**Isolation, identification and evaluation of plant growth-promoting bacteria for mitigating salinity stress in crops**

Madhu Choudhary, Gajender, Awtar Singh, T. Damodaran

This project was started with the concept that rhizospheric microbes of plants found in salt affected soils may serve as a potent source for novel plant growth-promoting (PGP) microbial resources that could ameliorate salt stress amelioration without harming the environment. The potential application of PGP microbes in agriculture is based on their ability to increase crop growth and yield. For the isolation of salt tolerant plant growth promoting bacteria (PGPB), rhizospheric soil samples were collected from two sites (1) Nain Farm (2) salt affected area of Jhajjar. Isolates which were showed PGP traits and also growth at higher EC were screened and out of these best five (HB6J2, HB8P1, HB6P2, HB4A1, HB4N3) and five from previous study (STB32, STB1, 10STB3c(1), 5STB19, 15STB2C) were selected for pot experiment (Fig.2). Pot with 28cm height and upper diameter of 28cm were filled with 12kg soil, soil ECe was set at approximately 8 dS/m. Surface sterilised wheat seed were treated with freshly grown cultures and seeded in the pots at the rate 15 seeds per pot. Fertilizers were given as per RDF. Wheat seeds of two varieties were chosen for pot study- HD2009, this is salt sensitive variety and KRL210, which is salt tolerant variety. The sensitive variety was taken to see the effect of isolates in mitigating salt effect and to see the beneficial effect on plant growth and yield salt tolerant variety was taken in the study.

Effect of microbial treatment on root-shoot length of KRL210

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Root length** | | | | **Shoot length** | | | |
| **Isolate** | 7DAS | 14DAS | 21DAS | 28DAS | 7DAS | 14DAS | 21DAS | 28DAS |
| **HB6J2** | 3.55 | 5.83 | 7.00de | 6.75cde | 3.33 | 10.43abcd | 17.50b | 19.50bc |
| **HB8P1** | 3.38 | 4.73 | 5.00f | 4.78f | 3.23 | 10.90ab | 15.75bc | 17.75cde |
| **HB6P2** | 3.08 | 4.45 | 7.58bcd | 7.08bcd | 3.60 | 11.33a | 17.50b | 18.80bcd |
| **HB4A1** | 3.80 | 4.48 | 6.13ef | 5.88e | 3.35 | 9.25e | 19.75a | 21.75a |
| **STB32** | 3.20 | 4.63 | 7.75abcd | 7.68ab | 3.10 | 9.68De | 16.88b | 18.88bcd |
| **HB4N3** | 2.98 | 4.73 | 6.75de | 6.63cde | 2.78 | 10.70abc | 15.88bc | 17.88cde |
| **STB1** | 3.40 | 5.45 | 7.38cde | 6.45de | 3.40 | 9.85Cde | 15.63bc | 17.38de |
| **10STB3c(1)** | 3.55 | 5.80 | 9.13a | 8.38a | 3.58 | 10.33bcd | 17.00b | 20.38ab |
| **5STB19** | 3.45 | 5.88 | 7.50bcde | 7.38bc | 3.13 | 10.25bcd | 16.50bc | 18.00cde |
| **15STB2C** | 3.43 | 4.88 | 8.88ab | 8.38a | 3.55 | 10.90ab | 17.00b | 18.88cde |
| **Control** | 2.98 | 5.18 | 8.50abc | 7.75ab | 3.43 | 10.23bcde | 14.63c | 16.63e |
|  | NS | NS |  |  | NS |  |  |  |
| **CV(%)** | 20.56 | 16.73 | 13.24 | 8.94 | 11.92 | 10.35 | 8.11 | 7.37 |

