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Effects of drought and salt stress on wheat seedling growth related traits under salicylic acid seed priming

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Abstract
Drought stress and salt stress often causes serious problems in wheat production areas. A study was conducted in the greenhouse of the Institute of Molecular Biology and Biotechnology, The University of Lahore effects on the seedling growth and development under NaCl treatments in wheat variety UJALA-2017, FAISLABAD-2008 and GALAXY-2013. The data was collected for various seedling traits and statistically analyzed, which revealed the significance of results for treatments, salt applications, genotypes and the interactions between salt treatments and genotypes. It was concluded from our study that the application of salicylic acid (SA) under salt (NaCl) stress conditions helps wheat seedlings to withstand and compete with stressful conditions. The study revealed that the seed priming with salicylic acid helps to improve root length, shoot length. The use of SA priming shows medium effects for the seedling growth of wheat under salt stress environmental conditions. The wheat variety Galaxy-2013 has shown good performance for most of the studied traits of seedlings under salt stress conditions. It was suggested from our study that the variety Galaxy-2013 may be used under salt stress conditions or salt affected soils to improve grain yield of wheat.

Keywords: wheat, triticum aestivum, drought, salt, salicylic acid, water priming, root, shoot

Introduction
Wheat is one the most extensive grown crop throughout the world. Wheat (*Triticum aestivum* L.) is most important food crop. It has been the basic food for the major civilizations of Europe, West Asia and North Africa. Approximately one sixth part of the total land in the world consists of wheat. It is most demanded food grain and its production leading over other cereals. Wheat consists of 55% of the carbohydrates and 20% of the food calories consumed globally (Ashraf *et al*., 2013 [12]; Ashraf and Harris, 2010) [12]. It ranks first among the world food and the grains crops in the terms of cultivated area which is about 223.813 million hectares or the production about 733.144m tones and the productivity is about 3280 kg ha^{-1} (Asseng *et al*. 2015) [13]. It stands second among the major cereals while the china stands the first. Wheat plays an important role in food security. The production of wheat in Pakistan is lower as compared with the other wheat growing counties in the world due to some factors including the quality of seed, irrigation water, biotic and abiotic conditions and fertilizers. In the abiotic stress conditions, drought, salt heat and heavy metals played important role in decreasing the yield production (Charles *et al*. 2006 [17]; Kirkegaard *et al*. 2008 [25], Raza *et al*. 2006). One of the most important environmental stresses is drought stress. This stress occurs only because of several reasons like low rainfall, high intensity of light and low and high temperatures this may causes the changes in the physiological, morphological traits in the plants (Ali *et al*., 2013; Ali *et al*., 2017 [14]; Aaliya *et al*., 2016 [1]; Abbas *et al*., 2015 [2]; Abbas *et al*., 2016 [1]; Hafeez *et al*., 2015 [22]; Hafeez *et al*., 2019 [23]; Kanwal *et al*., 2019) [8]. The bread wheat (*Triticum aestivum* L.) is an important crop among the other food crops throughout the world which occupies a significant position among all the cultivated cereal crops. The cultivation of wheat has been remained the symbolic of the green revolution which has played an important role in making the nations a food spare nation (Bhardwaj *et al*., 2010) [14]. The present study was carried out to access the effects of salt and drought on wheat seedlings under the applications of salicylic acid.

Material and Methods
A study was conducted in the greenhouse of the Institute of Molecular Biology and Biotechnology, The University of Lahore effects on the seedling growth and development under NaCl treatments in wheat variety UJALA-2017, FAISLABAD-2008 and GALAXY-2013. The seeds were soaked in 10ml of 0.25M SA for 2 hours. Then seeds were dried in petri dish. Sand was taken and autoclaved for 20 min. The autoclaved sand was put into every pot and seeds were sown in every pot.
Let the seeds were to grow

- After one week spray the plant by 10ml of 0.25 M SA
- Again after one week spray the plants by SA of 0.25 M
- Take the results after 1 month
- Measurement of shoot and root length
- Root dry weight
- Shoot dry weight
- Leaf area

The data was recorded for above studied traits and subjected to analysis of variance to access the significance of results (Steel *et al*., 1997) [33].

