

## **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**

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# List of Contents

Contents	pages
<b>I. Introduction</b>	<b>1</b>
1. Common bean	<b>1</b>
1.1. Nutritional value of dry common beans	<b>2</b>
1.2. Water requirements and its importance	<b>3</b>
1.3. The effect of water stress in agricultural and production of crops	<b>6</b>
2. Biofertilizers	<b>10</b>
2.1. Advantages of Biofertilizers	<b>11</b>
3. Arbuscular Mycorrhizal (AM) Fungi	<b>11</b>
3.1. Occurrence	<b>12</b>
3.2. Taxonomy	<b>13</b>
3.3. Morphology	<b>13</b>
3.3.1. Extra- and intraradical hyphae	<b>14</b>
3.3.2. Arbuscules	<b>15</b>
3.3.3. Vesicles	<b>16</b>
3.4. Colonization	<b>17</b>
3.5. Benefits of the AM fungi	<b>18</b>
4. Effective microorganisms (EM)	<b>19</b>
4.1. Benefits of EM to agriculture	<b>20</b>
4.2. Effective microorganisms (EM)	<b>23</b>
5. Endophytic microorganisms	<b>26</b>
5.1. Endophytic bacteria	<b>27</b>
5.2. The diversity of the endorhiza	<b>28</b>

5.3. Benefits of endophytic bacteria to agriculture	29
<b>Aim and plan of the Work</b>	<b>31</b>
<b>II. Materials and methods</b>	<b>32</b>
1. Mycorrhizal Fungi	32
1.1. Production of VAM inoculums	32
1.1.1. Extraction from soil and estimation of VAM spores	32
1.1.2. Multiplication of VAM inoculums	33
1.2. Staining of VAM infected root	33
1.2.2: Estimation of VAM Infection	34
2. Endophytic bacteria	34
2.1. Isolation and purification of endophytic bacteria	35
2.2. Identification of the selected endophytic bacteria isolate	35
2.2.1. Morphological and biochemical identification	35
2.2.1.1. Media used for bacterial isolate identification	35
2.2.1.1.1. Biochemical characteristics	37
2.2.2. Molecular identification	39
2.2.2.1. Bacterial genomic DNA extraction:	39
2.2.2.2. Measurement of DNA concentration and purity	40
2.2.2.3. Amplification and sequencing of the 16S rRNA gene	41
2.2.2.4. PCR products electrophoresis and visualization	41
2.2.2.5. Purification of the PCR product	42
2.2.2.6. Sequencing and sequence analysis	42
3. Effective microorganisms (EM)	42

4. Filed experiment	<b>43</b>
4.1. Common bean planting	<b>43</b>
4.2. Fertilization	<b>43</b>
4.3. Soil	<b>43</b>
4.4 The experimental design and treatments	<b>46</b>
4.5. cultural practices	<b>48</b>
4.6. Data recorded	<b>50</b>
4.6.1. Parameters of growth and fresh pod yield parameter	<b>50</b>
5. Estimation of photosynthetic pigments	<b>52</b>
6. Estimation of total nitrogen	<b>53</b>
6.1. Preparation of Nessler's reagent	<b>54</b>
7. Estimation of total phosphorus	<b>54</b>
7.1. Extraction of plant material	<b>54</b>
7.2. Reagents	<b>55</b>
7.3. Measurements	<b>55</b>
8. Estimation of Potassium (K), magnesium (Mg), calcium (Ca)	<b>55</b>
9. Estimation of Crude Protein	<b>56</b>
9.1. Method of extraction	<b>56</b>
10. Estimation of total Carbohydrates by using anthrone method	<b>56</b>
10.1. Preparation of anthrone reagent	<b>56</b>
10.2. Method of Estimation of Total carbohydrates	<b>57</b>
10.3. Estimation of Total Soluble Sugars (T.S.S)	<b>57</b>
11. Estimation of vitamin B1 (Thiamine)	<b>57</b>
11.1. Preparation of Thiamine reagents	<b>58</b>