Table. Effect of microbial treatment on root-shoot length of KRL210

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Root length** | | | | **Shoot length** | | | |
| **Isolate** | 7DAS | 14DAS | 21DAS | 28DAS | 7DAS | 14DAS | 21DAS | 28DAS |
| **HB6J2** | 3.55 | 5.83 | 7.00de | 6.75cde | 3.33 | 10.43abcd | 17.50b | 19.50bc |
| **HB8P1** | 3.38 | 4.73 | 5.00f | 4.78f | 3.23 | 10.90ab | 15.75bc | 17.75cde |
| **HB6P2** | 3.08 | 4.45 | 7.58bcd | 7.08bcd | 3.60 | 11.33a | 17.50b | 18.80bcd |
| **HB4A1** | 3.80 | 4.48 | 6.13ef | 5.88e | 3.35 | 9.25e | 19.75a | 21.75a |
| **STB32** | 3.20 | 4.63 | 7.75abcd | 7.68ab | 3.10 | 9.68De | 16.88b | 18.88bcd |
| **HB4N3** | 2.98 | 4.73 | 6.75de | 6.63cde | 2.78 | 10.70abc | 15.88bc | 17.88cde |
| **STB1** | 3.40 | 5.45 | 7.38cde | 6.45de | 3.40 | 9.85Cde | 15.63bc | 17.38de |
| **10STB3c(1)** | 3.55 | 5.80 | 9.13a | 8.38a | 3.58 | 10.33bcd | 17.00b | 20.38ab |
| **5STB19** | 3.45 | 5.88 | 7.50bcde | 7.38bc | 3.13 | 10.25bcd | 16.50bc | 18.00cde |
| **15STB2C** | 3.43 | 4.88 | 8.88ab | 8.38a | 3.55 | 10.90ab | 17.00b | 18.88cde |
| **Control** | 2.98 | 5.18 | 8.50abc | 7.75ab | 3.43 | 10.23bcde | 14.63c | 16.63e |
|  | NS | NS |  |  | NS |  |  |  |
| **CV(%)** | 20.56 | 16.73 | 13.24 | 8.94 | 11.92 | 10.35 | 8.11 | 7.37 |

Effect of microbial treatment on root-shoot length (HD2009)

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Root length** | | | | **Shoot length** | | | |
| **Isolate** | 7DAS | 14DAS | 21DAS | 28DAS | 7DAS | 14DAS | 21DAS | 28DAS |
| **HB6J2** | 2.65cd | 5.45abcd | 6.88 | 6.48cde | 3.83abcd | 11.25bcde | 17.68a | 19.68a |
| **HB8P1** | 2.55d | 5.10bcde | 7.38 | 7.15abcd | 3.45bcde | 10.38ef | 16.88ab | 18.88ab |
| **HB6P2** | 2.60d | 4.20e | 6.63 | 6.45cde | 4.15ab | 12.10bc | 15.33bc | 17.33bc |
| **HB4A1** | 2.85Bcd | 4.20e | 6.63 | 6.25de | 3.35de | 11.78bcd | 14.80c | 16.18c |
| **STB32** | 2.85Bcd | 4.18e | 7.75 | 7.63ab | 3.80abcd | 9.98f | 16.00abc | 18.00abc |
| **HB4N3** | 3.33ab | 6.25ab | 7.38 | 7.33abc | 4.23a | 11.13cde | 16.75ab | 18.75ab |
| **STB1** | 3.28abc | 5.53abcd | 7.00 | 6.75bcde | 3.38cde | 13.90a | 14.75c | 16.75c |
| **10STB3c(1)** | 3.28abc | 5.03cde | 7.63 | 7.38abc | 4.08abc | 11.60bcd | 14.25c | 16.25c |
| **5STB19** | 3.65a | 4.43de | 6.50 | 6.13e | 3.05e | 12.35b | 16.75ab | 18.75ab |
| **15STB2C** | 3.75a | 6.48a | 8.00 | 7.75a | 4.25a | 12.33b | 17.50a | 19.50a |
| **Control** | 2.71bcd | 5.65abc | 7.25 | 7.0abcde | 4.08abc | 10.83def | 14.62c | 16.37c |
|  |  |  | NS |  |  |  |  |  |
| **CV(%)** | 14.65 | 16.04 | 12.03 | 9.33 | 13.08 | 6.80 | 8.38 | 7.30 |

Effect of microbial treatment on wheat plant (HD2009)