Results and Discussions
Shoot length or SL (cm)
The results of the average shoot length under all applied treatments were recorded as 20.601cm (Table 1). The lower value of coefficient of variation (0.64%) for shoot length indicated that there was consistency among the results

which also cleared that the results were reliable for shoot length of wheat seedling under different treatments of salicylic acid (SA) and NaCl. The mean performance of genotypes under all treatments of NaCl and salicylic acid priming indicated that the genotypes/variety Galaxy-2013 (21.201cm) showed higher shoot length while Faislabad-2008 (20.701cm) and Ujala-2017 (19.901cm) average shoot length under all treatments (Table 1b). The results from table 1a showed that the higher shoot length was found under the treatment effects of T3 (22.80cm) while lowest was found under control (18.867cm). The results from figure 1 showed that the relative average performance of wheat genotypes was higher under drought stress conditions as compared with salt stress environment. The higher shoot length of wheat seedlings under NaCl treatment indicated that the genotypes with higher shoot length showed tolerance against salt stress without any application of growth regulator. It was found from results that the seed priming with application of salicylic acid for better growth and development plays an important role while depending upon the genetic potential of the crop plants. The genotype Galaxy-2013 showed good performance of shoot under salt stress conditions and also good response for applications of salicylic acid. It was suggested that the genotype or variety Galaxy-2013 may be used for improved plant growth, development and higher grain yield variety under salt stress and salt affected soils (Afzal *et al*. 2006b [4], Gautam and Singh 2009 [20], Loutfy *et al*. 2012) [20].

Table 1: Analysis of variance for different traits of wheat under different water treatments

Source	Root length	Shoot length	Leaf area	Dry root weight	Dry shoot weight
Replication	0.16488	0.11354	9.3193	0.00014	1.041E-06
Genotype	0.60200*	6.4500 *	6.9343*	0.00015*	2.754E-05*
Treatment	34.2209*	27.0976*	47.3807*	0.00108*	0.00100*
Gen*Treatment	7.533E-30*	5.861E-30*	1.4431*	0.00017*	9.754E-05*
Error	0.01574	0.01743	2.6957	0.00003	5.568E-05
Grand mean	19.445	20.601	5.6033	0.0189	0.0228
Coefficient of variation	0.65	0.64	9.30	17.16	12.74
Standard error	0.01574	0.01743	0.3351	0.001118	0.001523

*=significant at 5%probability leve

Table 2: All-Pairwise Comparisons Test of shoot length for treatment

Treatment	Mean	Homogeneous Groups
3	22.800	A
1	21.740	B
2	20.697	C
4	18.900	D
0	18.867	D

