Plant Archives Volume 20 No. 2, 2020 pp. 9383-9386 **e-ISSN:2581-6063 (online), ISSN:0972-5210**

STUDYING THE ROLE OF PROLINE IN REDUCING WATER STRESS AND INCREASING THE YIELD OF FIELD CROPS

Ahmed Hasan Fadhil* and Haider Talib Hussein

Al-Mussaib Technical College, Al-Furat Al-Awsat Technical University.

Abstract

It is concluded from this study that water is the main determinant of agricultural development and because Iraq is located in a region suffering from a scarcity of water resources, all efforts are directed to rationalizing the use of irrigation water by adopting modern methods of agriculture and irrigation that raise the efficiency of water use from a high return, In other words, the yield from the agricultural water unit was multiplied by the use of amino acid proline in several concentrations that contribute to reducing the water stress caused by the lack of irrigation water by using it to spray the vegetative group of plants. Including water scarcity, which is one of the non-biological environmental stresses that affect the growth and production of plants and lead to many physiological and chemical changes from the low rate of cellular division and thus leads to poor plant growth, As it leads to a loss of the water content of plant cells, causing an increase in the concentration of ions in the protein and to toxic levels, which leads to protein decomposition, cellular membranes damage, closure of stomata and imbalance of CO_2, affecting the photosynthesis process. Modern techniques have been used in the present time to study the effect of water stress, where proline is one of the amino acids that have an important role in protecting plants under the influence of water stress by maintaining the osmotic balance within plant cells.

Introduction

Proline acid is a free amino acid and consists of Glutamic acid and works as an enzymatic preservative that does not affect enzymatic activities and helps protect enzymes from decomposition preserves cellular compounds and plant membranes and accumulates in the roots (AL-Taey, *et al.,* 2010), stems and leaves, is abundant in the leaves of the plant and that its accumulation in the plant is a way to collect nitrogen from One of the nitrogenous compounds it produces from Protein decomposition, such as inhibition of protein building during plant stress and osmotic stress conditions, toxic compounds such as ammonium ions, which damage the plant, accumulate by special mechanics to dissolved compounds, such as amino acids and most importantly proline. The accumulation of amino acid (proline) in plants is the primary criterion for plant capacity To withstand drought. Proline accumulation is not only a response to stress but can also be a measure of tolerance with dehydration (Burhan and AL-Taey, 2018).

In the coming years, Iraq faces a water shortage due to global climate changes, mismanagement of water resources and dam construction on the Tigris and Euphrates rivers outside the Iraqi borders and this water scarcity will reach the maximum degree, the agricultural sector consumes 65% of the available water (Al-Kharabsheh and Ghanim, 2008 ; AL-Taey and Saadoon, 2014) This water scarcity requires rapid movement, plans and effective solutions, Including the adoption of scientific methods to deal with it, because water is the main determinant of agricultural development and because Iraq is located in a region suffering from scarce water resources. All efforts are focused on working to rationalize the use of irrigation water by adopting modern methods of agriculture and irrigation that raise water efficiency in order to obtain high returns or in other words double the yield from the agricultural water unit. The study aims to address the problem of water stress in the province by using proline with a workshop in several concentrations and the effect of this on increasing the yield of many agricultural crops.

***Author for correspondence :** E-mail : com.ahmd44 @atu.edu.iq

The effect of water stress on plant growth

Water stress is the lack of available water in the soil, which results in a decrease in the amount of water needed by the plant enough to cause damage in it affecting its

normal growth (Al-Fatlawi, 2013) and it is also the state that the plant goes through when the amount of water absorbed does not meet the plant's need to sustain all physiological and biological processes that need water naturally and appropriately and water stress may be caused by excess or less water and to distinguish between them is called stress resulting from dehydration or lack of water, water deficit stress, While water stress resulting from excess water beyond the appropriate level is the excessive water stress and because most plants suffer from lack of water more than they suffer from an increase in the appropriate limit, the term water stress in the majority has become the stress that arises in plants due to lack of water (Yasin, 2001).

Exposure of plants to water stress conditions leads to a decrease in the average of cell division and expansion and thus causes weak plant growth and its physiological and biological processes are affected by water stress, where it leads to the loss of the water content of the cells of the plant causing an increase in the concentration of ions in the protoplasm to toxic levels, which leads to protein degradation, damage to cell membranes and closure Stomata and disturbance in the diffusion of carbon dioxide, thereby negatively affecting the photosynthesis process. It reduces the rate of net photosynthesis and also causes the accumulation of sugars and amino acids, especially proline, which plays an important role in increasing the ability of plants to adapt to withstand drought as it works to regulate the osmosis of plant cells and that increasing its content increases its stability and the stability of cell membranes (Ashraf and Foolad, 2007).

