural practices and harvesting losses. There is a need for strengthening of proper link between extension workers and farmers to increase our agricultural yield (Hellal *et al*., 2019).

Role of ascorbic acid

Ascorbic acid is an organic molecule that is essential for healthy plant metabolism. Higher plants need ascorbic acid (AsA) in trace amounts to flourish. The ascorbic acid required by plants is diverse. It is a significant redox buffer, an enzyme cofactor, and an antioxidant (Zhang, 2013). AsA is found in all living plant cells, but is most abundant in the leaves and flowers, where the plant is actively growing. AsA is an important molecule involved in cell division and osmotic regulation (Smirnoff, 2018). AsA impacts plant mitosis and cell division. It influences phytochormone-mediated signaling pathways during the reproductive transition, as well as during development and senescence. It is a crucial component of the electron transport system in complex plants (Khan *et al*., 2011). Ascorbic acid promotes growth and productivity in lemongrass, sugar beet, cucumber, sweet pepper, and sunflower plants. The effect of ascorbic acid (AsA) on wheat growth parameters was studied. The study also found the appropriate Ascorbic acid concentration for wheat growth (Sardoei *et al*., 2014).

A study by Hussein & Alva (2015) looked at the effects of foliar ascorbic acid alone or combined with zinc sulphate on millet plant development and photosynthetic pigments in low salinity irrigation water (250 ppm) or high salinity irrigation water (5000 ppm)] (7.8 dSm-1). An increase in leaf number and area was achieved by applying ascorbic acid to the leaves. Plant height and biomass increased with zinc sulphate. According to this study, exogenous ascorbic acid can boost plant biomass and yield via improving foliar growth. Gul *et al*. (2015) examined the effects of exogenic administration of 0.5mM ascorbic acid (AsA) on growth, metabolic parameters, and ionic

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composition in Cymopsis tetragonoloba. Spraying AsA at 0 and 0.5mM with or without 0, 2.5, or 5 dS/m-1 sea salt concentrations was done in a pot. Various plant sections were tested for chlorophyll a, b and total chlorophyll as well as protein, carbohydrate, sodium, and potassium ions. The AsA application not only reduced the effects of salt stress but also increased all growth indicators. Desoky and Merwad (2015) employed the effects of foliar sprays of antioxidants such as ascorbic and salicylic acids at 0.1 and 0.2 percent on wheat plants (Triticum aestivum L.) cv. Sakha-93. Salt stress affected all of the wheat plants' vegetative properties, the study found. Spraying antioxidants helped reduce salt stress on vegetative parameters. The AsA2 treatment produced the greatest straw and grain at 0.1 percent. The effects of foliar ascorbic acid application on heat-stressed cotton crops were examined by Kamal et al. (2017).

On newly restored sandy soil, Bakry *et al*. (2012) inspected the effects of drought stress (2504, 2003, and 1502 m3/fed/Season) (100, 80, and 60%) and ascorbic acid (AsA) (0.0, 100, 200, and 300 mg/L) on wheat yield and protein content. Higher foliar ascorbic acid spray levels improved plant height, spike length, seed index, number of spikelet's per spike, protein content, protein and yield and water use efficiency.

METHODOLOGY

In the present study Seeds of wheat cultivars (chakwal-50, ujala-16), NPK fertilizers, pesticides and fungicides, 100mg\L and 200mg\L solutions of ascorbic acid are used. Two varieties of wheat crop (chakwal-50 and ujala-16) were collected from Punjab seed corporation center Lahore. Two distinct wheat cultivars, chakwal-50 and ujala-16, were evaluated in a field experiment conducted at the seed center, Department of Botany, University of Punjab, Lahore.

Experiment strategy

It is a completely randomized design (CRD). The experimental area was (13 × 26) 338f) 338f^2 which was additional separated into 2 blocks (B1, B2). Each block was divided into 6 sub plots and the area of each sub plot was (3× 2) ft^2 or 6ft^2. Each block has 2 replications that were further divided into 3 treatments control, 100mg/L & 200mg/L of ascorbic acid. Basal dose of N: P: K was used at the rate of (160: 110: 60) kg/ hectares. For this experimental area of (338ft^2) fertilizers were used at in the ratio of Nitrogen (500g), potash (345g), phosphorus (188g). Seed rate was use at the rate of 465.5g\acre and for each subplot (6ft^2) 8-gram seeds of wheat were used. NPK of 1g was also added in per liter of solution of ascorbic acid. A constant volume of 500 ml per sub plot of the solution were sprayed with the help of manual spray on all the sub plots.

