European Journal of Agricultural and Rural Education (EJARE)
Available Online at: https://www.scholarzest.com
Vol. 3 No. 3, March 2022
ISSN: 2660-5643

EFFECT OF FOLIAR APPLICATION WITH PROLINE ON GROWTH, YIELD, AND QUALITY OF FABA BEAN (*VICIA FABA* L.) (A REVIEW)

Saifuldeen Ahmed Hasan[1] , Raeed Mejbel Abdullah[2] and Mohammed Bustan Hanoon[3]
[1]Shatrah Technical Institute, Southern Technical University, Iraq.
[2]College of Health and Medical Techniques, Northern Technical University, Kirkuk, Iraq.
[3]Shatrah Technical Institute, Southern Technical University, Iraq.
saifahmed081@gmail.com

Article history:
Received: January 1st 2022
Accepted: February 1st 2022
Published: March 14th 2022

Abstract:
Proline is an amino acid, an important role in the osmotic regulation of the cytoplasm of cells, as a complementary solute, its effective role in maintaining the swelling of cells, on enzymatic activity in the cytoplasm, by keeping enzymes from degrading, the addition of proline to the plant increases the period and number of cell divisions and expands them.
The external addition of proline acid, its action was equivalent to genetic modification of a plant, using genetic engineering technology. Spraying Proline on plants improves the absorption of nutrients, and increase its accumulation in the root and vegetative total, leads to an increase in the photosynthesis process and the efficiency of the transfer of materials in the plant body, leads to an increase in yield and its components, proline accumulates during abiotic stresses, it also accumulates in various plant tissues under natural conditions that are not exposed to stress.

Keywords: Foliar Application, Proline, Faba Bean (*Vicia Faba* L.).

INTRODUCTION

Faba bean (*Vicia faba* L.) is an important seed legume crop, bean seeds contain a high percentage of protein (28-38%), carbohydrates (40-46%), fiber, minerals and vitamins such as vitamin B1, B2 and vitamin C, thus, it is considered a basic food for millions of people in poor countries (Khalil *et al*., 2015). The cultivated area in Iraq was approximately 125 thousand hectares, with a productivity of 4000 kg ha^{-1} (Arab Organization for Agricultural Development - Khartoum, 2016).

The productivity of the beans is sometimes determined by many problems, one of the most important is the problem of the phenomenon of flowers falling and aborting eggs, as this phenomenon occurs as a result of exposure to some environmental stresses or nutritional factors (Fange *et al*., 2010). Amino acids, including proline, it has an important role in reducing the use of chemical fertilizers (Raeed and Saifuldeen, 2020). It also helps to improve the quality of the crop (Al-Mohammadi, 2018). Proline also contributes to the growth of the pollen tube, as providing it from an external source increases the production of the vaccine, helps reduce the time required for fertilization, which contributes to the improvement of the fruit setting and the increase in production (Mohamed and Khalil, 1992), or, the precipitation may occur as a result of competition from the vegetative and reproductive parts, or between the reproductive parts themselves on the products of photosynthesis, which in turn directly or indirectly affect the hormonal balance, associated with the occurrence of detachment and flowering drop (Patrick and Stoddard, 2009), or the fall occurs as a result of the lack of readiness of some essential nutrients for the plant, which has an essential role in the stages of growth and reproduction, its deficiency affects the flowering activity of the plant, such as boron, phosphorous and potassium. They have important roles in the processes of fertilization and fertilization as well as the knotting of the horns (Van Doorn and Stead, 1997). As providing the amino acid (IAA, Indole acetic acid) at balanced rates, to reduce flower drop and increase fertilization and knots naturally (Saifuldeen and Raeed, 2020). The contract process requires a hormonal stimulant obtained from the pollen, which is a rich source of auxin or the amino acid tryptophan, which turns into IAA (Hussain, 2011).

The basis for raising the expansion and productivity of the bean, by planting high yielding varieties, follow effective field methods, in order to obtain the potential of these types, knowing the extent of their adaptation to local conditions (Al-Jubouri *et al*., 2001). Based on the aforementioned reasons explaining the flowering drop, as a result of the separation of reproductive organs or the activity of physiological processes or environmental and hormonal factors, this study was carried out, which aimed to study the effect of proline on the yield and quality of the bean, and to determine the most appropriate concentration.

