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Effects of abiotic stresses on crop yield: A review

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Abstract
Approximately 9% of the earth's surface is covered by crops, with 91 percent of that being subjected to various stresses. Abiotic stresses account for around half of all yield losses, with high temperatures (20%), low temperatures (7%), salinity (10%), drought (9%), and other abiotic stresses accounting for the rest (4%). Abiotic stresses such as drought, heat, and salinity have a significant impact on agricultural productivity. Since there is no way to expand agricultural land, increased production from these stressed lands is essential to satisfy the ever-increasing demand. This review summarized crop responses to abiotic stresses in terms of morphological, physiological, and biochemical responses on some of the crops. To combat those stresses, better crop management practice such as conservation tillage, zero tillage and increased water use performance, as well as the application of micronutrients and phytohormones are needed.

Keywords: Abiotic stress, drought, yield, salinity, cold, heat

Introduction
Crops face a variety of environmental stresses during their life cycle, including both biotic and abiotic stresses. The major limiting factor in agricultural systems is environmental stresses. Globally 91% of world crop production suffer stresses and only 9% of area is beneficial for crop production. Abiotic stress has become a major impact on the crop productivity globally by reducing crop yields in major crop plants. The abiotic stress are similar with osmotic stress which resulting in disruption of hemostatic and distribution of ion in cell. 50% to 70% yields were losses due to adverse environmental conditions, abiotic stress. Drought, salinity, heat or low temperature are the major stresses which is helping in increasing yield loss in crop plants.

Climate changes is becoming one of the biggest challenge for future that agriculture sectors must face. Crop plants can withstand stresses up to tolerable level through their defense mechanisms. However, the degree of adaptability and unsusceptible to abiotic stress may differ from crop to crop and variety to variety. Crop shows symptoms of having these stresses later on after their physiology undergo significant changes (Cramer *et al.*, 2010) [12].

Drought stress is a worldwide problem that help in reducing crop yields production as well as crop quality. Climates changes are the leading reason which increases in temperature and atmosphere $C0_2$ level and disturbance in rainfalls pattern significantly. The in-appropriate or uneven rainfall pattern causes drought stress in many areas. Water availability to the plants are reduces which even leads to reducing in crop yields and some plants suffered dead and serious injury. Plants which are grown under drought stress are subjected to stunted growth, reduction in shoot growth, reduce in chlorophyll content and producing immense amount of proline.

Soil salinity poses a serious threat to our agriculture world because it helps in reducing crop yield in an affected areas. Soil salinity effects in plant growth and crop yield. Under soil salt stress conditions, due to the presence of more salts, the osmotic pressure in soil solution exceeds than the osmotic pressure in plants, resulting in the limitation of plants to taken up waters and minerals such as Ca^{2+} and K^{+}. Cold or heat temperature is one of the main abiotic stresses that restrict the agricultural productivity, has become global concern. Cold stress effects the cellular functions in the plants. However, plants withstand cold stress by changing physiological and biochemical processes. Crop plants that encountered heat stress have lesser percentage of seed germination, yield reduction and photosynthetic efficiency declines.

Effects of drought stress on crop yield
Mafakheri *et al.*, (2010) [32] reported that due to the reduction in numbers of pod in plants, yield was reduced significantly during drought stress. Boyer (1971) [8] stated that scarcity of water is one of the major issues in crop production, plant health and overall productivity.