The observation of high levels of amino acids, particularly proline, in plants growing under water stress conditions is due to the hydrolysis of protein and the conversion of clutamic acid to free proline. Tan *et al.,* (2008) indicated that the intensity of water stress increases the proline content in the leaves, but this increase depends on the stage of growth during which the water stress occurs. It also leads to a decrease in the absorption of nutrients from the soil solution by the roots of plants and their transmission and distribution to different parts of the plant (Farooq *et al.,* 2009).

Li *et al.,* (2019) concluded in their experiment to study the effect of water stress and its effects on the quality of the fruit of strawberry (Fragaria × ananassa), where the results showed the effect of reducing irrigation on the size of the fruit, but it had a greater effect on the physiology of the fruit.As the dry matter content increased as a percentage of fresh weight by a quarter of the weight of the fruit for water stressed plants compared to the comparison treatment, it was accompanied by an increased concentration of antioxidant monosaccharides and total phenols.

Proline amino acid

Proline is the chemical name of Pyrrole-2-carboxylic acid and its formula is ($C_5H_9O_2N$) and it is one of the important amino acids in plants, where it enters into the protein synthesis and was discovered in 1900 by the scientist Wilstetter and it was first isolated in 1901 by the scientist Fischer, It is also considered a non-polar amino acid where it differs from its analogues of other amino acids from among 20 amino acids, where it is characterized by its unique structural formula in which the (NH2) group is not free (linked) and thus it differs from the rest of the other amino acids *i.e.* its function Secondary, not primary (Bouchareb, 2008).

Proline has the ability to store amine groups by moving from one place to another inside the plant and giving the amine groups to the cells that need to build protein to produce energy and it is also a source for it, as the oxidation of one molecule of proline produces 30 ATP and NADPH2 (Sun) *et al.,* 2011). Nanjo *et al.,* (1999) confirmed that the accumulation of this acid in high-end plants is due to the increase in its construction from clutamic acid and the decrease in its catabolism, where the acid Pyrroline-5-Carboxylate (P5C)) is reduced to proline, This pathway is dominated by two enzymes, namely Pyrroline-5-Carboxylate Synthase (P5CS) in the proline-acid building steps and the enzyme Pyrroline-5-

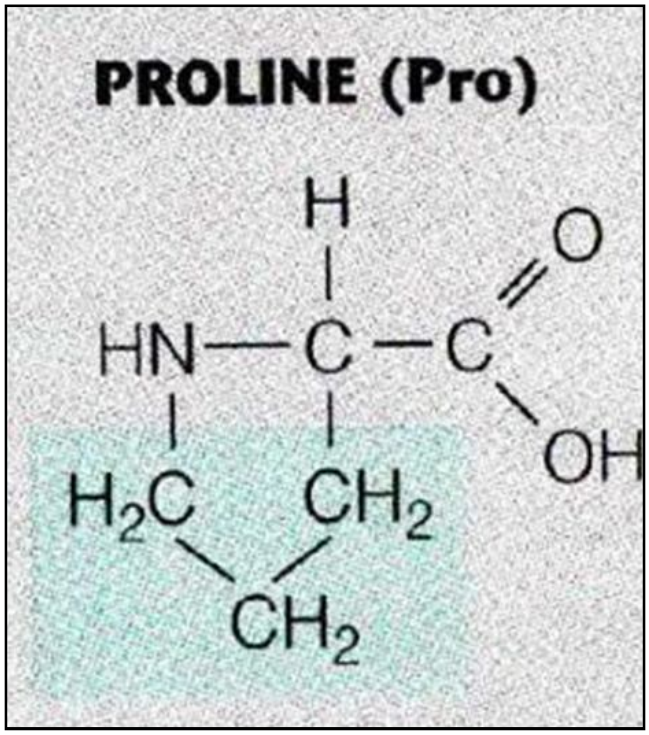

Fig. 1: The chemical composition of proline ($C_5H_9NO_2$).

Carboxylate Reductase (P5CR) that appears in the final building steps. As for the catabolism of proline and its oxidation to clutamic acid, it is controlled by Proline Dehydrogenase (ProDH) in the first catabolism steps and Pyrroline-5-Carboxylate Dehydrogenase (P5CDH) in the last catabolism steps.

Proline has a role as an osmotic regulator in order to protect plants from damage, maintain protein construction, neutralize the toxicity of active oxygen species (ROS), maintain the activity of enzymes and the integrity of the membranes, in addition to maintaining the balance of osmotic stress in the cytosol in addition to its role in stimulating genes related to environmental stress tolerance (Kaouther *et al.,* 2013).

The proline importance for the plant (Bouchareb, 2008)

1- The importance of proline in regulating the Osmotic pressure of the plant tissue.