PROLINE AND ITS IMPORTANCE:

Proline is one of the most important essential amino acids, involved in the synthesis of proteins, in addition, it is one of the non-polar amino acids, containing aliphatic group, but there is a difference between it and the aliphatic group of other acids, this does not prevent the convergence of its biochemical qualities with others, the characteristics of other amino acids. Proline is the only one of the 20 amino acids, since the group NH_2 in it is not free, therefore, it contains a secondary, not a primary, function, which is why it is called the Imine Acid (Nemmar, 1983).

PROLINE FORMATION STAGES:

Proline is formed from glutamic acid by Acide Semialdihyade glutamique, which becomes helical to give Acide pyrotine caboxylique (P5C), becomes helical to give proline, also, the y-carboxyle deglutamate group, it reacts with the amine molecule ATP to form Acylphosphate, get Pyroline carboxylique, the latter, in turn, is reduced with the loss of a water molecule H2O to form pyroline carboxylique, the latter is also reduced again to the NADPH molecule, in order to obtain proline, according to what is similar to it (Nemmar, 1983), as shown in the following form:

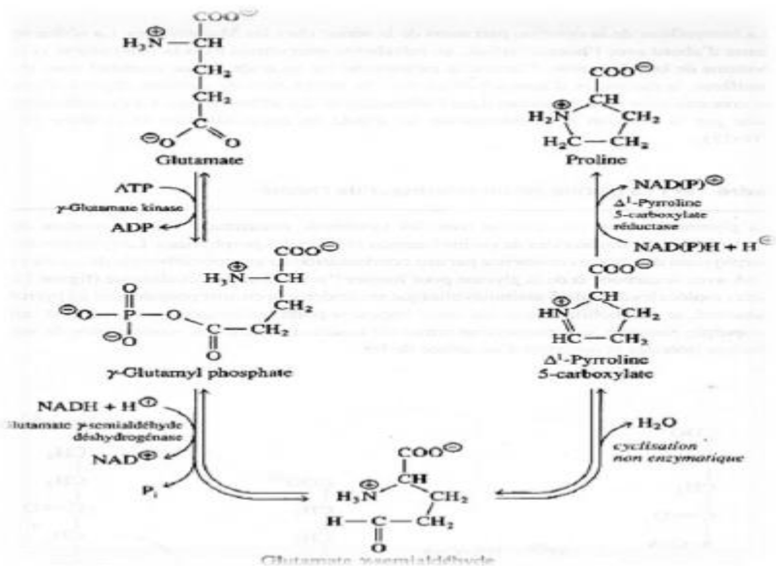

Figure (1) The stages of proline formation (Henchi *et al.*, 1982).

STAGES OF PROLINE CATABOLISM.

In the process of demolishing proline is the first step, it begins by administering the compound P5C i.e. 5-Carboxylique acid Proline to the inner mitochondrial membrane, directed by the enzyme Proline Oxydase, this compound is converted to glutamate, by Dehydrogenase P5C. Many scientists have also proven that the process of demolition of proline in bacteria and insects, it is initiated by conversion to P5C by the enzyme Prolineoxydase inside the mitochondria in the presence of O2 and flavoproteine (Kiyosine *et al.*, 1996). The isolate of the gene Proline Oxydase, helps break down Dehydrogenese Proline and build up Proline. However, it is difficult to isolate this enzyme in a pure state. The reason for this is that its activity is related to the inner membrane of the mitochondria, it is noted that this enzyme gives electrons that directly enter the respiratory chain. The process of oxidation of proline during its collection under dry conditions in plants, they are reactivated after re-watering (Royapati and Stewart, 1991).

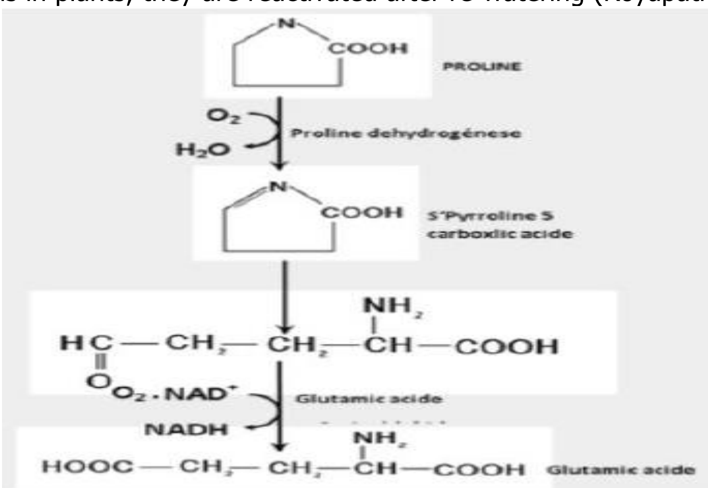

Figure (2) Conversion of Proline to Glutmiqye. (Lake *et al.*, 1995).