According to Serraj *et al.*, (2003) [50] concluded that drought stress is a complex syndrome affected by edaphic and changes in several climatic changes. Manikavelu *et al.*, (2006) [35] stated that drought stress during vegetative stages reduces the developmental growth of the rice crop. Harris *et al.*, (2002) [19] reported that drought damaged germination and promote poor stand establishment in first and foremost. Serraj *et al.*, (2005) [53] concluded that intermittent drought during the vegetative process, drought during reproductive growth, or drought at the end of the crop cycle may all cause yield losses. Khan *et al.*, (2001) [22] performed a study on maize on six treatments with different irrigations reported that plant height and stem diameter and leaf areas are decreasing noticeably with water stress increased. Manivannan *et al.*, (2007) [7] reported that there was a large decline in cell enlargement and more leaf senescence during water stress. Farooq *et al.*, (2016) concluded that drought decreases mass flow-dependent mineral nutrient uptake and translocation from the roots to the shoot, affecting all plant metabolic processes. Fahad *et al.*, (2017) [37] observed that drought stress reduces plant enzymatic activity, resulting in lower yield and quality of oilseed crops. Sabagh *et al.*, (2019) [11] concluded that oilseed crops's early growth stages, followed by anthesis and grain filling, are the most vulnerable to drought. Toscano *et al.*, (2016) [39] reported that drought stress causes various morphological, physiological, and metabolic changes in plants. It can happen at any stage of plant production, but certain plant growth phases are extremely sensitive to soil moisture levels, which significantly reduces overall crop yield. Krishnamurthy L *et al.*, (2010) [18] recorded that grain yield is a function of yield potential and time to 50% flowering under drought stress. Ludlow and Muchow (1990) [22] found that water deficit can limit growth and productivity of the chickpea crop. Mwale *et al.*, (2003) [28] resulted that crop sown in unfavourable moisture seedbeds due to limited irrigation at sowing time resulted in low yield and synchronised seedling emergence. Farooq *et al.*, (2016) [12] reported that drought is harmful at certain stages of development, including the generation and function of reproductive organs, and yields are reduced by 27-87 percent. Hao *et al.*, (2013) [13] observed that drought-stressed plants's chlorophyll content was decreased by 31% compared to non-stressed plants. Mafakheri *et al.*, (2010) [32] stated that drought stress has an effect on chlorophyll material, fluorescence, and photosynthesis. According to Demir *et al.*, water delay during onset can reduce the rate of germination, poor crop improvement and low yield. 46. Nanjo *et al.* (2003) stated that by accumulating proline, plants develop a defence mechanism and cellular homeostasis, increasing their stress tolerance. Ghodke *et al.* (2018) [30] stated that both irrigated and drought stress plots showed substantial difference in bulb yield in their research, when the onion was subjected to a 40-day drought stress treatment, its yield was reduced by 65 percent.

Effects of salinity on crop yield

Naz *et al.* (2009) concluded that salinity is one of the most significant abiotic stressors affecting plant growth and productivity, especially in arid and semi-arid regions. The presence of soluble salts in excess amount in soil altered the plants normal physiological processes and hinder plant growth during salt stress (Cramer, 1997) [13]. Salinity interrupt germination by reducing the osmotic potential of the soil in which seed declines the water imbibition (Khan and Weber, 2008). Ditommaso (2004) [14] observed that with the increasing in salinity stress there is a huge rate of decreasing in germination in plants. Carpici *et al.*, (2009) studied that the reduction in germination index in maize is due to the salinity stress. Khodarahmpour *et al.*, (2012) [17] observed that in maize crop there was a reduction in 32% germination rate, 80% root, 78% shoot length and plume length. Ishitani *et al.*, (1996) [20] observed that high level in salinity in barley caused reduction in growth and yield by 65%. Ahmad *et al.*, (2002) [3] stated that dry matter and cotton seeds yield was reduced significantly during salinity stress. Rengasamy (2006) [46] concluded that the accumulation of soluble salts in the soil column causes significant damage to the environment and agricultural production. Md. Aslam *et al.*, (2017) [38] observed that plants close their stomata in an attempt to stop or escape stress, resulting in stunted growth, wilting, and lower productivity. To meet the rising demands of a growing population, a 38 percent increase in food production is needed by 2025, with a further 50 percent increase required by 2050. Many factors, primarily physical and chemical deterioration of soil due to erosion and salinity, are restricting global demands. Concluded that plant height, number of leaves on main stem, number of branches on plant, root length, root dry weight, shoot dry weight were all reduced by salinity. Pannucio *et al.*, (2014) [44] objected that shoot length and root length all significantly reduced in the presence of salinity. Shakeri *et al.*, (2017) [55] reported that increased salinity in irrigation water had a significant negative effect on sorghum production and yield components. Tavousi *et al.*, (2015) [57] concluded that when the salinity of the water rises, so does its quality of usage, while salinity stress has no effect on yield, we do note a decrease in yield as salinity rises. Due to difficulties in extracting water from the soil and ion toxicity, high saline conditions cause osmotic stress, which can adversely affect the growth of many plants (Al-Taey and Majid, 2018) [5].