Table 3: All-Pairwise Comparisons Test of shoot length for treatment

Genotypes	Mean	Homogeneous Groups
3	21.201	A
2	20.701	B
1	19.901	C

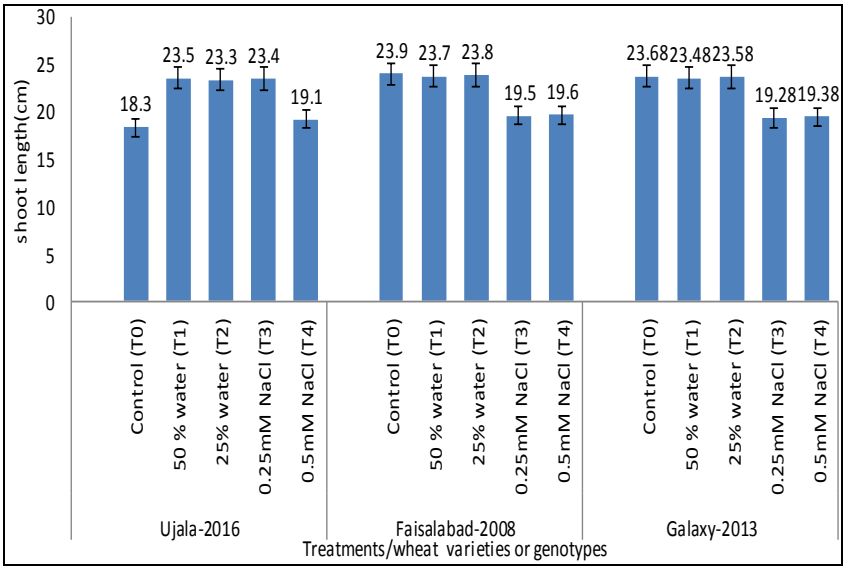

Fig 1: Shoot length of wheat genotypes under drought and salt stress conditions Leaf area or LA (cm^2)

The result indicates that the average leaf area of wheat was recorded as 6.2740 under all the treatment concentrations of NaCl (Table 1). The lower value of coefficient of variation (0.16%) for leaf area which indicated that there was

consistency among the results which also cleared that the results were reliable for leaf area of wheat seedling under different treatments of salicylic acid and NaCl or salt The mean performance of genotypes under all treatments of NaCl and salicylic acid priming indicated that the genotypes/variety Galaxy-2013 (6.4640cm2) showed higher leaf area while Faislabad-2008 (6.2640cm2) and Ujala-2016 (6.2067) average leaf area under all treatments (Table 2b). The results form table 2a indicated that the higher leaf area (97.3033cm^2) under T3 (NaCl application) treatment, T4 or water priming + NaCl (6.3967cm^2) was found while lowest was for control (5.190cm^2) and treatment T5 or salicylic acid + NaCl (4.6556cm^2). The figure 2 showed that the leaf for all of the genotypes was higher under drought stress conditions as compare with slat stress conditions. The higher leaf area of wheat seedlings under NaCl treatment indicated that the genotypes with higher leaf area showed tolerance against salt stress without any application of growth regulator. The higher leaf area also revealed that the photosynthetic rate under salt stress may be higher which helped the seedlings to withstand under stressful environmental conditions (Ali *et al*., 2013 [22]; Aaliya *et al*., 2016 [1]; Abbas *et al*., 2015 [2]; Mahmood *et al*., 2019ab [2, 3]; Naseem *et al*., 2015ab [29, 30]; Bibi *et al*., 2018 [16]; Agarwal *et al*. 2015 [5]; Shakirova *et al*. 2003) [31].

Table 4: all pair wise comparison test of la for salt treatments

Treatment	Mean	Homogenous Group
3	7.3033	A
4	6.3967	B
1	6.2800	C
2	6.2000	D
0	5.1900	E