11.2. Extraction of Thiamine	<b>58</b>
11.3. Oxidization	<b>58</b>
12. Estimation of Folic acid	<b>58</b>
13. Estimation of proline	<b>59</b>
14. Estimation Crude Fiber Contents.	<b>59</b>
15. Estimation of antioxidant and defence enzymes activity	<b>60</b>
15.1. Phenylalanine ammonia lyase (PAL)	<b>60</b>
15.1.1. Extraction	<b>60</b>
15.1.2. Assay	<b>60</b>
15.2. Polyphenoloxidase (PPO)	<b>60</b>
15.2.1. Extraction	<b>61</b>
15.2.2. Assay	<b>61</b>
15.3. Peroxidase (POD)	<b>61</b>
15.3.1. Extraction	<b>61</b>
15.3.2. Assay	<b>62</b>
16. Ultrastructural Studies	<b>62</b>
16.1. Reagents	<b>62</b>
16.1.1. Preparation of lead citrate stain	<b>62</b>
16.1.2: Preparation of 1% toluidine blue in 1 % borax	<b>63</b>
16.2: Preparations for transmission electron microscopy (TEM)	<b>63</b>
17. Statistical analysis	<b>64</b>
<b>III. RESULTS</b>	<b>65</b>
1. Identification of the endophytic bacteria	<b>65</b>
1.1. Morphological and biochemical identification	<b>65</b>

1.2. Molecular identification	<b>65</b>
2. Vegetative growth parameters of Common bean plants as affected by water stress and microorganisms as well as their interactions	<b>68</b>
3. Water status (EL, RWC, WSD and WC)	<b>77</b>
4. Photosynthetic pigments	<b>79</b>
5. Enzymes activity and proline content	<b>82</b>
6. Concentration of nutrients for common bean plants shoots and roots as affected by different water stress levels and microorganisms as well as their interactions	<b>85</b>
6.1. Concentration of Nitrogen	<b>85</b>
6.2. Concentration of Phosphorus	<b>86</b>
6.3. Concentration of Potassium	<b>91</b>
6.4. Concentration of Calcium	<b>94</b>
6.5. Concentration of Magnesium%:	<b>97</b>
7. Yield parameters	<b>100</b>
7.1. Fresh yield	<b>100</b>
7.2. Dry yield	<b>106</b>
8. Quality of common bean dry	<b>110</b>
8.1 Concentration of Nutrients in seeds of common bean plants	<b>110</b>
8.2. Crude protein, total carbohydrates, crude fiber, total soluble sugar, folic acid and Vitamin B1 in seeds of common bean plants	<b>112</b>
9. Ultrastructural studies	<b>121</b>
10. Mycorrhizal root colonization	<b>127</b>
<b>IV. DISCUSSION</b>	<b>129</b>
1. Mycorrhizal root infection	<b>132</b>

2. Effect of drought and biofertilizer inoculation on some growth characteristics of common bean plants	<b>135</b>
3. Effect of drought and biofertilizers inoculation on Photosynthetic pigments of common bean plants	<b>136</b>
4. Water status	<b>138</b>
5. Antioxidant enzyme activities	<b>141</b>
6. Effect of water stress and biofertilizer inoculations on proline content of common bean plants	<b>144</b>
7. Effect of water stress and biofertilizer inoculations on nutrients content (Nitrogen, Phosphorus, Potassium, Magnesium, and Calcium) of shoot and root system of common bean plants	<b>145</b>
8. Yield and its components	<b>147</b>
8.1. Fresh yield parameters	<b>147</b>
8.2. Dry yield parameters	<b>148</b>
8.3. Concentration of nutrients in seeds	<b>149</b>
8.4 Concentration of biochemical parameters in seeds	<b>150</b>
9. Ultra structural studies	<b>153</b>
<b>V. SUMMARY</b>	<b>155</b>
<b>VI- REFERENCES</b>	<b>159</b>
<b>ARABIC SUMMARY</b>	<b>۱</b>