Grains of wheat were sown in the field and foliar sprayed with ascorbic acid at the concentration of (100mg\L and 200mg\L). The ascorbic acid was treated foliarly twice; after 45 days of sowing in the vegetative stage and again after 125 days of sowing in the reproductive stage, the plants were sprayed with ascorbic acid. The amount of spraying was kept to a minimum in order to completely cover the plant leaves till it dripped.

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Growth parameters

The data of growth parameters were collected both on vegetative and reproductive stage respectively. The study examined the following parameters that are Plant height (cm), Number of tillers (cm), Number of spikes (cm), Shoot length (cm), Leaf length (cm), Chlorophyll content, no. of grains/plot, Yield / plot (g), thousand-gram weight (g) and yield / plant (g). The data for plant height (cm), leaf length (cm), was taken for all the treatments. Plant tallness was taken by measuring the plants from top including spikes towards roots. Leaf length was taken from node of leaf to tip. The data of total number of tillers were collected through simply numeration the number of tillers. The data of shoot length was taken from base of root to the base of spikes. The data of thousand grain weight (g) was taken by weighting the 1000 grains of wheat for all the treatment of each replication. Grains per plant (g) were measured by weighing the total grains of each plant. After taking data for all of above parameter's plants were uprooted for destructive sampling. Grains per plant (g) were measured by weighing the total grains of each plant. After threshing of wheat of each subplot the data of total yields of plants (g) was collected.

Photosynthetic pigments of leaves were determined and calculated after 90 and 105 days from sowing of wheat plants by using SPAD-502Plus chlorophyll meter.

Figure 1: (a) Sowing of wheat Cultivars. (b) View of replication of wheat after germination.

(a) **(b)**

Figure 2: (c) wheat crop at vegetative phase and (d) view of wheat field at reproductive stage.

(c) **(d)**

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Statistical analysis

Duncan's multiple range tests were used to statistically examine the data. At a 0.05 percent probability level, the mean values were recorded (Cherian *et al*., 1999 and Takemura *et al*., 2000).

RESULTS

Result revealed that, both the cultivars of wheat reacted contrarily at the two different treatments of ascorbic acid as a foliar application.

Table 3.1: Effect of various Ascorbic acid concentrations on the different parameters of wheat Plant.

Plant Height				
Treatment	1*		2*	
	CH-50	UJ-16	CH-50	UJ-16
T0	83.63ab ± 4.93	77.1a ± 4.98	88.88a ± 3.92	90.55a ± 0.25
T1	80.41b ± 6.07	78.56a ± 3.75	90.76a ± 0.07	92.31a ± 3.91
T2	85.35a ± 5.39	80.53a ± 6.04	90.76a ± 0.15	95.66a ± 5.44
LSD (0.05)	3.78	12.58	4.54	6.28

No. of Tillers				
Treatment	1*		2*	
	CH-50	UJ-16	CH-50	UJ-16
T0	13.16a ± 1.94	13.66ab ± 1.96	9.66a ± 1.36	12.66a ± 3.38
T1	12a ± 2.16	11.33b ± 2.06	15.33a ± 4.63	15.33a ± 3.50
T2	13a ± 2.50	15.5a ± 2.58	13.16a ± 3.65	13.49a ± 4.03
LSD (0.05)	3.49	2.76	7.36	3.7

Leaf length				
Treatment	1*		2*	
	CH-50	UJ-16	CH-50	UJ-16
T0	20.56a ± 0.16	22.35a ± 3.84	20.66a ± 0.15	25.43a ± 5.81
T1	23.78a ± 4.81	25.53a ± 5.14	22.15a ± 3.85	25.48a ± 5.13
T2	14.56a ± 14.22	30.5a ± 0.27	32.16a ± 4.88	30.21a ± 0.21
LSD (0.05)	32.74	12.89	13.08	5.62