PROLINE ACCUMULATION.

When a reaction occurs to the plant's acclimatization or sensitivity to a stress (lack of water, low temperature or salinity), leads to longer accumulation of proline in the plant, this can be inferred and recognized early through the plant cycle (Saifuldeen and Raeed, 2021). The presence of proline in a number of plants, it is considered evidence that the proline assembly is independent of the growth phase in plants, at the same time, it is associated with aquatic feeding. Proline has an important role in maintaining the high internal osmotic pressure at the cellular level (Bates *et al.*, 1973).

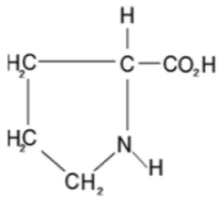

Figure (3) The general form of proline.

PROLINE ACCUMULATION FACTORS.

The synthesis of proline in plants depends on the presence of water, salt or thermal stress (Raupeliene, 2015).

1. High temperature:

When temperatures rise, the amount of proline in plant cells, increases in response to this effect, has a weak water content (Singh *et al.*, 1974). Proline content decreases under the influence of high temperature, although the flower bud is developed for the tomato plant, under normal conditions, the proline content of leaves is lower than that of the rest of the flowering organs, while its content in leaves increases with increasing temperature (Palfi *et al.*, 1974).

2. Cold:

Proline accumulates in large quantities inside the leaves, in the contact area between the root and the stem, while it collects less in the roots of alfalfa exposed to low temperatures (1.5 degrees Celsius) (Paquin, 1986). The decrease in temperature not only affects the synthesis of proline, rather, it has an effect on its transfer to the legs and vessels, where proline is synthesized in the leaves and then distributed to other parts of the plant to reach the stem and root areas (Paquin, 1982).

3. Water content:

The lack of water at the plant level, especially in the leaves, is expressed in a net increase, to collect some nitrogenous substances, sugars and organic acids (Gupta, 2011). Proline accumulates in the roots of plants in large quantities, especially in the early stages of dehydration and in both leaf blade and sheath (Bates *et al.*, 1973), where the proline aggregation correlates with water content changes in plants, this induces its synthesis in plants with drought tolerance (Henchi *et al.*, 2007).

4. Light effect:

Photosynthesis assists in the biosynthesis pathway of proline either by the progression of ATP or NADPH, by stimulating carbohydrates, which is a precursor to the accumulation of proline in the stroma of chloroplast, to be added to those found in the cytoplasm that are often active in the dark (Joyce et al., 1992). Daniel *et al.* (2014) and Shayeb (1998) showed that both CO2 and light intensity in the ventilation medium lead to an increase in the proportion of proline in tissues. Stewart *et al.* (1977) also confirmed that proline accumulates in green tissues when exposed to light stress.

THE ROLE OF PROLINE IN PLANTS UNDER THE INFLUENCE OF DROUGHT:

Among the most important vital functions of proline under the influence of water stress conditions in the plant are:

1. Osmotic regulation: The accumulation of proline in the cytoplasm of cells increases the osmotic effort of the cell, this increases the cell's ability to draw water from neighboring cells and keep the cell swollen (Lake *et al.*, 1995).

2. Antioxidant: It is one of the most important antioxidants, because it protects the plasma membranes and enzymes from oxidation, it also works to get rid of free radicals from cellular tissues (Joyce *et al.*, 1992). It also acts as inert internal oxygen, role is to capture oxygen radicals, it was noted by Tsuji *et al.* (2003) when studying the wheat crop, were exposed to water stress decreased the activity of the enzyme (SOD) Superoxide Dismutase, increased accumulation of oxidative free radicals, they showed the extent of the role of proline in removing the negative effect of these roots, because it is a good catcher for them.

3. Nitrogen metabolism: Nitrogen is stored instead of being lost to the atmosphere when protein is broken down and ammonia is formed, helps to transfer nitrogen during stress from one organ to another, removes the toxic effects of ammonia accumulation in cells, for being an antidote to ammonia poisoning (Fange *et al.*, 2010).