Effects of temperature on crop yield

Cold stress is a limiting factors for increasing in crop and growth reduction in wheat and also effect the winter wheat (Ruelland *et al.*, (2009) [47]. Yoshida (1981) [62] discussed that during early seedling and germination stages in plants have serious chilling injury problems. Nahar *et al.*, (2012) [40] recorded that chilling injury in plants reduces the plant growth, seed coloration, wheat bands and specks, leaf whitening and reduction in numbers of tillers and she also concluded that cold stress enhances early maturity, stunted growth, bushy plants and yellowing of leaves. Yadav S. (2010) [61] stated that low temperature stress affects plant reproductive stages, causing delayed flowering and sterile pollen, which has a significant impact on crop yield. Atayee *et al.*, (2020) [6] reported that chilling injury and death of many horticulture plants can be caused by cold stress, which causes a variety of physiological disruptions in chilling-sensitive plants. Proline, a well-known osmoprotectant, accumulates in response to cold stress. It also has an effect on nearly every aspect of plant cellular activity. Membrane disintegration is one of the most significant effects of cold stress-induced dehydration (Saito K. and Matsuda F. Y, 2010) [49].

Ahmad *et al.*, (2009) [2] stated that heat stress during anthesis and grain filling period, accelerated early maturity, reducing grain sizes and increases the yield losses and it also resulted in early senescence and shortening of photosynthetic activities periods. High temperature resulted in low seeds yield and low physical traits of seeds of wheat crop (Grass and Burris, 1995) [17]. According to Monika *et al*., (2016) [37], she reported that the losses in grain weight is a result of injury caused by high temperature during grain developmental stages. Calderini *et al*., (1999) [9] and Wardlaw (2002) [60] discovered that high temperatures during pre- and post-anthesis in the field trigger grain weight loss. Kamal *et al*., (2017) [21] observed that heat stress inhibits the biosynthesis of phenolics, proline, and other secondary metabolites, resulting in increased thermo-sensitivity. Kousar *et al*., (2018) [45] reported that heat stress reduces plant yield due to the negative impact of heat on grain growth, such as assimilate translocation, length, and rate of grain filling.

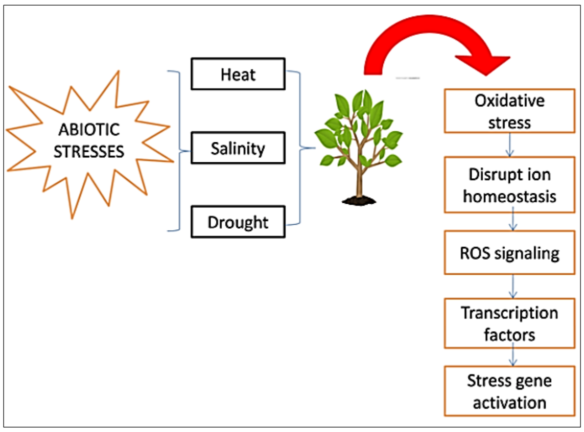

Fig 1:

Agronomical practices towards abiotic stress

The abiotic stress can be reduced with better understanding and knowledge of crop responses towards drought, salinity and cold and heat stresses through agronomical practices in a sustainable ways. The above stresses can be maintained through management practices like mulching, plant geometry, seed resistant variety, sowing time and providing adequate irrigation and without exploiting our environment.

Deep ploughing is beneficial to pulses crops as it leads to better root proliferation and higher and high productivity in shallow area. According to Lipiec *et al*., (2002) [28] adding organic manures and soil organic matter increases the water storage ability in the soils which is helpful in availability of water for crops. Water lost through evaporations can be reduced by practising mulchings with plastic or biodegradable films. Waraich *et al*., (2012) [59] concluded that applications of micronutrients under heat stress can increase the potential to preserve water potential in tissues by increasing heat stress tolerance. Clough *et al*., (1987) [11] stated that using of anti-transpirants reduces the transpirational losses and lower the water use and improved tolerance towards drough stress.