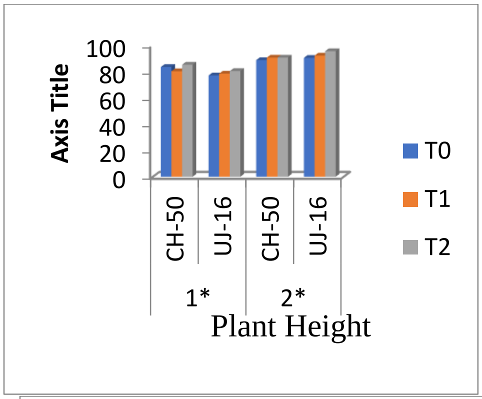
Treatment	Shoot length 1*		2*	
	CH-50	UJ-16	CH-50	UJ-16
T0	50.53b ± 0.32	50.23b ± 0.24	78.73a ± 4.13	80.55a ± 3.80
T1	52.28b ± 4.23	50.25b ± 0.21	80.35a ± 0.18	82.11a ± 3.86
T2	58.81a ± 3.89	50.63a ± 0.20	80.43a ± 0.25	82.16a ± 3.99
LSD (0.05)	6.32	0.17	4.25	5.86

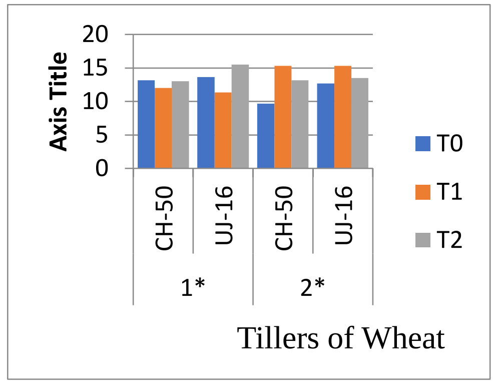
Treatment	No. of spikes 1*		Chlorophyll contents 2*	
	CH-50	UJ-16	CH-50	UJ-16
T0	11.33a ± 3.66	15.83a ± 4.355	100.55a ± 5.19	106.9a ± 5.31
T1	13.99a ± 3.93	10.5a ± 1.471	95.78a ± 9.44	99.8a ± 6.16
T2	13.16a ± 3.33	12.66a ± 4.22	106.11a ± 16.79	104.8a ± 7.67
LSD (0.05)	5.35	13.23	29.14	19.95

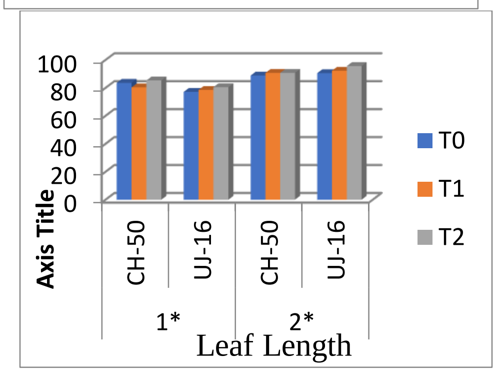
Treatment	No. of grains/plot		Yield/plant	
	CH-50	UJ-16	CH-50	UJ-16
T0	46.99a ± 6.16	38.16b ± 2.63	9.65a ± 4.17	23.13a ± 5.64
T1	48.99a ± 6.87	39.49b ± 1.87	9.11a ± 5.07	23.75a ± 8.55
T2	55a ± 5.89	47.66a ± 4.22	10.30a ± 6.81	23.97a ± 7.98
LSD (0.05)	12.99	2.93	20.51	26.55

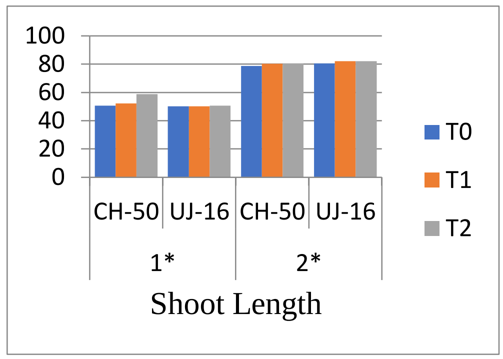
Mean is significantly different at P= 0.05 according to Duncan's multiple range test.
*: Spray LSD: Least significant difference