4. Contributes to various physiological processes:

One of these operations is the regulation of opening and closing stomata, the process of continuity in the elongation of cells and the growth of flowers and embryos, energy is a substance with a reducing force or a carbon structure in other reactions during irrigation, it also contributes to the image storage material, as it stores carbon and ooze materials, which are essential and required for growth under stress conditions (Joyce *et al.*, 1992).

5. Protection:
It activates, protects and stabilizes mitochondrial enzymes under stress conditions, represents a network of metabolic signals, to monitor functions in mitochondria, it acts as a molecular coating that has the ability to protect the integrity of the protein, increases the activity of various enzymes, especially the enzymes that act as antioxidants (CAT, GST and APX) (Gupta, 2011).

ENZYMATIC INTERPRETATION OF PROLINE ASSEMBLY:

Proline has an important role in osmotic regulation for plants, subjected to a number of unfavorable factors, such as drought and increased salinity in the soil (Delauney and Verma, 1993). There are new studies presented in the formation of proline and the genes that destroy it (Catabolism gens), as there were important results for the different functions of proline, as an energy source, carbon, nitrogen and osmotic regulator to counteract drought, there are also two types of enzymes that help build and break down proline, and these enzymes are (Pyroline 5 Carboxylase reductase), this in turn acts as an enzyme for protein biosynthesis, while Proline dehydrogenase is an enzyme that breaks down proline.

THE EFFECT OF PROLINE:

1. Effect of proline on vegetative growth characteristics:

In an experiment conducted on the bean crop, Amin *et al.*, (2011) found four concentrations of proline: 0, 25, 50 and 100 mg L^{-1}, there is a significant increase in most of the vegetative growth traits. The concentration of 50 mg L^{-1} gave the highest plant height, number of branches, and plant dry weight of 126.10 cm, 5.60 branches of plant-1 and 68.40 g of plant^{-1}, respectively, compare with the no-spray treatment, which was given the lowest averages for the traits, it reached 112.60 cm, 4.10 plant branch^{-1} and 60.30 g plant^{-1}, respectively.

In a study conducted in Egypt on the effect of proline on the yield of beans, Qasim *et al.*, (2012) indicated when using four concentrations of 0, 25, 50 and 75 mg L^{-1}, there was a significant increase when spraying with a concentration of 50 mg L^{-1} in the characteristics of the number of branches in the plant and the length of the pod, its average was 12.10 plant branch^{-1} and 23.10 cm, by comparison, which gave 5.30 plant branch^{-1} and 15.70 cm for the traits, respectively, while the concentration of 25 mg L^{-1} gave the highest plant height which was 168.11 cm compared to that which gave 131.20 cm.

Dawood *et al.*, (2014) confirmed in their experiment conducted in Egypt on the bean crop on the effect of spraying with proline and using three concentrations of 0, 25 and 50 micromol on an increase in plant height, dry and fresh weight of the plant at the concentration of 25 micromole with a significant difference from concentrations 0 and 50 micromol.

Sadak *et al.*, (2015) observed in their experiment that was conducted in Egypt on the bean crop on the effect of spraying with proline using four concentrations of 0, 50, 100 and 150 micromoles, and there were significant differences in most growth traits when increasing the spraying concentrations, as the concentration gave 150 mg L^{-1} The highest averages of plant height, number of branches and fresh weight of the plant, which reached 77 cm, 11.31 plant branch^{-1} and 490 g plant^{-1}, respectively, compared to no spraying (comparison treatment), which gave the lowest averages, which reached 69 cm, 8.13 plant branch^{-1} and 232 g Plant^{-1} for the recipes, respectively.

The results of Al-Saadi *et al.* (2016) at the University of Baghdad on pea crop using three concentrations of spraying with proline are 0, 25 and 50 mg L^{-1} showed the superiority of spraying with proline, as the highest concentration of 50 mg L^{-1} gave an increase in plant height of 15% and the dry weight of the plant 55 % compared to control.

Al-Hassani (2017) observed in his study conducted on the bean crop on the effect of spraying with Proline using three concentrations of Proline (0, 40 and 80) mg L^{-1}. It was clear from the results that increasing the concentration of Proline to 80 mg L^{-1} in the spray solution led to an increase in the concentrations of elements in the leaves of the plant and the growth characteristics are the height of the plant, the number of branches, the leaf area and its guide, and the dry and soft weight.