Table 5: all pair wise comparison test for la for genotypes

Genotypes	Mean	Homogenous Group
3	6.4640	A
2	6.2640	B
1	6. 0940	C

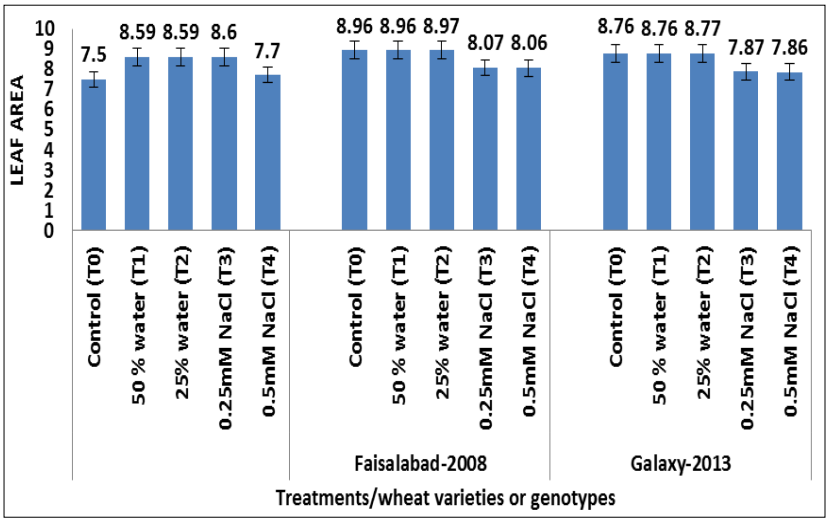

Fig 2: leaf area of wheat genotypes under drought and salt stress conditions

Root length

The results of the average root length under all applied treatments were recorded as 19.445cm (Table 1). The lower value of coefficient of variation (0.65%) for root length indicated that there was consistency among the results which also cleared that the results were reliable for root length of wheat seedling under different treatment applications of salicylic acid (SA) and NaCl. The mean performance of genotypes under all treatments of NaCl and salicylic acid priming indicated that the genotypes/variety Galaxy-2013 (19.65cm) showed higher root length while Faislabad-2008 (19.432cm) and ujala-2016 (19.252cm) average root length under all treatments (Table 3b). The higher root length under treatment T3 (22.593cm) while lowest under T2 (17.460cm) were recorded for treatments of drought and salt stress (Table 3a). The figure 3 showed that the overall relative performance of wheat genotypes was higher under drought stress as compared with salt stress conditions. The higher root length of wheat seedlings under NaCl treatment indicated that the genotypes with higher root length showed tolerance against salt stress without any application of growth regulator which can absorb water mineral salts from deeper soil. The genotype Galaxy-2013 showed good performance for root length under salt stress conditions and also good response for applications of salicylic acid (Ali *et al*., 2013 [22]; Ali *et al*., 2014; Ali *et al*., 2016 [13]; Ali *et al*., 2017 [14]; Aaliya *et al*., 2016 [1]; Abbas *et al*., 2015; Abbas *et al*., 2016 [2]; Hafeez *et al*., 2015 [1]; Hafeez *et al*., 2019 [2]; Ashraf *et al*., 2008 [1]).

Table 6: All-Pairwise Comparisons Test of root length for treatment

Treatment	Mean	Homogeneous Groups
3	22.593	A
1	19.740	B
0	19.040	C
4	18.393	D
2	17.460	E