Conclusions

Abiotic stress is a biggest challenges for future generation due to rapid changes in climatic. Drought and heat stress cause a variety of changes in plant growth and morphology, which are often represented by a variety of alterations in plant growth and morphology. Because of changing climatic conditions and extensive use of natural resources, there is a need to minimize yield losses due to various abiotic stresses such as problematic soils, temperature stress, moisture stress, depleting water quality, waterlogging, nutrient deficiency/toxicity, crop lodging, and so on. Adopting appropriate agronomic management practices will help to reduce abiotic stresses to a large extent such as changing sowing times, selecting resistant genotypes, and choosing the best planting method for the area's edaphic and climatic conditions.

References

1. Ahmad MM. Soil salinity as a selection pressure is a key determinant for the evolution of salt tolerance in blue panicgrass (Panicumantidotale Retz.). Flora 2010;205:37-45.
2. Ahmad P, Jaleel CA, Salem MA, Nabi G, Sharma S. Roles of enzymatic and nonenzymatic antioxidants in plants during abiotic stress. Crit Rev Biotechnol 2009;30:161–175.
3. Ahmad S, Khan N, Iqbal MZ, Hussain A, Hassan M. Salt tolerance of cotton (*Gossypium hirsutum* L.). Asian J Plant Sci 2002;1:715–719.
4. Akash Hidangmayum 1 AS. Abiotic stress responses in cereals and pulses crop and their agronomic practices to enhance tolerance. Eur Asian Journal of Bio Sciences 2018.
5. Al-Taey DK. The activity of antioxidants enzymes and NPK contents as affected by water qaulity, kinetin, bio and organic fertilization in lettuce (*Lactuca sativa* L.). Iraqi J Agric. Sci 2018.
6. Atayee AR, Noori MS. Alleviation of cold stress in vegetable crops. J Sci Agric 2020;4:38–44.
7. Boyer J. Plant productivity and the environment. Science 1982;218(4571):443-448.
8. Boyer JS. Recovery of photosynthesis in sunflower after a period of low water potential. Plant Physiology 1971;47:816–820.
9. Calderini DL. Final grain weight in wheat as affected by short period of high temperatures during pre and post-anthesis under field conditions. Aust. J Plant Physiol 1999.
10. Çarpıcı E, Çelik B, Bayram NG, Asik B. The Effects of Salt Stress on Growth, Biochemical Parameter and Minaral Element Content of Maize (Zea mays L.) Cultivars. African Journal of Biotechnology 2010;9(41):6937-6942.
11. Clough GH, LS. Continuous use of polyethylene mulched beds with overhead or drip irrigation for successive vegetable production. In Proceedings of the 20th National Agriculture Plastics Congress, Portland, OR, USA 1987.
12. Cramer G. Abiotic stress and plant responses from the whole vine to the genes. Aust. J Grape Wine Res 2010.
13. Cramer GR. Uptake and role of ions in salt tolerance, in P. K. Jaiwal, R. P. Singh and A. Gulati, (eds.), Strategies for Improving Salt Tolerance in Higher Plants, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi 1997, 55-86.
14. Ditommaso A. Germination behavior of common ragweed (*Ambrosia artemisiifolia*) populations across a range of salinities. Weed Sci 2004;52:1002.
15. Farooq M, GN. Drought stress in grain legumes during reproduction and grain filling. J Agron. Crop Sci 2016.
16. Ghodke PH, PA. Physiological and Biochemical Responses in Onion Crop to Drought Stress. International Journal of Current Microbiology and Applied Sciences ISSN: 2319-7706 2018;(7).
17. Grassl L. and Burris JS. Effect of heat stress during seed development and maturation on wheat (Triticum durum) seed quality. Seed germination and seedling vigor. Canadien Journal of Plant Science 1995.

