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Plant growth promoting rhizobacteria on radishes

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The possibility that specific bacteria can be used to increase plant growth has interested researchers over the years. With the exception of rhizobia spp., results are controversial (Brown, 1974; Mishustin *et al.*, 1962). We have evidence indicating that specific strains of rhizosphere bacteria stimulate plant growth and have termed them "plant growth promoting rhizobacteria" (PGPR).

Potential PGPR are screened in greenhouse tests prior to field use (Burr *et al.*, 1978; Suslow *et al.*, 1978) and are selected on their capacity to cause an increase in root or total plant weight. One of the problems in selecting PGPR and subsequently studying their ecology is that many agronomic plant such as potatoes and sugar beets do not grow well in the greenhouse and require a long time for determining yields. We decided that radish *(Raphanus sativus)* might be an ideal plant to study PGPR since it grows rapidly and develops well in both field and greenhouse trials. In addition, isogenic cultivars are available which greatly reduce yield variability. This paper presents the results of greenhouse assays and field trials with PGPR on radish.

Methods

Isolation of PGPR test strains

Roots growing in field soil were washed, and alloquats from dilutions were plated onto King's medium B. Single colonies were removed and purified after 24-48 hrs incubation at 28 °C.

Greenhouse assay

Radish seeds cv. red comet were agitated for 24 hrs in bacterial suspensions at 10^8 cfu/ml of the individual test strains. Controls were agitated in sterile water rinsed from King's medium B slants. Seeds were planted in the greenhouse in field soil from the Salinas Valley of California (clay loam). Each treatment consisted of 6-8 replicate pots with 2 plants/pot. Weights of radishes were recorded 28-30 days after planting.

Field trials

Bacterial suspensions were prepared from strains which induced significant increases in radish weight in the greenhouse. Seeds were stirred with 5 ml of the bacterial suspension (10^8 cfu/ml) and 5 ml of 0.5 % methyl cellulose for 1 min. Talc was mixed with the seed suspension, and the resulting slurry was dried for 48 hrs at 15 °C. Controls were with treated sterile water rinsed from King's medium B slants, methyl cellulose, and talc.

Field trials were designed as 6 × 6 latin squares (5 treatments and 1 control per experiment, each replicated 6 times).

Radishes were harvested and weighed 4 weeks after planting. Weights were expressed for each plot as average weight per plant.

Results and discussion

Greenhouse assay

Eleven of 53 strains assayed induced significant root increases (Table 1-3). Increases as great as 567 % occurred in the greenhouse. These increases were much more than those reported for potato (Burr *et al.*, 1978).

Table 1. Weight of radishes in the greenhouse (1)

Bacterial strain used	Weight g	% increase compared to control
I 4	5.1 A (2)	425
I 5	6.0 A	500
I 7	4.5 A	375
I 11	5.0 A	417
I 17	4.5 A	375
water	1.2 B	- - -

(1) Average of 6 replications (2 plants/replication).
(2) Numbers with different letters are significantly different (LSD 0.01 = 1.7).

Table 2. Weight of radishes in the greenhouse

Bacterial strain used	Weight g	% increase compared to control
I 21	6.2 A (1)	517
I 22	6.0 A	500
I 24	6.5 A	541
TL3 B2	5.4 A	450
BK 1	3.4 AB	283
water	1.2 B	- - -

(1) LSD 0.05 = 3.4.

Table 3. Weight of radishes in the greenhouse

Bacterial strain used	Weight g	% increase compared to control
E 2	3.4 A (1)	567
E 6	2.8 AB	467
E 8	3.2 A	533
E 10	2.9 AB	483
E 12	1.1 BC	183
water	0.6 C	- - -

(1) LSD 0.10 = 2.1

Field trials

Nine of the 11 PGPR strains that significantly caused increased plant growth in the greenhouse also induced significant yield increase in the field (Tables 4-6). Field increases ranged up to 200 % (Table 4).

Table 4. Waight of radishes; field trials (1)

Bacterial strain used	Weight g	% increase compared to control
I 4	1.5 A (2)	167
I 11	1.5 A	167
I 24	1.5 A	167
E6	1.8 A	200
I 21	1.5 A	167
water, talc, methyl cellulose	0.9 A	- - -

(1) Average of 6 replications.
(2) Numbers with different letters are significantly different (LSD 0.01 = 0.4).

Table 5. Weight of radishes; field trials

Bacterial strain used	Weight g	% increase compared to control
B 10	1.1 AB (1)	110
TL3 B1	1.4 A	140
E 8	1.4 A	140
TL3 B2	1.2 AB	120
8K 1	1.2 AB	120
water, talc, methyl cellulose	1.0 B	- - -

(1) LSD 0.05 = 0 4.

Table 6. Weight of radishes; field trials

Bacterial strain used	Weight g	% increase compared to control
I 5	1.6 A (1)	133
E10	1.2 AB	100
I 22	1.4 AB	117
I 17	1.6 A	133
I 7	1.4 AB	117
water, talc, methyl cellulose	1.2 B	- - -

(1) LSD = 0.3.

The effect of PGPR on radish was much greater than that obtained with potatoes or sugar beets (Burr *et al.*, 1978; Suslow *et al.*, 1978). A surprisingly large number of isolates stimulated radish growth – 21 % in the greenhouse and 17 % in the field – compared to similar work with sugar beets and potatoes. This may in part be influenced by the short growing period of radish; PGPR appear to stimulate plant growth early in the season. The greenhouse assay for detection of PGPR strains reliably reflects potential for plant growth stimulation in the field.

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