Table 7: All-Pairwise Comparisons Test of root length for genotypes

Genotypes	Mean	Homogeneous Groups
3	19.652	A
2	19.432	B
1	19.252	C

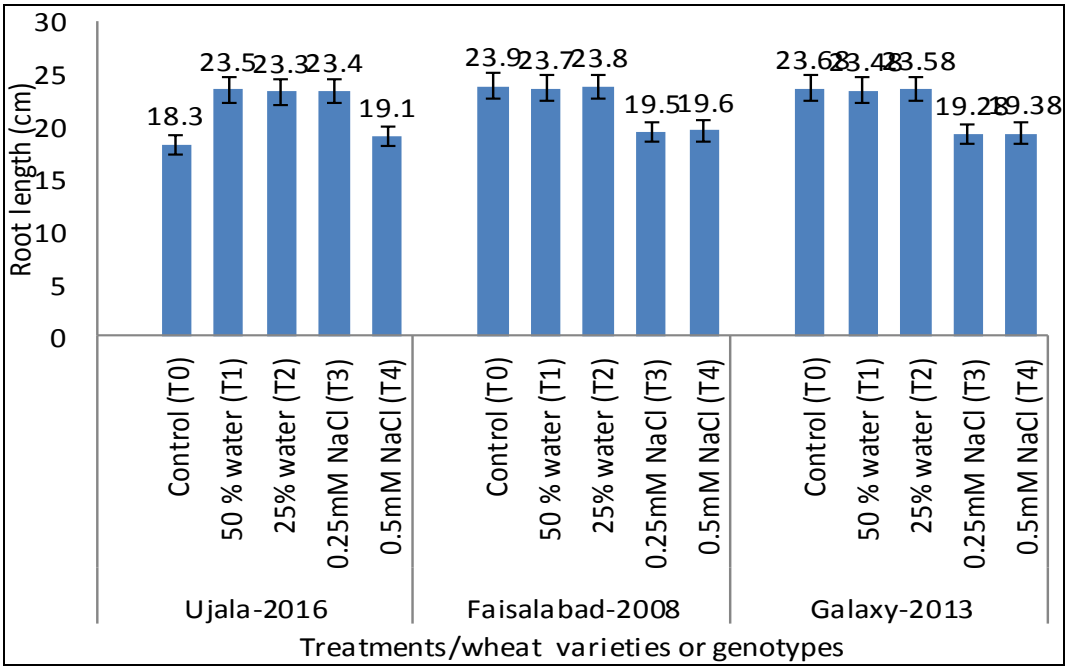

Fig 3: Root length of wheat genotypes under drought and salt stress conditions

Shoot dry weight

The result of the average shoot dry weight under all applied treatments were recorded as 0.0894g (Table 1). The lower value of coefficient of variation or CV (7.63%) for shoot dry weight indicated that there was consistency among the results which also cleared that the results were reliable for shoot dry weight of wheat seedling under different applications of salicylic acid (SA) and NaCl. The higher dry shoot weight was found under treatment T2 90.0993g) while lower shoot dry weight (0.077g) under control (Table 1). The mean performance of genotypes under all treatments of NaCl and salicylic acid priming indicated that the genotypes/variety faislabad-2008 (0.1194g) showed higher shoot dry weight while Galaxy2013 (0.0894g) and Ujala-2017 (0.0594g) average shoot dry weight under all treatments (Table 4b).

The figure 4 showed that the average shoot dry weight was found higher under drought conditions as compared with salt stress conditions. The higher shoot dry weight of wheat seedlings under NaCl treatment indicated that the genotypes with higher shoot dry weight showed tolerance against salt stress without any application of growth regulator which can produce the heavy amount of organic compounds through photosynthesis which help the seedlings to withstand under stressful environmental conditions. It was suggested that the genotype or variety Faisalbad-2008 may be used for improved plant growth, development and higher grain yield variety under salt stress and salt affected soils (Abbas *et al*., 2016 [1]; Hafeez *et al*., 2015 [4]; Hafeez *et al*., 2019 [1]; Kanwal *et al*., 2019 [8]; Bhutta *et al*., 2015 [15]; Afzal *et al*. 2006 [4], Ashraf *et al*. 2010 [12], Hamada 2001 [23], Singh and Usha 2003) [32].

Table 8: All-Pairwise Comparisons Test of shoot dry weight for Treatment

Treatment	Mean	Homogeneous Groups
2	0.0993	A
4	0.0973	A
1	0.0867	B
3	0.0860	B
0	0.0777	B