18. Hao X, Li P, Feng Y, Han X, Gao J, Lin E *et al*. Effects of fully open-air [CO2] photosynthesis and ultrastructure of Isatis indigotica. Fort. PLoS ONE 2013.
19. Harris D, TR. On-farm seed priming to improve crop establishment and yield in dry direct-seeded rice, in. Research Strategies and Opportunities, International Research Institute, Manila, Philippines 2002.
20. Ishitani M, Majumder AL, Bornhouser A, Michalowski CB, Jensen RG, Bohnert HJ. Coordinate transcriptional induction of myo-inositol during environmental stress. The Plant Journal. 1996;9:537–548.
21. Kamal MA, SM. Ascorbic acid triggered biochemical transformation at different phenological stages of heat stressed Bt cotton. J argon crop Sci 2017.
22. Khan MB, HN. Effect of water stress on growth and yield components of maize variety. 202. J Res. (Science) 2001.
23. Khan MAm Weber DJ. Ecophysiology of High Salinity Tolerant Plants (Tasks for Vegetation Science), 1st ed.
24. Khodarahmpour ZM. Effects of NaCI salinity on maize (*Zea mays* L.) at germination and early seedling stage. Afr. J Biotechnol 2012;11:298-304.
25. Krishnamurthy LK. Sources of tolerance to terminal drought in the chickpea (*Cicer arietinum* L.) minicore germplasm. Field Crops Res 2010;119:322-330.
26. KY SY. Cold stress tolerance mechanisms in plants. A review. Agronomy for Sustainable Development Agron. Sustain 2010.
27. Lipiec J, DC. Effect of drought and heat stresses on plant growth and yield: a review. International Agrophysics 2013;27:463-477.
28. Lipiec J, Ferrero A, Giovanetti V, Nosalewicz A, Turski M. Response of structure to simulated trampling of woodland soil. Adv Geoecol 2002;35:133–140.
29. Long NV. Effects of salinity stress on growth and yield of quinoa (*Chenopodium quinoa* willd.) At flower initiation stages. Vietnam J Agri. Sci 2016.
30. Ludlow MM. Critical evaluation of traits for improving crop yields in water-limited environments. Advances in Agronomy 1990.
31. M. R. Panuccio, S. E. Jacobsen, S. S. Akhtar, A. Muscolo. Effect of saline water on seed germination and early seedling growth of the halophyte quinoa. AoB PLANTS, 2014, 6.
32. Mafakheri AA, Siosemardeh, B Bahramnejad, PC Struik, E Sohrabi. Effect of drought stress on yield, proline and chlorophyll contents in three chickpea cultivars. Australian Journal of crop science 2010;4(8):580-585.
33. Mafakheri AS. Effect of drought stress on yield, proline and chlorophyllcontents in three chickpea cultivars. Journal of crop science 2012.
34. Mamta Kajlaa VK. Increase in wheat production through management of abiotic stresses: A review. Journal of Applied and Natural Science 2015;7(2):1070-1080.
35. Manikavelu A, NN. Drought tolerance in rice: morphological and molecular genetic consideration. Plant Growth and Regulation 2006;50:121-138.
36. Manivannan P, JC. Changes in antioxidant metabolism of *Vigna unguiculata* L. Walp. by propiconazole under water deficit stress. Colloids Surf B: Biointerf 2007.
37. Monikaa Joshi, FS. Effect of heat stress on crop phenology, yield and seed quality attributes of wheat (*Triticumaestivum* L.). Journal of Agrometeorology 2016;18(2):206-215.
38. Muhammad Aslam Khalil Ahmad, MA. Salinity Stress in Crop Plants: Effects of stress, Tolerance Mechanisms and Breeding Strategies for Improvement. Journal of agriculture and basic sciences 2017.
39. Mwale SS, HC. Germination, emergence and growth of sunflower (*Helianthus annuus* L.) in response to osmotic seed priming. Seed Sci Technol 2003;31:199-206.
40. Nahar K, Hasanuzzaman M, Fujit M. Extreme temperature responses, oxidative stress and antioxidant defense in plants. In: Abiotic Stress – Plant Responses and Applications in Agriculture. Vahdat K, Leslie C, editors In Tech 2012, 169–205.
41. Nahar KJ. Screening of indica rice (*Oryza sativa* L.) genotypes against low temperature stress. Bot. Res. Int 2009.
42. Nanjo T, Fujita M, Seki M, Kato T, Tabata S, Shinozaki K. Toxicity of free proline revealed in an arabidopsis T-DNA-tagged mutant deficient in proline dehydrogenase. Plant Cell Physiol 2003;44:541-548.
43. Naz I, Bano A, Tamoor-ul-Hassan. Isolation of phytohormones producing plant growth promoting rhizobacteria from weeds growing in Khewra salt range, Pakistan and their implication in providing salt tolerance to Glycine max L. Afr. J. Biotechnol 2009;8(21):5762–5766.
44. Panuccio MR, JS. Effect of saline water on seed germination and early seedling growth of the halophyte quinoa. J Plant Sci 2014.
45. Rehana Kousar1, Qud R. Salicylic acid mediated heat stress tolerance in selected bread wheat genotypes of pakistan. Pak. J Bot 2018, 50(6).
46. Rengasamy P. World salinization with emphasis on Australia. Journal of Experimental Botany 2006;57(5):1017–1023.
47. Ruelland EM. Cold signaling and cold acclimation in plants. Advances in Botanical Research. Amsterdam: Elsvier Science 2009.
48. Sabagh EL, Hbgahiabkaawhs A. Effects of drought stress on the quality of major oilseed crops: implications and possible mitigation strategies. Applied ecology and environmental research 2019.
49. Saito K, Matsuda F. Metabolomics for functional genomics, systems biology, and biotechnology. Annu Rev Plant Biol 2010;61:463–489.
50. Serraj R, Chauhan Y, Bidinger F, Seetharama N, Nigam S, Saxena N. Management of drought in icrisat cereal and legume mandate crops. In Water Productivity in Agriculture: Limits and Opportunities for Improvement. CAB International: Wallingford, UK 2003.
51. Serraj R, Chauhan Y, Bidinger F, Seetharama N, Nigam S, Saxena N. (n.d.). Management of drought in icrisat cereal and legume mandate crops. In Water Productivity in Agriculture: Limits and Opportunities for Improvement 2003.
52. Serraj RB. Management of drought in ICRISAT cereal and legume mandate crops. CAB International, Wallingford 2003, 127-144.
53. Serraj R, Hash CT, Rizvi SMH, Sharma A, Yadav RS and Bidinger FR. Recent advances in marker-assisted selection for drought tolerance in pearl millet. Plant Prod. Sci 2005;8(3):332-335.
54. Shah fahad AA. Crop Production under Drought and Heat Stress: Plant Responses and Management Options. Front. Plant Sci 2017.
55. Shakeria E YE. Evaluation of grain sorghum (*Sorghum*