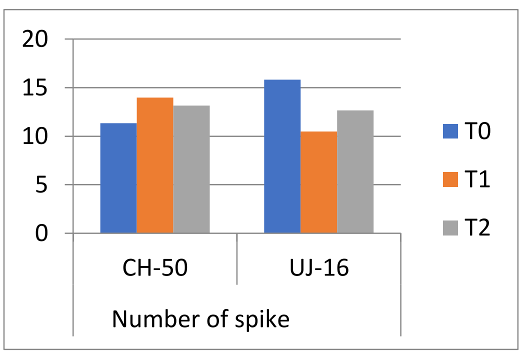
Graph 3.2: Effect of different concentration of Ascorbic acid on the plant height and number of tillers, leaf length, shoot length, no. of spikes, chlorophyll content, no. of grain /plot, yield /plant, thousand gram weigh, and yield/ plot of wheat based on Duncan's multiple range tests.

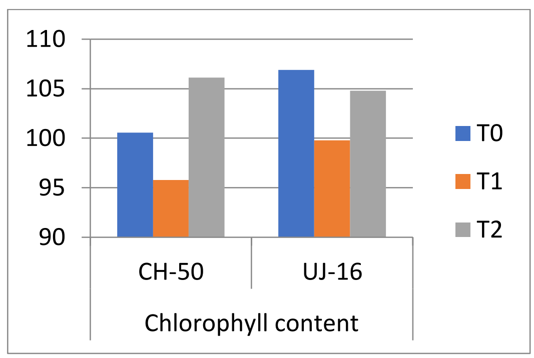












Based on Duncan's multiple range tests it was observed that plant height was significantly increased at T_2 treatment of AsA in both varieties during both vegetative and reproductive stage. The CH-50 showed best result of plant height (85.35a ± 5.39) as compared to UJ- (16 80.53a ±6.04) at 200 mg/L conc. of AsA (Table 3.1).

Number of tillers was significantly increased at T_0 treatment of ascorbic acid in chakwal-50 and at 200mg/L treatment of AsA in ujala-16 during vegetative stage. At 100mg/L treatment of AsA number of tillers was significantly increased in both varieties during reproductive stage. On the other side the no. of tillers of UJ-16 was best at 100 mg/L conc. (15.5a ± 2.58) and CH-50 at 200 mg/L conc (15.33a ± 4.63). Based on Duncan's multiple range tests it was observed that leaf length was significantly increased at T_1 treatment of AsA in ck-50 and at T_2 treatment of AsA in uj-16 during vegetative stage. At T_2 treatment of AsA leaf length was significantly increased in

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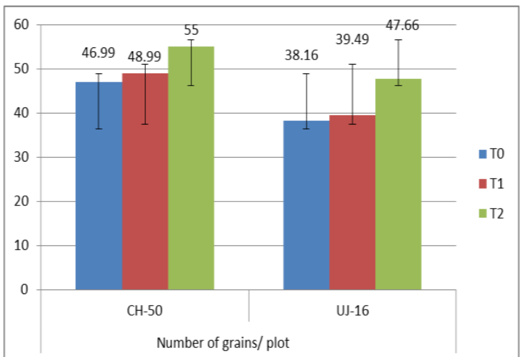
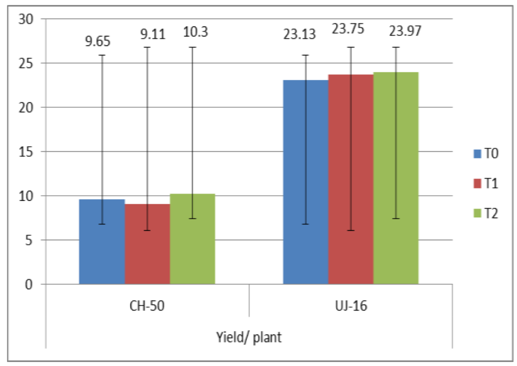
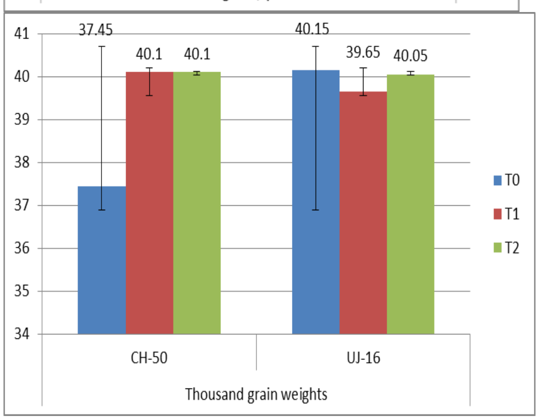
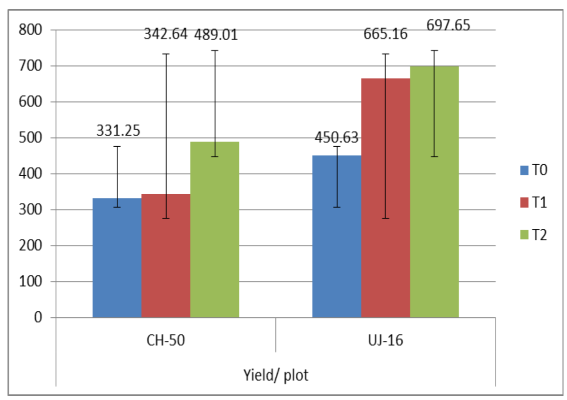
both varieties during reproductive stage. At T_2 treatment of AsA in both vegetative and reproductive stage, the shoot length was significantly increased. It was observed that at T_2 treatment of growth hormone in both vegetative and reproductive stage, the shoot length was significantly increased (Graph 3.2).