2- The importance of proline in energy conservation and storage of amine groups.

3- The importance of proline in maintaining the colloidal properties of the cell protoplasm.

4- The importance of proline in maintaining the enzymes present in the mitochondria.

5- The importance of proline in the process of capturing free radicals.

Literature Review

Dear reader, the use of proline on plants with specific concentrations gives a good return, in order to bear the plant to dehydration, which results in the scarcity of irrigation water and to increase it. Many researchers have conducted their experiments to treat the lack of irrigation, including:

The researcher, Majeed and Al-Bahadli (2016), when using proline to reduce the moisture tension of the sunflower crop when spraying it on the vegetative part of the plant, reached concentrations of 50 and 100 mg/L, that the concentration of 100 mg/L of proline gave the highest rate of growth and qualitative traits. Al-Saadi (2013) showed when using proline with concentrations of 75 and 150 mg/L on the cucumber yield by adding proline on the vegetative part of the plant was significant in the effect of all the traits of vegetative and flowering growth and the result, especially when used at a concentration of 150 mg/L.

Abbas and Alik (2016) observed that the addition of proline acid concentrations 0, 30, 60 and 90 mg/L on the sunflower yield as the concentration 60 mg/L of proline acid was significantly excelled on other concentrations under study.

AL-Taey and AL-Musawi (2019) reached to significant values in proline contents of Rockets leaves with increased salinity levels of irrigation water, Al-Qazzaz *et al.,* (2016), when studying the chamomile plant by adding three concentrations of proline acid (50, 100 and 150 mg/L), found that spraying with proline acid had a positive effect in removing the negative effect of water stress, the concentration 150 mg/L was significantly in all studied traits. Mustaf (2017), when using Proline acid, reached concentrations (80 and 160 mg/L) as a spray on the strawberry plant grown in greenhouses. This depends on the type of crop, the number of irrigation periods and the plant's exposure to periods of water stress. Aakool (2011) found that dry periods have a significant effect on the accumulation of free proline in the tissues of wheat plants prone to drought and this depends on the type of cultivated cultivars.

Al-Bassam (2014), showed that there is a discrepancy between the concentrations used of the amino acid proline (50 and 100 ppm) and the results obtained showed that the concentration 50 mg/L was excelled on the other concentrations in all the studied properties on the Solanumm elongena. Dawud and Glim (2018) showed that the use of proline acid with two concentrations (100 and 200 mg/L) on the yellow corn crop if its use as a feed or grain crop, the results showed that foliar spray with proline at a concentration of 200 mg/L led to a significant increase in all Studied traits.

Conclusions and recommendations

The spraying of proline gives the highest average of traits that a farmer needs if it is feed or grain crop and in water scarcity or spaced irrigation periods and uses spraying on the vegetative part of the plant and from these concentrations

1- Spray Proline, at a concentration of 60 mg/L

2- Spray proline at a concentration of 100 mg/L.

3- Spray Proline, at a concentration of 160 mg/L

This is according to the farmer's vision to use any of these specific concentrations and each concentration depends on the distance or scarcity of irrigation periods.

References

Aakool, Salman Shabib (2011). The effect of dehydration and lack of water on the accumulation of free proline in the tissues of wheat plant. *Kufa Journal of Agricultural Sciences,* **3(1):** Pages: 252 - 258.

Abbas, Hawra Ali and Alik Makiya Kazem (2016). The role of proline acid in improving sunflower and its components under water stress conditions. *Iraqi Journal of*

Agricultural Sciences, **47(2):** Pages: 438 - 451.

Al-Ghanimi, Abd al-Aun Hashim Alwan, Abd al-Jasim Muhaisen Jasim al-Jabour and Restrictions of the Snake Yusef Al-Asadi (2015). Reducing the effect of water stress by using proline in terms of the growth of some yellow corn cultivars. *Journal of the University of Karbala scientific,* **13(2):** Pages: 229 - 245.

Al-Kharabsheh, Atef Ali Hamed and Othman Mohammad Ghoneim (2008). Water harvesting in arid and semi-arid regions in the Arab world. Safa House for Publishing and Distribution. Oman. Jordan.

Al-Qazzaz, Amal Ghanem Mahmoud, Abbas Jassem Hussein Al-Saadi, Hassan Abdel-Zahra Ali Al-Saadi, Suhad Saad Yahya and Rasha Habib Fadel Abdul (2016). The effect of foliar spray with proline acid on growth indicators of *Matricaria Chamomilla* L. plant exposed to water stress. *Journal of the Biotechnology Research Center,* **10(1):** Page: 78-83.

Al-Saadi, Maysoon Musa Kazim (2013). Effect of cultivation and proline distances on growth and yield of *Cucumis sativus* L. planted in southern Iraq (Basra Governorate). *Maysan Journal of Academic Studies,* **12:** Number 22.