2. Effect of proline on yield and its components:

Many previous studies and research showed that spraying with Proline, increases the efficiency of the photosynthesis process, thus a positive increase in crop productivity (Ashraf and Foolad, 2007). As the results reached by (El Sayed and Ahmed, 2011) showed in their experiment on the bean crop on the effect of spraying with Proline, using four concentrations: 0, 25, 50 and 75 mg L^{-1}, the increase in the concentration of proline led to a significant increase in yield and its components. The concentration of 75 mg L^{-1} gave the highest mean for the number of pods, the number of seeds, the weight of 100 seeds, and the yield of individual and total plants, their averages were 25.3 pods^{-1}, 4.80 pods^{-1}, 122.80 g, 113.12 g pods^{-1}, and 3.50 tons ha^{-1}, respectively, compared to the comparison treatment that gave the lowest mean of 12.10 pods^{-1} and 2.10 pods^{-1}, 98.31 g, 68.10 g plant^{-1} and 2.80 tons ha^{-1} for the traits, respectively.

Amin *et al.*, (2011) noted the results of their experiment on the effect of proline on the bean yield, there was a significant increase in some yield components when spraying at a concentration of 50 mg L^{-1}, as the number of pods, individual plant yield, total seed yield and harvest index were 36.70 pods^{-1}, 82.01 g plant^{-1}, 4.03 tons ha^{-1} and 41.90%. respectively, compare with no spraying, which gave the lowest mean of 23.10 g plant^{-1}, 53.40 g plant^{-1}, 2.40 g plant^{-1}, and 33.70%, respectively.

Qasim *et al.* (2012) obtained a significant increase in the number of pods, the number of seeds, the weight of 100 seeds, the individual and total seed yield when spraying with a concentration of 50 mg L^{-1}, with an increase of 89%, 85%, 37%, 24% and 164, in their experiment on the bean crop. % of the adjectives in the sequence compared to the comparison treatment.

Ahmed (2014) confirmed that the effect of spraying with proline on chickpea yield caused a significant difference with the concentration of 20 mg L^{-1} in the characteristic of the number of pods and the number of seeds compared to the comparison treatment that exceeded the weight of the 100 seeds.

Al-Qazzaz (2014) indicated in his experiment on the pea crop using three concentrations of proline, which are 0, 25 and 50 mg L^{-1}, with a significant difference when spraying at a concentration of 50 mg L^{-1} in the yield components and gave the highest average number of pods reached $plant^{-1}$ and the number of seeds The weight of the seeds was 23.42 pods plant-1, 4.05 g pods $plant^{-1}$ and 8.38 g pods $plant^{-1}$, respectively, compared to the comparison that gave the lowest mean of 5.00 pods $plant^{-1}$, 14.20 g $plant^{-1}$ and 3.19 g $pods^{-1}$ for the traits, respectively.

In an experiment conducted on marrow, Al-Qaisi *et al.*, (2015) found that spraying with a concentration of 20 mg L^{-1} of proline, led to a significant increase in the number of pods, number of seeds, seed weight, seed yield, vital yield and harvest index, as it reached 15.50 g pod^{-1}, 9.67 g pod^{-1}, 1.58 g pod^{-1}, 6.57 g $plant^{-1}$, 25.23 g $plant^{-1}$ and 25.98%, compared to the comparison treatment that gave the lowest averages of 9.00 g $plant^{-1}$, 4.83 g pod^{-1}, 0.80 g pod^{-1}, 3.55 g $plant^{-1}$, 15.91 g $plant^{-1}$, and 22.19% for the traits, respectively.

Al-Saadi *et al.*, (2016) indicated in their experiment on pea crop the superiority of spraying with proline at a concentration of 25 mg L^{-1} in the biological yield, as it gave the highest average of 10.48 g $plant^{-1}$ compared to concentrations zero and 50 mg^{-1}, which gave the lowest averages reached 7.32 and 9.98 g $plant^{-1}$, respectively.

In a study conducted by Al-Hassani (2017) on the bean crop on the effect of spraying with Proline using three concentrations of Proline (0, 40 and 80) mg L^{-1}, it was clear from the results that increasing the concentration of Proline to 80 mg L^{-1} in the spray solution It led to an increase in the percentage of fertilization and the two components of yield (the number of pods per plant and the weight of 100 seeds) in both seasons, and the increase in the total seed yield was 19.4 and 16.4%.