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Na+** | | | **K+** | | | **Na+/K+** | | |
| **Isolate** | 14DAS | 21DAS | 28DAS | 14DAS | 21DAS | 28DAS | 14DAS | 21DAS | 28DAS |
| **HB6J2** | 2.96 | 1.95 | 2.53 | 51.62 | 50.38 | 51.74 | 0.057 | 0.039 | 0.049 |
| **HB8P1** | 2.73 | 2.32 | 4.41 | 49.98 | 42.54 | 52.16 | 0.055 | 0.055 | 0.085 |
| **HB6P2** | 2.73 | 3.74 | 1.48 | 46.26 | 37.68 | 44.36 | 0.059 | 0.099 | 0.033 |
| **HB4A1** | 1.98 | 2.31 | 3.92 | 64.25 | 43.35 | 45.44 | 0.031 | 0.053 | 0.086 |
| **STB32** | 2.39 | 2.01 | 4.28 | 58.11 | 47.84 | 39.05 | 0.041 | 0.042 | 0.110 |
| **HB4N3** | 2.46 | 3.09 | 5.98 | 51.53 | 75.56 | 44.73 | 0.048 | 0.041 | 0.134 |
| **STB1** | 3.61 | 2.17 | 8.3 | 58.1 | 47.67 | 81.05 | 0.062 | 0.046 | 0.102 |
| **10STB3c(1)** | 3.1 | 3.38 | 4.86 | 56.52 | 48.65 | 60.62 | 0.055 | 0.069 | 0.080 |
| **5STB19** | 3.42 | 6.07 | 4.2 | 58.19 | 78.42 | 45.23 | 0.059 | 0.077 | 0.093 |
| **15STB2C** | 2.13 | 2.37 | 5.27 | 29.2 | 40.21 | 40.81 | 0.073 | 0.059 | 0.129 |
| **Control** | 4.5 | 3.98 | 5.84 | 49.15 | 42.85 | 33.2 | 0.092 | 0.093 | 0.176 |

Effect of microbial treatment on wheat plant (KRL210)

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | | **Na+** | | | **K+** | | | **Na+/K+** | | |
| **Isolates** | 14DAS | | 21DAS | 28DAS | 14DAS | 21DAS | 28DAS | 14DAS | 21DAS | 28DAS |
| **HB6J2** | | 1.51 | 2.59 | 3.48 | 54.67 | 51.05 | 54.74 | 0.028 | 0.051 | 0.064 |
| **HB8P1** | | 2.26 | 3.86 | 6.39 | 30.82 | 40.85 | 45.54 | 0.073 | 0.094 | 0.140 |
| **HB6P2** | | 1.7 | 3.97 | 3.77 | 61.91 | 43.39 | 44.9 | 0.027 | 0.091 | 0.084 |
| **HB4A1** | | 3.85 | 3.9 | 6.47 | 47.19 | 43.2 | 39.83 | 0.082 | 0.090 | 0.162 |
| **STB32** | | 3.78 | 1.29 | 2.65 | 52.14 | 45.64 | 42.02 | 0.072 | 0.028 | 0.063 |
| **HB4N3** | | 4.57 | 5.44 | 5.24 | 54.17 | 49.74 | 43.05 | 0.084 | 0.109 | 0.122 |
| **STB1** | | 3.22 | 4.73 | 4.64 | 48.68 | 38.2 | 44.94 | 0.066 | 0.124 | 0.103 |
| **10STB3c(1)** | | 1.5 | 1.61 | 4.71 | 59.6 | 45.29 | 41.65 | 0.025 | 0.036 | 0.113 |
| **5STB19** | | 2.89 | 4.75 | 6.08 | 48.99 | 47.55 | 39.43 | 0.059 | 0.100 | 0.154 |
| **15STB2C** | | 4.89 | 3.85 | 3.75 | 42.55 | 43.74 | 47.82 | 0.115 | 0.088 | 0.078 |
| **Control** | | 1.16 | 2.73 | 1.96 | 36.7 | 50.71 | 43.11 | 0.032 | 0.054 | 0.045 |