## List of Tables

Table No.	Title	Page
<b>1</b>	The soil used throughout the present investigation	<b>46</b>
<b>2</b>	Morphological and biochemical characteristics of the endophytic bacteria strain	<b>66</b>
<b>3</b>	Effect of water stress and different microorganisms on shoot and root fresh and dry weight of common bean plants during vegetative and fruiting stages	<b>70</b>
<b>4</b>	Effect of water stress and different microorganisms on plant height, No. of leaves and leaves area of common bean plants during vegetative and fruiting stages	<b>71</b>
<b>5</b>	Effect of water stress and different microorganisms on water status (EL, RWC, WSD and WC) during vegetative and fruiting stages	<b>77</b>
<b>6</b>	Effect of water stress and different microorganisms on photosynthetic pigments contents (mg.g <sup>-1</sup> fresh weight) during vegetative and fruiting stages	<b>80</b>
<b>7</b>	Effect of water stress and different microorganisms on enzymes (POX, PPO and PPL) and proline contents during vegetative and fruiting stages	<b>83</b>
<b>8</b>	Effect of water stress and different microorganisms on nitrogen concentration (%) in shoot, root of common bean plants during vegetative and fruiting stages	<b>87</b>
<b>9</b>	Effect of water stress and different microorganisms on phosphorus concentration (%) in shoot, root of common bean plants during vegetative and fruiting stages	<b>88</b>
<b>10</b>	Effect of water stress levels and different microorganisms on potassium concentration (%) in shoot, root of common bean during vegetative and fruiting stages	<b>92</b>
<b>11</b>	Effect of water stress and different microorganisms on Calcium concentration (%) in shoot, root of common bean plants during vegetative and fruiting stages	<b>95</b>



<b>12</b>	Effect of water stress and different microorganisms on Magnesium concentration (%) in shoot, root of common bean plants during vegetative and fruiting stages	<b>98</b>
<b>13</b>	Effect of water stress and different microorganisms on fresh yield of common bean plants during fruiting stages.	<b>101</b>
<b>14</b>	Effect of water stress and different microorganisms on No of seed/plant, No. of pods/plant, pod length, weight of 100 seed g, weight of pods g of common bean plants	<b>107</b>
<b>15</b>	Effect of water stress and different microorganisms on weight of seed/plant, yield ton/fed, relative green yield, WUE ton.m <sup>3</sup> and harvest index of common bean plants seed	<b>108</b>
<b>16</b>	Effect of water stress levels and different microorganisms on N, P, K, Ca and Mg% of common bean seeds	<b>111</b>
<b>17</b>	Effect of water stress levels and different microorganisms on quality parameters of common bean seeds	<b>114</b>
<b>18</b>	Frequency of mycorrhizal colonization (F), intensity of mycorrhizal colonization (M) and arbuscular frequency (A) in root of common bean plants ( <i>Phaseolus vulgaris</i> L.) under different water stress levels	<b>128</b>

## List of Figures

Figure No.	Title	Page
<b>1</b>	Water balance in Egypt 2013	<b>5</b>
<b>2</b>	The available water per capita and number of	<b>5</b>
<b>3</b>	Arbuscular mycorrhizal fungi (AMF) symbiosis	<b>9</b>
<b>4</b>	Extraradical and intraradical hyphae (a), mature arbuscule (b) and vesicle (c) of AMF ( <i>Glomus</i> sp.) (Brundrett, 2008)	<b>15</b>
<b>5</b>	Mature arbuscules (A) of <i>Glomus</i> showing trunk and numerous fine branch hyphae (arrows) (Bar = 10µm) (Brundrett, 2008)	<b>16</b>
<b>6</b>	Vesicles (V) produced by a <i>Glomus</i> species in a leek root. This root also contains many intercellular hyphae. (Bar = 10 µm) (Brundrett, 2008)	<b>17</b>
<b>7</b>	Simplified microscopic section of colonized root showing typical AMF internal and external structures. ( <a href="http://www.davidmoore.org.uk/assets/mostly_mycology/diane_howarth/am.htm">http://www.davidmoore.org.uk/assets/mostly_mycology/diane_howarth/am.htm</a> )	<b>18</b>
<b>8</b>	Molecular phylogenetic tree of the partial sequence of 16S rRNA, showing the relation between <i>Bacillus amyloliquefaciens</i> GGA and the other closely-related sequences in the GenBank	<b>67</b>
<b>9</b>	Interaction effect of water stress on leaves area cm <sup>2</sup> of <i>phaseolus vulgaris</i> L. plant by using microorganisms during vegetative and fruiting stages	<b>72</b>
<b>10</b>	Interaction effect of water stress on EI of <i>phaseolus vulgaris</i> L. plant by using microorganisms during vegetative and fruiting stages	<b>78</b>
<b>11</b>	Interaction effect of water stress on total pigments mg/g of <i>phaseolus vulgaris</i> L. plant by using microorganisms during vegetative and fruiting stages	<b>81</b>
<b>12</b>	Interaction effect of water stress on proline mg/g of <i>phaseolus vulgaris</i> L. plant by using microorganisms during vegetative and fruiting stages	<b>84</b>