Table 9: All-Pairwise Comparisons Test of shoot dry weight for genotypes

Genotypes	Mean	Homogeneous Groups
2	0.1194	A
3	0.0894	B
1	0.0594	C

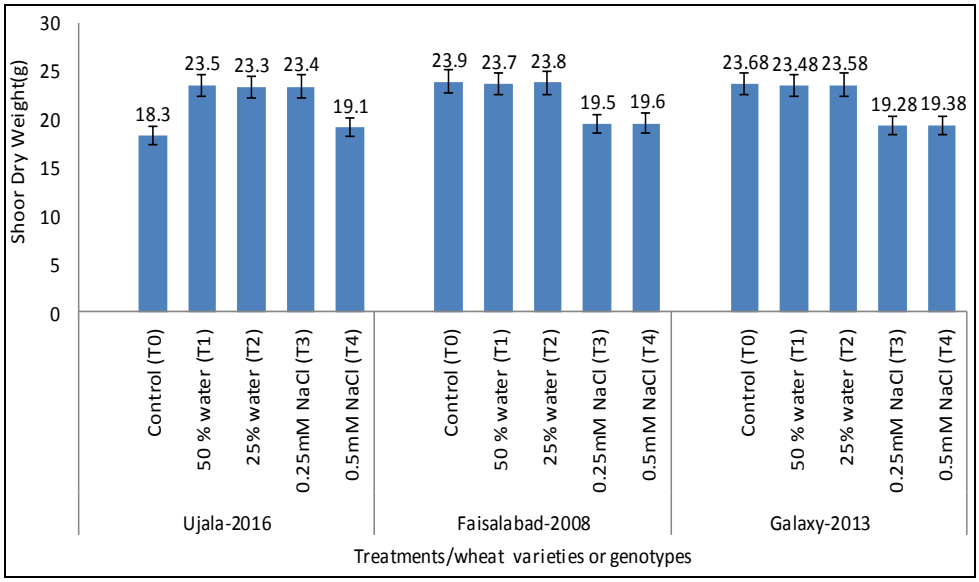

Fig 4: Shoot dry weight of wheat genotypes under drought and salt stress conditions

Root dry weight

The results given in table were reported among treatments, genotypes and for interactions results that the average root dry weight under all applied treatments were recorded as 0.0884g (Table 1). The lower value of coefficient of variation (9.60%) for root dry weight indicated that there was consistency among the results which also cleared that the results were reliable for root dry weight of wheat seedling. The results form table revealed that there was lower root dry weight (0.078831g) under T1 (water priming) treatment, T0 control (0.0831g) while higher was for T2 or SA priming (0.0946g) (Table 5a). The mean performance of genotypes under all treatments of NaCl and salicylic acid priming indicated that the genotypes/variety Faislabad-2008 (0.1107g) showed higher root dry weight while Galaxy-2013 (0.1044g) and ujala-2016 (0.0504g) average root dry weight under all treatments (Table 5b and Figure 5). The higher root dry weight of wheat seedlings under NaCl treatment indicated that the genotypes with higher root dry weight showed tolerance against salt stress without any application of growth regulator which can produce large amount of organic compounds through photosynthesis and helped the seedlings to withstand under stressful environmental conditions It was suggested that the genotype or variety faislabad-2008 may be used for improved plant growth, development and higher grain yield variety under salt stress and salt affected soils (Datta *et al*. 2009 [18], Farooq and Azam 2006 [19], Mansour 1994) [28].

Table 10: All pair wise Comparison test of root dry weight for treatment

Treatment	Mean	Homogenous Group
4	0.0969	A
2	0.0946	AB
3	0.0889	ABC
0	0.0831	BC
1	0.0786	C

Table 11: All pair wise comparison for root dry weight for genotypes

Genotypes	Means	Homogenous Groups
2	0.1104	A
3	0.1044	A
1	0.0504	B

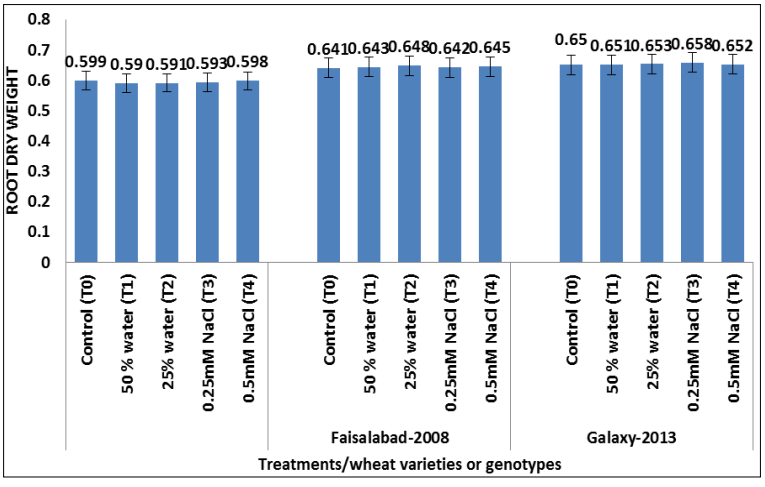

Fig 5: leaf per plant of wheat genotypes under drought and salt stress conditions

Conclusions

The study revealed that the seed priming with salicylic acid helps to improve root length, shoot length. The use of water priming shows medium effects for the seedling growth of wheat under salt stress environmental conditions. The wheat variety Galaxy-2013 has shown good performance for most of the studied traits of seedlings under salt stress conditions. It was suggested from our study that the variety Galaxy-2013 may be used under salt stress conditions or salt affected soils to improve grain yield of wheat.