3. Effect of proline on qualitative trait:

In an experiment on the bean crop, Qasim *et al.* (2012) found that increasing the concentrations of spraying with proline leads to an increase in the percentage of protein in the seeds, as the highest concentration of 75 mg L^{-1} gave the highest average protein percentage of 35.6% compared to no spraying, which gave the lowest average of 25.8% .

Dawood *et al.*, (2014) indicated in their experiment on the bean crop on the effect of spraying with proline, using three concentrations of 0, 25 and 50 micromol, that the concentration of 25 micromole was significantly superior to the percentage of nitrogen, phosphorous and potassium in the plant. The highest average was 2.24%, 0.34% and 2.20% compared to the concentrations 0 and 50 micromoles, which gave the lowest averages were (2.15 and 2.06%), (0.29 and 0.25%) and (2.06 and 1.96%) for the traits, respectively. As for the concentration of proline in the plant, the control treatment, which did not differ significantly from the concentration of 25 mg L^{-1}, gave an average of 0.74 and 0.72 mg g^{-1}, and it was significantly different from the concentration 50 mg L^{-1}, which gave the lowest mean of 0.68 mg g^{-1}.

Al-Qaisi *et al.*, (2015) found in an experiment conducted on the marrow crop on the effect of spraying with proline that spraying with a concentration of 20 mg L^{-1} led to a significant increase in the percentage of nitrogen in the leaves and the percentage of protein, as it gave an average of 4.03% and 22.74%, respectively, compared to the comparison, which gave the lowest mean of 2.48% and 10.33% for the traits respectively.

Al-Saadi et al. (2016) observed in their study on pea crop using three concentrations of proline spray (0, 25 and 50 mg L^{-1}) that there was a significant increase in the percentage of nitrogen and phosphorous in the plant when spraying at a concentration of 50 mg L^{-1}, which did not differ significantly from The concentration is 25 mg L^{-1}, which gave averages of (3.62 and 3.41%) and (0.51 and 0.44%) compared to no spraying, which gave the lowest average of (3.17%) and (0.38%) for the traits, respectively.

Al-Moussawi (2017) observed through the use of two concentrations of proline on bean (0 and 2 mg L^{-1}) a significant increase when spraying with a concentration of 2 mg L^{-1} in the seed content of proline and the percentage of protein was 22.19 µg kg^{-1} and 33.34%, respectively, compared to no spraying, which gave an average of 14.69 µg kg^{-1} and 29.31%, respectively, while the comparison was superior in the boron content of seeds with a significant difference on the concentration 2 mg L^{-1} and no significant differences were found in the auxin content of seeds between spraying And not spraying with proline.

In a study conducted by Al-Hassani (2017) on the bean crop on the effect of spraying with Proline using three concentrations of proline (0, 40 and 80) mg L^{-1}, it was clear from the results that increasing the concentration of proline to 80 mg L^{-1} in the spray solution, led to an increase in the percentage of protein in seeds by 10.5 and 4.6% for the two seasons, respectively, compared to the control treatment.

CONCLUSIONS RECOMMENDATIONS

Conclusions: The superiority of spraying with Proline at a concentration of (50) mg L^{-1} by giving the highest averages in most of the studied traits and in most scientific references.

Recommendations: Expand the use of proline and at other spraying times, and that this also be applied to other economic crops, because of its significant effect on most of the studied traits.

REFERENCES:

