Damietta University
Faculty of Science
Botany Department

Alleviation of Water Stress in The Common Bean Plants (*Phaseolus vulgaris* L.) by Using Microorganisms

A Thesis Submitted for the Dgree of Doctor of Philosophy in Science/ Botany and Microbiology/ Microbiology

Mai Abdullah Ahmed Abdel-Latif

B. Sc. Botany and Chemistry, Mansoura University (2004)
M. Sc. of Science /Botany/ Microbiology, Mansoura University (2016)

Supervisors

Prof. Dr. Gamal M. Abdel-Fattah

Prof. of Microbiology
Botany Department,
Faculty of Science - Mansoura University

Prof. Dr. Zakaria A.M. Baka

Prof. of Microbiology
Botany and Microbiology Department,
Faculty of Science - Damietta University

Prof. Dr. Mahmoud M.B. Shokr

Prof of Self-Pollinated Vegetable crops
Hoticultural Research Institute Agricultural Research Center

Prof. Dr. Taha M. S. El-Katony

Prof. of Plant Physiology
Botany and Microbiology Department,
Faculty of Science - Damietta University

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V. Summary

Common bean are one of the most field crop in Egypt, due to its high nutritive value, it is a traditional food in the human diet, as it is low in fat and rich in proteins, vitamins, complex carbohydrates, and minerals. In addition to contributing nutritional requirements, consumption of dry beans has been linked to reduced risk of heart disease and cancer. Beans are a rich source of protein and carbohydrates, as well as being a good source of vitamin B complex such as niacin, riboflavin, folic acid and thiamine. It also provides iron, copper, zinc, phosphorus, potassium, magnesium and calcium, furthermore, has high fiber content. It is also an excellent source of polyunsaturated fatty acids**.** Egypt has only one main source of water supply, the River Nile, which supplies over 95% of the water needs of the country**.** We should pay more attention to make use of each drop, and reduces loss to the minimum as we can, not only does Egypt share the Nile water with many countries but it also lies at the end of the Nile's route toward the sea, this means that it receives the Nile after it has emptied much of its water along the way**.** Major challenge facing Egypt now is the strong need for better development and management of the available limited resources of water, land and energy to meet the needs of a population growth**.**

The results of the present study showed that VAM fungi play an important role in the improving the yield production and growth of common bean with combination of other microorganisms particularly EM (effective microorganisms) under different of water stress, where mycorrhizal and EM treatments showed a significant increase as compared to others microorganisms and their combinations plants throught the following data:

1. The results demonstrated that the mycorrhizal and EM common bean plants under WS_1 level were significantly higher than other ones.

2. The content of photosynthetic pigments (Chlorophyll a, Chlorophyll b, Carotenoids, Chlorophyll a / b and total pigments) was increased with plant growth, the contents of photosynthetic pigments in inoculated plants with mycorrhizal fungi and EM microorganisms were significantly greater than those of other plants at all stages of plant growth, particularly under WS_1 level of water stress.

3. The effect of water stress and different microorganisms as well as their interaction on enzymes content (POX, PPO and PPL) and proline of common bean during vegetative and fruiting stages under study The highest mean values were obtained with the treatment of AMF+EM under WS_1 for enzymes (POX, PPO and PPL). Comparing with the water stress of WS_2 only recorded the highest values of proline during both stages (vegetative and fruiting).

4. Increasing in nutrient contents (N, P, K, Ca, and Mg) in common bean plants were inoculated with mycorrhizal fungi and effective microorganisms (EM) at WS_1 level of water stress were significantly higher than other plants at all stages of plant growth.

5. Fresh yield components of common bean plants in expression of fresh and dry weight of pods (g plant $^{-1}$), No. of pods per plant, No. of flower per plant and fruit setting (%) as affected by different water stress levels, microorganisms and their interaction. the highest values of fresh yield and its components was connected

with the plants treated with AMF+EM comparing with other treatments particularly at WS_1 level of water stress. In addition to dry yield the effect of water stress and different microorganisms as well as their interaction on Dry yield and yield components of common bean seeds in expression of No of seed/plant, No. of pods/plant, pod length, weight of 100 seed g, weight of pods g, weight of seed/plant, yield ton/fed, relative green yield, WUE ton/m^3 and harvest index, show clearly that the mycorrhizal and EM common bean plants under WS_1 level were significantly higher than other ones.

6. Nutritional elements of common bean seeds, Nitrogen, Phosphorus, Potassium, Calcium and Magnesium were significantly higher obtained from the treatment of AMF+EM under WS_1 and all these values were better than that obtained for the control treatment under all water stress.

7. The present data showed that co inoculation of common bean seeds with the mixture of microorganisms under all water stress levels significantly increased the average values of crude protein, total carbohydrates, crude fiber, total soluble sugar, folic acid and vitamin B_1 in seeds of common bean than those obtained for the control plants under the same water stress, realized the highest value for crude protein, total carbohydrates, crude fiber, total soluble sugar, folic acid and vitamin B_1 in seeds of common bean were connected with the treatment of AMF+EM under water stress (WS_1).

8. TEM micrographs of leaf cells were taken from treated *Phaseolus vulgaris* L. with mycorrhizal fungi and effective microorganisms

under water stress (13 days) showing chloroplasts (C) with numerous big starch grains (S). No plastoglobuli (P) are observed inside the chloroplasts. These cells were also observed to be enclosed by a normal cell wall (W), vacuoles (V) and intercellular spaces (IS). In addition, an integrated nucleus (N) enclosed by a double membrane and containing numerous euchromatins (EU) and clumps of heterochromatins (arrows). Note a chloroplast (C) with big starch grains (S). No plastoglobuli (P) are observed inside the chloroplasts. Note an integrated cell wall (W), vacuole (V) and few lipid globules (L) inside the cytoplasm.

Finally, the results reported here concluded that, the combination of effective microorganisms (EM) with vesicular arbuscular mycorrhizal fungi under the second water level (WS_1) was the best treatment as compared to the other treatments which lead to reduction of water irrigation used as compared with recommended one. So we recommended applying these biofertilizers for reducing the water quantity of irrigation and saving the waste one because of their effectiveness, safety for the human health and environment and inexpensiveness.