No. of spikes was significantly increased at 100mg/L treatment of AsA in ck-50 and at T_0 treatment of uj-16.The chlorophyll was significantly increased at 200mg/L treatment of growth hormone in CH-50 and T_0 treatment in UJ-16.









Based on Duncan's multiple range tests it was observed that yield/ plant, no. of grains/ plot, yield/ plot at T_2 treatment of ascorbic acid in both varieties significantly increased.

The thousand grain weight of cultivar CH-50 (40.1a ± 1.06) showed great at 100 mg/L conc. of AsA. At 200 mg/L conc. of AsA both varieties exhibited good yield/plot CH-50 (489.01a ± 262.52) and UJ-16 (697.65a ± 155.23). Similarly at 200mg/L doze of ascorbic acid both the wheat cultivars increased yield/plant CH-50 (10.30a ± 6.81) and UJ-16 (23.97a ± 7.98). The UJ-16 and CH-50CH-50 showed high no. of grains/plot at 200 mg/L conc. of AsA CH- 50 (55a ± 5.89) and UJ-16 showed 47.66a ± 5.57 (Table 3.1).

DISCUSSION

It is observed that growth parameters in both varieties such as plant height (cm), leaf length (cm), yield/ plot (g), no of spikes, chlorophyll content and thousand grain weight (g) significantly increased at 200mg/L treatment of ascorbic acid. This work was parallel with Amin et al. (2008),

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who discovered that ascorbic acid at concentrations of 100, 200, and 400 mg/L was more effective at promoting vegetative development in wheat plants at the milky and softy-dough stages. The increases in growth characteristics (i.e., plant height, number of tillers, spikes/plants, and dry weight/plant (g)) were greatest when 400 mg/L AsA was applied to resistor plants during two physiological stages of growth. Significant increases in the same growth characteristics were seen when different amounts of ascorbic acid were added at the milky and softy-dough stages of growth. Ascorbic acid at 200 or 400 mg/L achieved the greatest growth criterion values. The ascorbic acid significantly enhanced the plant height (cm), shoot length in this experiment at the 200mg/L concentration. It was revealed that AsA plays momentous role in the vegetative growth of plants. Mazher *et al*. (2011) investigated that foliar application of AsA promoted the plant height of *Codiaeum variegatum L.* and these findings are in line with our experiment.