Al-Taey D.K.A. and Z.J.M. Al-Musawi (2019). Effect of Nano-fertilizers, salicylic acid and organic matter in growth and yield of rocket (*Eruca sativa* Mill) under Salt stress. *International Journal of Botany Studies,* **4(3):** 77-81.

AL-Taey, D.K.A. and A.H. Saadoon (2014). Effect of treatment of Salicylic acid and water Salinity on the Growth and Nitrate Accumulation with nitrate reductase activity in the Leaves of Spinach, *Spenacia oleracea* L. *Journal of Babylon University, Pure and Applied Sciences*, **3(22):** 1188-1203.

Al-Taey, D.K.A., S.S.M. AlAzawi and M.H. Husien (2010). Effect of Spraying Acetyl Salicylic Acid on the Plant Tolerance for Salt Stress & Survival Percentage after Transplanting of Orange (*Citrus sinensis*). *Babylon Journal University -Pure and Applied science*, **18(4):** 1513-1520.

Al-Fatlawi, Sanaa Khadim Abdul-Amir (2013). The effect of spraying with Epsaque acid on the tolerance of wheatgrass (*Triticum aestivum* L.) growing under different levels of water stress. Master Thesis - College of Education for Pure Sciences - Department of Life Sciences - University of Karbala.

Ashraf, M. and M.R. Foolad (2007). Roles of glycine betaine and proline in improving plant abiotic stress resistance. *Environ. Exp. Bot.,* **59:** 206–216.

Bouchareb, Radia (2008). The extent of the balance of nucleic and amino acids in durum wheat (Triticum durum Desf) grown under saline conditions. Master's thesis, University of Mentouri, Constantinople, Algeria.

Burhan A.K. and D.K.A. AL-Taey (2018). Effect of Potassium humate, humic acid and compost of rice wastes in the growth and yield of two cultivars of Dill under salt stress conditions. *Advances In Natural And Applied Sciences,* **12(11):** 1-6.

Dawud, Wissam Malik and Amer Glim (2018). The response of vegetative growth traits and the yield of *Zea mays* L. to corn spraying with protein and arginine. *Diyala Journal of Agricultural Sciences,* **10(2):** Pages: 129 - 136.

Farooq, M., A. Wahid, N. Kobayashi, D. Fujita and S.M.A. Basra (2009). Plant drought stress: effects, mechanisms and management. *Agron. Sustain. Dev.,* **29:** 185–212.

Kaouther, Z., H. Nina, A. Rezwan and H. Cherif (2013). Evaluation of salt tolerance (NaCl) in Tunisian chili pepper (*Capsicum frutescens* L.) on growth, mineral analysis and solutes synthesis. *Journal of stress physiology and biochemistry,* **9(1):**.

Li, H., J. Yin, M. Zhang, N. Sigrimis, Y. Gao and W. Zheng (2019). Automatic diagnosis of strawberry water stress status based on machine vision. *International Journal of Agricultural and Biological Engineering,* **12(1):** 159-164.þ

Majeed, Hashem Rashid and Shaker Ismail Al-Bahadli (2016). The effect of proline acid in reducing the Water Stress strength and prolonging the irrigation periods of the *Helianthus annuus* L. sunflower crop. *Al-Qadisiyah Journal of Agricultural Sciences,* **6(1):** Pages: 90 - 102.

Mustafa, Khaled Ibrahim (2017). Study the effect of irrigation with magnetically treated water and spraying with the amino acid proline on the growth and yield of strawberry in unheated greenhouses. *Diyala Journal of Agricultural Sciences,* **9(1):** Pages: 150 - 161.

Nanjo, T., M. Kobayashi, Y. Yoshiba, Y. Kakubari, K. Yamaguchi-Shinozaki and K. Shinozaki (1999). Antisense suppression of proline degradation improves tolerance to freezing and salinity in Arabidopsis thaliana. *FEBS letters,* **461(3):** 205-210.

Sun, C., X. Li, Y. Hu, P. Zhao, T. Xu, J. Sun and X. Gao (2015). Proline, sugars and antioxidant enzymes respond to drought stress in the leaves of strawberry plants. *Korean Journal of Horticultural Science & Technology,* **33(5):** 625-632.þ

Tan, J., H. Zhao, J. Hong, Y. Han, H. Li and W. Zhao (2008). Effects of exogenous nitric oxide on photosynthesis, antioxidant capacity and proline accumulation in wheat seedlings subjected to osmotic stress. *World J. Agric. Sci.,* **4(3):** 307-313.

Yassin, Bassam Taha (2001). Fundamentals of Plant Physiology. College of Science, Qatar University, Dar Al Sharq Press.