References

1. Aaliya K, Qamar Z, Nas ir IA, Ali Q, Munim AF. Transformation, evaluation of gtgene and multivariate genetic analysis for morpho-physiological and yield attributing traits in Zea mays. Genetika. 2016; 48(1):423-43.
2. Abbas HG, Mahmood A, Ali Q. Genetic variability and correlation analysis for various yield traits of cotton (Gossypium hirsutum L.). Journal of Agricultural Research. 2015; 53(4):481-91.
3. Abbas HG, Mahmood A, Ali Q. Zero tillage: a potential technology to improve cotton yield. Genetika, 2016, 48(2).
4. Afzal I, Basra SM, Farooq M, Nawaz A. Alleviation of salinity stress in spring wheat by hormonal priming with ABA, salicylic acid and ascorbic acid. Int. J. Agric. Bot. 2006; 8: 23-28.
5. Agarwal S, Sairam R, Srivastava G, Tyagi A, Meena R, Akhtar SS, *et al*. Residual effects of bio char on improving growth, physiology and yield of wheat under salt stress. Agricultural Water Management. 2015; 158: 61-68.
6. Ali Q, Ahsan M, Ali F, Aslam M, Khan NH, Munzoor M, Mustafa HS, *et al*. Heritability, heterosis and heter obeltiosis studies for morphological traits of maize (Zea mays L.) seedlings. Advancements in Life sciences. 2013; 1(1):52-63.
7. Ali Q, Ali A, Ahsan M, Nasir IA, Abbas HG, Ashraf MA, *et al*. Line× Tester analysis for morpho-physiological traits of Zea mays L seedlings. Advancements in Life sciences. 2014; 1(4):242-53.
8. Ali F, Ahsan M, Ali Q, Kanwal N, Phenotypic stability of Zea mays grain yield and its attributing traits under drought stress. Frontiers in plant science'. 2017; 8:1397.
9. Ali Q, Ahsan M, Kanwal N, Ali F, Ali A, Ahmed W, *et al*. Screening for drought tolerance: comparison of maize hybrids under water deficit condition. Advancements in Life Sciences. 2016; 3(2):51-58.
10. Ashraf M, Akram N, Arteca R, Foolad MR. The physiological, biochemical and molecular roles of brassinosteroids and salicylic acid in plant processes and salt tolerance. Critical Reviews in Plant Sciences. 2010; 29:162-190.
11. Ashraf M, Akram N, Arteca R, Foolad MR. The physiological, biochemical and molecular roles of brassinosteroids and salicylic acid in plant processes and salt tolerance. Critical Reviews in Plant Sciences. 2010; 29: 162-190.
12. Ashraf M, Harris P. Photosynthesis under stressful environments: an overview. Photosynthetic. 2013; 51: 163-190.
13. Asseng S, Ewert F, Martre P, Rötter RP, Lobell DB, Cammarano D, Rising temperatures reduce global wheat production. Nature climate change. 2015; 5:143.
14. Bhardwaj V, Yadav V, Chauhan BS. Effect of nitrogen application timings and varieties on growth and yield of wheat grown on raised beds. Archives of Agronomy and Soil Science. 2010; 56: 211-222.
15. Bhutta MA, Muhammad KQ, Muhammad KS, Mahmood A, Malook SU, Ali Q, *et al*.Oxidative damage caused by Reactive Oxygen Species under drought stress in Gossypium hirsutum. Life Sci. J. 2015; 12(4s):51-9.
16. Bibi T, Mustafa HS, Mahmood T, Hameed A, Ali Q. Multivariate analysis for adaptability and yield stability of rapeseed (Brassica napus L.) strains in different agro-climatic zones. Genetika (0534-0012). 2018; 1:50(2).