In current experiment AsA promoted the growth parameters significantly at 200mg/L in wheat. Azoz *et al*. (2016) also investigated the effect of diverse concentrations of ascorbic acid (200 and 300 ppm) on morphological characters of vegetative growth that AsA play significant role in improving plant height (cm), leaf length (cm), and yield in Basil Plant (*Ocimum basilicum* L.*)*. According to the tested concentration Basil plants with 200 ppm ascorbic acid proved to be the most positive effective concentration with promoting vegetative growth and increased productivity as these findings are in line with our experiment. Growth parameters such as number of tillers, and no. of spikes, chlorophyll content, and thousand grain weights may also significantly increase at 100mg/L treatment of ascorbic acid in this experiment. El-awadi *et al.* (2014) investigated that at 100 ppm, the treatments of AsA resulted in significant increases in grain weight/spike, grain weight/plant, grain weight of 1000 grains (g), and grain yield (kg/fed.) in the two cultivars. This work was in line with current experiment. Athar and Ashraf (2006) also investigated that AsA enhanced chlorophyll content at 100 mg/L concentration in both wheat cultivars under saline conditions these finding are parallel with our experiment. Thomson et al. (2017) explored the growth and yield of garden pea (*Pisum sativum* L.) cv. Bonneville after foliar spraying with acetyl salicylic acid and ascorbic acid. Garden pea yields, yield per hectare, and economics were all highest when ascorbic acid was used at a concentration of 200 ppm. In this study the no. of grains/plot, yield/plot and yield/plant boost wheat development and yield at 200mg/L treatment of AsA in both varieties of wheat plant. According to this study, exogenous ascorbic acid enhanced foliar growth, perhaps leading to greater plant biomass and yield. Current study is consistent with the findings of the researchers cited above. However, they apply different treatments at different time intervals and they use different cultivars. Ascorbic acid bared progressive effects and momentous proliferation in the growth factors of wheat.

CONCLUSION

Wheat is the world's most widely consumed staple food, and it is critical to the country's human hunger and economic well-being. Wheat is the most important crop in Pakistani agriculture. Ascorbic acid is an antioxidant chemical that is used to boost wheat growth characteristics. The effect of varying concentrations of ascorbic acid on selected wheat parameters was investigated, and the consequences exposed that the vegetative and reproductive growth of wheat plants was greatly boosted when treated with 100mg/L and 200mg/L ascorbic acid. The experiment could be repeated with a higher ascorbic acid concentration. It will help us understand the role of AsA in wheat growth and help us find the ideal concentration. As a result, it's thought that AsA is mostly responsible for wheat growth and yield.

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References

Amin, A.A., Rashad, E.S.M. and Gharib, F.A. (2008). Changes in morphological, physiological and reproductive characters of wheat plants as affected by foliar application with salicylic acid and ascorbic acid. *Australian journal of basic and applied sciences*, *2*(2), 252-261.

Azoz, S.N., El-Taher, A.M., Boghdady, M.S. and Nassar, D.M. (2016). The impact of foliar spray with ascorbic acid on growth, productivity, anatomical structure and biochemical constituents of volatile and fixed oils of basil plant (*Ocimum basilicum* L.). *Middle East Journal of Agriculture Research*, *5*(4), 549-565.

Athar, R.E.H.M.A.N. and Ashraf, M.U.H.A.M.M.A.D. (2006). Interactive effect of foliarly applied ascorbic acid and salt stress on wheat (*Triticum aestivum* L.) at the seedling stage. *Pakistan Journal of Bot*any, *38*(5), 1407-1414.

Badar, H. and Din, O.M. (2005) Wheat production and marketing: a comparative study of traditional and progressive farmers in Faisalabad (Pakistan). *Journal of Agriculture and Social Sci*ence *1*(1), 16-19.

Bakry, A. B., Abdelraouf, R. E., Ahmed, M. A., and El Karamany, M. F. (2012). Effect of drought stress and ascorbic acid foliar application on productivity and irrigation water use efficiency of wheat under newly reclaimed sandy soil. *Journal of Applied Sciences Research*, *8*(8), 4552-4558.

Chandio, A.A., Yuansheng, J. and Magsi, H. (2016). Agricultural sub-sectors performance: an analysis of sector-wise share in agriculture GDP of Pakistan. *International Journal of Economics and Finance*, *8*(2), 156-162.

Cherian, S., Reddy, M. P., & Pandya, J. B. (1999). Studies on salt tolerance in *Avicennia marina* (Forstk.) Vierh: effect of NaCl salinity on growth, ion accumulation and enzyme activity. *Indian Journal of Plant Physiology*, *4*(4), 266-270.

Desoky, E.S.M. and Merwad, A.R.M. (2015). Improving the salinity tolerance in wheat plants using salicylic and ascorbic acids. *Journal of Agricultural Science*, *7*(10), 203.