Effect of microbial treatment on wheat root (HD2009)

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Na+** | | | **K+** | | | **Na+/K+** | | |
| **Isolate** | 14DAS | 21DAS | 28DAS | 14DAS | 21DAS | 28DAS | 14DAS | 21DAS | 28DAS |
| **HB6J2** | 7.88 | 5.49 | 7.46 | 20.66 | 7.5 | 8.73 | 0.381 | 0.732 | 0.855 |
| **HB8P1** | 6.09 | 6.49 | 6.66 | 7.92 | 9.23 | 8.43 | 0.769 | 0.703 | 0.790 |
| **HB6P2** | 4.89 | 5.03 | 8.08 | 8.43 | 6.85 | 7.27 | 0.580 | 0.734 | 1.111 |
| **HB4A1** | 5.27 | 6.2 | 7.14 | 6.21 | 9.96 | 6.76 | 0.849 | 0.622 | 1.056 |
| **STB32** | 6.91 | 2.83 | 10.5 | 13.37 | 6.53 | 11.05 | 0.517 | 0.433 | 0.950 |
| **HB4N3** | 12.41 | 3.33 | 10.02 | 17.07 | 6.82 | 8.23 | 0.727 | 0.488 | 1.217 |
| **STB1** | 8.53 | 7.75 | 9.31 | 10 | 8.16 | 10.19 | 0.853 | 0.950 | 0.914 |
| **10STB3c(1)** | 6.93 | 5.63 | 7.16 | 7.22 | 6.59 | 7.96 | 0.960 | 0.854 | 0.899 |
| **5STB19** | 10.3 | 4.22 | 6.75 | 10.03 | 7.07 | 7.28 | 1.027 | 0.597 | 0.927 |
| **15STB2C** | 6.96 | 6.75 | 9.29 | 8.16 | 6.89 | 8.17 | 0.853 | 0.980 | 1.137 |
| **Control** | 4.06 | 5.28 | 8.54 | 4.8 | 5.84 | 6.2 | 0.846 | 0.904 | 1.377 |

Effect of microbial treatment on wheat root (KRL210)

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Na+** | | | **K+** | | | **Na+/K+** | | |
| **Isolates** | 14DAS | 21DAS | 28DAS | 14DAS | 21DAS | 28DAS | 14DAS | 21DAS | 28DAS |
| **HB6J2** | 6.32 | 6.26 | 6.15 | 6.67 | 8.68 | 9.93 | 0.948 | 0.721 | 0.619 |
| **HB8P1** | 5.35 | 6.33 | 10.16 | 8.29 | 5.81 | 12.21 | 0.645 | 1.090 | 0.832 |
| **HB6P2** | 6.22 | 5.44 | 10.35 | 7.51 | 5.37 | 11.48 | 0.828 | 1.013 | 0.902 |
| **HB4A1** | 4.39 | 6 | 6.18 | 10.97 | 6.34 | 4.54 | 0.400 | 0.946 | 1.361 |
| **STB32** | 7.01 | 4.53 | 5.96 | 7.91 | 4.81 | 6.5 | 0.886 | 0.942 | 0.917 |
| **HB4N3** | 5.48 | 5.57 | 10.09 | 9.13 | 5.84 | 8.97 | 0.600 | 0.954 | 1.125 |
| **STB1** | 4.77 | 7.21 | 7.92 | 8.24 | 6.31 | 7.92 | 0.579 | 1.143 | 1.000 |
| **10STB3c(1)** | 8.55 | 4.56 | 5.57 | 7.28 | 5.33 | 5.65 | 1.174 | 0.856 | 0.986 |
| **5STB19** | 5.4 | 4.72 | 10.05 | 6.49 | 5.48 | 9.46 | 0.832 | 0.861 | 1.062 |
| **15STB2C** | 3.54 | 5.21 | 9.74 | 4.74 | 7.35 | 12.39 | 0.747 | 0.709 | 0.786 |
| **Control** | 4.16 | 7.2 | 7.95 | 6.35 | 7.28 | 11.93 | 0.655 | 0.989 | 0.666 |