<b>13</b>	Interaction effect of water stress levels on total N% of <i>phaseolus vulgaris</i> L. plant by using microorganisms during vegetative and fruiting stages	<b>89</b>
<b>14</b>	Interaction effect of water stress on total P% of <i>phaseolus vulgaris</i> L. plant by using microorganisms during vegetative and fruiting stages	<b>90</b>
<b>15</b>	Interaction effect of water stress on total K% of <i>phaseolus vulgaris</i> L. plant by using microorganisms during vegetative and fruiting stages	<b>93</b>
<b>16</b>	Interaction effect of water stress on total Ca% of <i>phaseolus vulgaris</i> L. plant by using microorganisms during vegetative and fruiting stages	<b>96</b>
<b>17</b>	Interaction effect of water stress on total Mg% of <i>phaseolus vulgaris</i> L. plant by using microorganisms during vegetative and fruiting stages	<b>99</b>
<b>18</b>	Interaction effect of water stress on protien% of <i>phaseolus vulgaris</i> L. seeds by using microorganisms	<b>115</b>
<b>19</b>	Interaction effect of water stress on total cabohydraties % of <i>phaseolus vulgaris</i> L. seeds by using microorganisms	<b>114</b>
<b>20</b>	Interaction effect of water stress on fiber % of <i>phaseolus vulgaris</i> L. seeds by using microorganisms	<b>117</b>
<b>21</b>	Interaction effect of water stress on T.soluble sugar % of <i>phaseolus vulgaris</i> L.seeds by using microorganisms	<b>118</b>
<b>22</b>	Interaction effect of water stress on folic acid % of <i>phaseolus vulgaris</i> L. seeds by using microorganisms	<b>119</b>
<b>23</b>	Interaction effect of water stress on V.B1 of <i>phaseolus vulgaris</i> L. seeds by using microorganisms	<b>120</b>
<b>24</b>	TEM micrographs of leaf cells were taken from treated <i>Phaseolus vulgaris</i> L.with mycorrhizae and effective microorganisms under water stress (13 days) showing	<b>122</b>
<b>25</b>	TEM micrographs of leaf cells were taken from untreated <i>Phaseolus vulgaris</i> L. (Control) under water stress (13 days) and without effective microorganisms	<b>123</b>

<b>26</b>	TEM micrographs of leaf cells were taken from untreated <i>Phaseolus vulgaris</i> L. (Control) irrigated with water (8days) and without effective microorganisms	<b>124</b>
<b>27</b>	TEM micrographs of leaf cells were taken from treated <i>Phaseolus vulgaris</i> with arbuscular mycorrhizae under water stress (13 days)	<b>125</b>
<b>28</b>	TEM micrographs of leaf cells were taken from <i>Phaseolus vulgaris</i> L. treated with effective microorganisms and subjected to water stress (13 days)	<b>126</b>
<b>29</b>	TEM micrograph of a leaf cell was taken from <i>Phaseolus vulgaris</i> L. subjected to water stress (13 days) and treated with endophytic bacteria	<b>127</b>
<b>30</b>	Arbuscular mycorrhizal fungi (AMF) symbiosis	<b>134</b>

## **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<sub>1</sub> 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<sub>1</sub> 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<sub>1</sub> for enzymes (POX, PPO and PPL). Comparing with the water stress of WS<sub>2</sub> 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<sub>1</sub> 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<sup>-1</sup>), 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<sub>1</sub> 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<sup>3</sup> and harvest index, show clearly that the mycorrhizal and EM common bean plants under WS<sub>1</sub> 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<sub>1</sub> 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<sub>1</sub> 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<sub>1</sub> in seeds of common bean were connected with the treatment of AMF+EM under water stress (WS<sub>1</sub>).
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.