El-Awadi, M.E., El-Lethy, S.R. and El-Rokiek, K.G. (2014). Effect of the two antioxidants; Glutathione and ascorbic acid on vegetative growth, yield and some biochemical changes in two wheat cultivars. *Journal of Plant Sciences*, *2*(5), 215-221.

Gul, H., Ahmad, R. and Hamayun, M. (2015). Impact of exogenously applied ascorbic acid on growth, some biochemical constituents and ionic composition of guar (*Cymopsis tetragonoloba*) subjected to salinity stress. *Life Sciences*, *3*(1-2), 22-40.

Hellal, F., El-Sayed, S., Zewainy, R., & Amer, A. (2019). Importance of phosphate pock application for sustaining agricultural production in Egypt. *Bulletin of the National*

Vol.7, No.1, pp.62-72, 2022
Print ISSN: 2055-8139(Print)
Online ISSN: 2055-8147(Online)

Research Centre, *43*(1), 1-11.

Hussain, A. and Routray, J.K. (2012). Status and factors of food security in Pakistan. *International Journal of Development Issues*.

Hussein, M.M. and Alva, A.K. (2014). Effects of zinc and ascorbic acid application on the growth and photosynthetic pigments of millet plants grown under different salinity. *Agricultural Sciences*, *5*(13), 1253.

Ijaz, F., Khaliq, I., Shahzad, M.T. and Saleem, B. (2013). Computation of heritability of yield and some morphological traits in F2 populations of spring wheat (*Triticum aestivum* L). *International journal of Modern Agriculture*, *2*(3), 102-107.

Kamal, M.A., Saleem, M.F., Wahid, M.A. and Shakeel, A. (2017). EFFECTS OF ASCORBIC ACID ON MEMBRANE STABILITY AND YIELD OF HEATSTRESSED BT COTTON. *JAPS: Journal of Animal & Plant Sciences*, *27*(1):192-199.

Kirchmann, H., Bergström, L., Kätterer, T., Andrén, O., & Andersson, R. (2009). Can organic crop production feed the world? In *Organic crop production–Ambitions and limitations*, 39-72.

Khan, T.A., Mazid, M. and Mohammad, F. (2011). Role of ascorbic acid against pathogenesis in plants. *Journal of Stress Physiology & Biochemistry*, *7*(3), pp.222-234.

Mazher, A.A., Zaghloul, S.M., Mahmoud, S.A. and Siam, H.S. (2011). Stimulatory effect of kinetin, ascorbic acid and glutamic acid on growth and chemical constituents of Codiaeum variegatum L. plants. *American-Eurasian Journal of Agricultural & Environmental Sciences*, *10*(3), 318-323.

Kazmi, R.H., Khan, M.Q. and Abbasi, M.K. (2003). Effect of water stress on the performance of wheat grown under controlled conditions at Rawalakot, Azad Jammu and Kashmir [Pakistan]. *Sarhad Journal of Agriculture (Pakistan)*.

SALEHI, S.A., Shahdadneghad, M., RohanyYazdi, M. and Mohammadi, T. (2014). Effects of zinc sulphate and Ascorbic acid on Flowering Characteristics of Ornamental plant Gazania (*Gazania rigens*) cv. daybreak red stripe. *International Journal of Advanced Biological and Biomedical Research*, 2(2):392-398.

Smirnoff, N. (2018). Ascorbic acid metabolism and functions: A comparison of plants and mammals. *Free Radical Biology and Medicine*, *122*,116-129.

Takemura, T., Hanagata, N., Sugihara, K., Baba, S., Karube, I., & Dubinsky, Z. (2000). Physiological and biochemical responses to salt stress in the mangrove, *Bruguiera gymnorrhiza*. *Aquatic Botany*, *68*(1), 15-28.

Thomson, T., Patel, G.S., Thakar, J.B. and Pandya, K.S. (2017). Effect of foliar application of acetyl salicylic acid and ascorbic acid on protein content, yield and economics of garden pea (*Pisum sativum* L.) cv. *Bonneville. International Journal of Current Microbiology and Applied Sci*ences *6*(6), 1987-1990.

Zhang, Y., (2012). Ascorbic acid in plants: biosynthesis, regulation and enhancement. *Springer Science & Business Media*, 7–33.