1. **Ahmed, S.A. (2014).** Effect of *Nerium Oleaudir* L. oleander leaf extract and proline yield on growth and yield of Chict (*Cicer aeitium* L.). Ibn Al-Haytham Journal of Pure and Applied Sciences, 27(3): 131-140.
2. **Al-Hassani, A.R.K. (2017).** Effect of foliar feeding with proline and a mixture of nutrients on the growth and yield of cultivars of bean (*Vicia Faba* L.) PhD thesis. College of Agriculture, Al-Muthanna University.
3. **Al-Jubouri, A.A.A., S.A. Abdo and K.I. Muhammad. (2001).** Responsiveness of structures from *Vicia faba* L. to planting dates under the conditions of the central region in Iraq, Iraqi Journal of Agricultural Sciences, 32(2): 113-120.
4. Al-Musawi, S.T.A. (2017). Response of some bean cultivars to spraying with auxin IAA, boron and proline and reducing flower drop. Master's Thesis - Department of Field Crops, College of Agriculture, Al-Muthanna University.
5. **Al-Qaisi, W.A., A.J. Al-Saadi and A.L. Aziz. (2015).** The effect of the interaction between drought stress and proline on the growth and yield of mung bean plant. The University of Science City Journal, 7(2): 45-57.
6. **Al-Qazzaz, A.G.M. (2014).** Effect of gibberellin and proline on some growth and yield indicators of pea plant (*Pisum sativum* L.). Karbala University Journal. 12(2): 277-283.
7. **Al-Saadi, A.H.J., A.G.M. Al-Qazzaz, S.M. Yassin, S.S. Yahya and R.H.F. Abed (2016).** Effect of different concentrations of gibberellin and proline acids on the growth and productivity of pea (*Pisum sativum* L.) plant. Baghdad Journal of Science. 13(2): 261-267.
8. **Amin, H., F. Abouziena, M.T. Abdelhamid, M. El-Rashad and A.F. Gharib (2011).** Improving Growth and Productivity of Faba Bean Plants by Foliar Application of Thiourea and Aspartic Acid. International Journal of Plant & Soil Science 3(6): 724-736, 2014; Article no. IJPSS.2014.6.015.
9. **Ashraf, M. and M.R. Foolad (2007)** Roles of glycine betaine and proline in improving plant abiotic stress resistance, Environmental and Experimental Botany, vol. 59, pp. 207-216.
10. **Bates, L.S. ; R. Waldren and I.D. Teare (1973)** Rapid Determination of free proline for Water –stress studies . Plant and Soil .39 : 205-207.
11. **Dawood, M.G., H.A. Taie, R.M. Nassar, A.M.T. Abdelhamid and U. Schmidhalter (2014).** The changes induced in the physiological, biochemical and anatomical characteristic of (*Vicia Faba* L.) by the exogenous application of proline under seawater stress. South African Journal of Botany., 93. 54-63.
12. **Delauney, A. and D.P. Verma (1993)**. Proline biosynthesis and Osmoregulation. Plant J., 4 (2): 215-223.
13. **El Sayed, H. and E. Ahmed (2011).** Influence of NaCl and proline treatments on growth development of Broad Bean (*Vicia faba* L.) Plant. J. of Life Sci. 5 :(2011) 513-523.
14. **Fange, X., C.T. Neil, Y. Guijun, L. Fengmin and K.H.M. Siddique (2010).** Flower number , pod production , pollen viability and pistil function are reduced and flower and pod abortion increased in Chickpea (*Cicer arietinum* L.) under terminal drought . Journal of Experimental Botany 61 (2) : 335 – 345.
15. **Gupta, S.D. (2011).** Reactive Oxygen Species and Antioxidant in Higher Plants .CRC Press, Enfield , New Hampshire , USA:362P.
16. **Henchi, B., J. Boukhris, V. Da Silva (1982).** Effect de la secheresse sur le Comportement Metabolique de Plantago Albicans. L. Acta Uecol Plant., 3: 659-660.
17. **Hussein, M.A. (2011).** Effect of spraying with some nutrients on growth, flowering life, early and total yield of green bean. *Vicia faba* L. Master Thesis . Department of horticulture and garden engineering. College of Agriculture, University of Baghdad.
18. **Joyce, P.A., D. Aspinall and L.G. Plaeg (1992).** Photosynthesis and the Accumulation of Proline in Response of Water Defict. Aust. J. Plant physiol. 19: 249-261.
19. **Khalil, N.A., A. Al-Mutawali, M. Al-Metwally, M. Shafiq and W.A. Al-Murshidi. (2015).** Cereal and legume crops. faculty of Agriculture . Cairo University . p. 186.
20. **Kiyosue, T., Y. Yoshiba, K.Y. Shinozaki and K. Shinozaki (1996).** Anuclear Gene Encoding Mitochondrial Proline Deshydrogenase , an Enzyme Involved in Proline Metabolism, is Upregulated by Proline Nut Down Regulated by Deshydratation in Arabidopsis.The plant Cell, 8: 1323-1335.
21. **Lake, W.B.,Y. Seneane and F. Alemayebu (1995).** Evalution of Ethio Plan Barley Iand Races for Disease and Agronomic characters .Rachis 14 (1/2):21-25.
22. **Mohamed, S.M., and M.M. Khalil (1992).** Effect of tryptophan and arginine on growth and flowering of some winter annuals. Egypt J. Applied Sci., 7(10):82 -93.
23. **Muhammadi, M.H.M. (2018).** Effect of spraying date with Nutrigreen amino acid concentrations on growth characteristics, yield, its components and quality characteristics of Triticosecal X Wittmack cultivars of wheat, Master's thesis, College of Agriculture, Tikrit University.
24. **Nemmar, M. (1983).** Contribution a letude de la Resistance a la Secheresse Chez les Varietes Dubledur (*Triticum durum Desf.*) et de ble tendre (*Triticum aestivum* L.) : Evolution des Teneurs en proline au cours du cycle de developpment .,E.N.S.A.Montpellier.
25. **Palfi, G., E. Kaves and R. Nehez (1974).** Main types of Amino Acid Regulation in Cultivars With Deficient Water Supply and their Partucalapplication in Agriculture. Noventermeles, 23: 219-228.
26. **Paquin, R. (1986).** Effet de I' humidite du sol sur la teneur en proline liber et des sucre de la Luzerne endurcie au froid et a la secheresse .Can. J. Plant., 66: 95-101.