17. Charles R, Jolliet O, Gaillard G, Pellet D. Environmental analysis of intensity level in wheat crop production using life cycle assessment. Agriculture, ecosystems & environment, 2006, 113: 216-225.
18. Datta J, Nag S, Banerjee A, Mondai N. Impact of salt stress on five varieties of wheat (Triticum aestivum L.) cultivars under laboratory condition. Journal of Applied Sciences and Environmental Management, 2009, 13.
19. Farooq S, Azam F. The use of cell membrane stability (CMS) technique to screen for salt tolerant wheat varieties. Journal of plant physiology. 2006; 163:629-637.
20. Gautam S, Singh PK. Salicylic acid-induced salinity tolerance in corn grown under NaCl stress. Acta physiologies plantarum. 2009; 31:1185.
21. Hafeez MN, Ahmad S, Mamoon-Ur-Rashid M, Ali A, Salman S, Bakhsh A, *et al*. An overview of enhancing drought tolerance in cotton through manipulating stress resistance genes. Applied Ecology and Environmental Research. 2019; 17(3):7003-25.
22. Hafeez MN, Sadique S, Hassan S, Sarwar MB, Rashid B, Ali Q, *et al*. Physiological, morphological, biochemical and molecular basis of drought tolerance in cotton. Int. J. Biol. Pharm. Allied Sci. 2015; 4:1091-112.
23. Hamada A. Salicylic acid versus salinity-drought-induced stress on wheat seedlings. Rostlinna Vyroba-UZPI (Czech Republic), 2001.
24. Kanwal N, Ali F, Ali Q, Sadaqat HA. Phenotypic tendency of achene yield and oil contents in sunflower hybrids. Acta Agriculturae Scandinavica, Section B: Soil & Plant Science. 2019; 69(8):690-705.
25. Kirkegaard J, Christen O, Krupinsky J, Layzell D. Break crop benefits in temperate wheat production. Field Crops Research. 2008; 107:185-195.
26. Loutfy N, El-Tayeb MA, Hassanen AM, Moustafa MF, Sakuma Y, Inouhe M, *et al*. Changes in the water status and osmotic solute contents in response to drought and salicylic acid treatments in four different cultivars of wheat (Triticum aestivum). Journal of plant research. 2012; 125:173-184.
27. Mahmood T, Mustafa HS, Aftab M, Ali Q, Malik A. Super Canola: Newly Developed High Yielding, Lodging and Drought Tolerant Double Zero Cultivar of Rapeseed (Brassica napus L.). Genetics and Molecular Research, 2019, 18(2).

28. Mansour M. Changes in growth, osmotic potential and cell permeability of wheat cultivars under salt stress. Biologia Plantarum. 1994; 36:429.
29. Naseem Z, Masood SA, Ali Q, Ali A, Kanwal N. Study of genetic variability in Helianthus annuus for seedling traits: An Overview. Life Sci J. 2015; 12(3):109-114.
30. Naseem Z, Masood SA, Irshad S, Annum N, Bashir MK, Anum R, *et al*. Critical study of gene action and combining ability for varietal development in wheat: An Overview. Life Sci J. 2015; 12(3):104-108.
31. Shakirova FM, Sakhabutdinova AR, Bezrukova MV, Fatkhutdinova RA, Fatkhutdinova DR. Changes in the hormonal status of wheat seedlings induced by salicylic acid and salinity. Plant science. 2003; 164:317-322.
32. Singh B, Usha K. Salicylic acid induced physiological and biochemical changes in wheat seedlings under water stress. Plant Growth Regulation. 2003; 39:137-141.
33. Steel RGD, Torrie JH, Dickey DA. Principles and Procedures of Statistics: A biometrical approach (3rd ed.). McGraw Hill Inc. New York, USA, 1997.