bicolor L.) lines/cultivars under salinity stress using tolerance indices. International Journal of Plant Production 2017, 11(1).
56. Silva EC. Drought Stress and Plant Nutrition. Plant Stress 2011. Springer Science and Business Media: Amsterdam, The Netherland, 2008.
57. Tavousi M, Freidoon Kaveh, Amin Alizadeh, Hossein Babazadeh and Ali Tehranifar. Effects of Drought and Salinity on Yield and Water Use Efficiency in Pomegranate Tree. J. Mater. Environ. Sci. 2015;6(7): 1975-1980.
58. Toscano SF. Physiological and Biochemical Responses in Two Ornamental Shrubs to Drought Stress. Front Plant Sci 2016;7:645-645.
59. Waraich EA, R Ahmad, A Halim and T Aziz. Alleviation of temperature stress by nutrient management in crop plants: a review. Journal of Soil Science and Plant Nutrition 2012;12(2):221-244.
60. Wardlaw I. Interaction between drought and chronic high temperature during kernel filling in wheat in a controlled environment. Ann. Bot 2002;90(4):469-476.
61. Yadav SK. Cold stress tolerance mechanisms in plants. A review. Agron. Sustain. Dev 2010;30:515-527.
62. Yoshida S. Physiological analysis of rice yield. Fundamentals of rice crop science. International Rice Research Institute 1981.