27. **Paquin, R. and L. Vezina (1982).** Effet des basses temperatures sur la distribution dans les Plantes de Luzerne .Media Presse .Physiol vege; 20(1): 101-109.
28. **Patrick, J.W. and F.L. Stoddard, (2009).** Phsiology of flowering and grian filling in Faba Bean . Field Crops Research Abst., 115(3): 234-242.
29. **Qasim, A., A. Farooq, A. Muhammad, N. Saari, and R. Perveen (2012).** Ameliorating effects of exogenously applied proline on seed composition, seed oil quality and oil antioxidant activity of faba bean (*Vicia faba* L.) under drought Stress. Int. J. Mol. Sci. 14: 818-835.
30. **Raeed, M.A. and S.A. Hasan (2020).** Estimation of components of genetic variance using Jinks-Hayman method analysis on the crop of faba bean (*Vicia faba* L.) . Int. J. Agricult. Stat. Sci. 16(1); 1897-1903 .
31. **Raupeliene, A. (20150.** Effect of Foliar Application of Amino Acids on the Hotosynthetic Indicators and Yield of Wheat . Proceedings of the 7th International Scientific Conference Rural Developpment ,Aleksaanadras Stulginskis University, Lithuania.
32. **Royapati, P.J. and C.R. Stwart (1991).** Solubilizationof aproline dehydrogenase from maize (*Zea mays* L) Mitochondria. Plant Physiol., 95: 787-791.
33. **Sadak, M.S., M.T. Abd El-hamid, and U. Schemedhalter (2015).** Effect of foliar application of amino acids on plant yield and some physiological parameters in Faba bean plants irrigated with seawater. Acta biol. Colomb. 20(1): 141-152.
34. **Saifuldeen A.H. and R.M. Abdullah (2020).** Estimating the performance and gene action of a number of individual genotypes and hybrids on the crop of faba bean (*Vicia faba* L.) . Plant Archives , 20(2) ; pp. 8981-8988 .
35. **Saifuldeen A.H. and R.M. Abdullah (2021).** Characterization of Genetic Variability Through The use of Rapds Markers, of A Group of Native and Commercial Genotypes of Bean Species . . Int. J. Agricult. Stat. Sci. 17(1) ; pp. 1817-1703 .
36. **Shayeb, G. (1998).** Proline content in different members of durum wheat, an attempt to explain the conditions of accumulation under water deficiency (*Triticum Durum* Desf). Master's thesis. Institute, Natural and Life Sciences, Constantine University, p. 84.
37. **Singh, T.N., D. Aspinall and L.G. Paleg (1973).** Stress metabolism I-Nitrogen metabolism and grough in the barley plant during the water stress . Aust. J. Biol. Sci., 26: 65-76.
38. **Stewart, C.R., S.F. Boggers, D. Aspinall and L.G. Paleg (1977).** Inhibition of proline oxidation in by water stress. Plant. Physiol. 59: 930-932.
39. **The Arab Organization for Agricultural Development - Khartoum. (2016).** The annual book of the Arab agricultural statistsics . Volume (36): pg. 50.
40. **Tsuji, W., M.E. Ali, S. Inanaga, and Y. Sugimoto (2003).** Growth and Gas Exchange of Three Sorghum Cultivars under Drought Stress. Biologica. Plantarum. 46(4): 583-587.
41. **Van Doorn , W.G. and A.D. Stead (1997).** Abscission of flowers and floral parts. Journal of Experimental Botany 48 (309): 821-837.