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Combined effect of microbial inoculants on the quality of beetroot

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ABSTRACT

The highest total soluble solids (TSS) was observed in the tubers of plants provided with 75 per cent N, P plus 100 per cent K with microbial consortia of *Azotobacter chroococcum, Glucanobacter diazotrophicus, Bacillus megaterium* and *Trichoderma harzianum* (T_{10}). The lowest TSS was observed in the tubers of control plants. In general plants treated with combined microbial inoculation showed better plant nutrient uptake than untreated plants. Maximum total uptake of N and P was recorded in the plants provided with 75 per cent N, P plus full dose of K with combined inoculation of *Azotobacter chroococcum, Glucanobacter diazotrophicus, Bacillus megaterium* and *Trichoderma harzianum*.

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INTRODUCTION

Nutrient management is most important in Beetroot to obtain good growth and higher yield of root crops. The crop benefiting microbial inoculants generally called as biofertilizers, help in augmenting the crop productivity through effective mobilization of major plant nutrients like N, P and K and other minor nutrients needed by the crop. These beneficial micro-organisms are also known to secrete plant growth promoting substances like IAA, GA, cytokinins, vitamins for the improvement of crop growth, yield and for quality produce.

Beetroot or garden beet (*Beta vulgaris* L.) is an important root vegetable crop (root modification) belonging to the botanical family Chenopodiaceae. It is indigenous to Southern Europe (Campbell, 1970). The chromosome number of cultivated beetroot types is 2n=2x=18. It is a popular root vegetable grown mainly for its fleshy enlarged roots in almost all the states of India but not as common as radish, carrot and turnip. The garden beet is eaten boiled or as salad, cooked with other vegetables and it is also used in pickles, chutneys and in canned food products. The garden beet is rich in proteins, carbohydrates, calcium, phosphorus, iron and vitamin C (Aykroyd, 1963). The beet tops are also rich in iron, vitamin A, vitamin C and protein. Apart from

these, it also contains traces of minerals, fat, potassium, vitamin B1 and B2. The red colour of beetroot is due to β-cyanin, a nitrogen containing compound, with chemical properties similar to anthocyanin. Beetroot also contains a yellow pigment *viz*., β- xanthin. The ratio of these two pigments varies with cultivation and changes during the growth and environmental conditions (Nilsson, 1973).

Beetroot grows best on fairly deep, friable loam, moist and well drained soils. Heavy yields are obtained from deep rich alluvial or silt loams. It is sensitive to soil acidity and yields are adversely affected as the soil pH goes below 5.8. But it thrives well in alkaline soils with a pH as high as 9.0 to 10.0. Soil with a pH of 6.0-7.0 is considered as ideal for beetroot cultivation. About 25-30 tons of roots could be expected from one hectare area (Kale and Masalkar, 1993).

MATERIAL AND METHODS

A study on the effect of microbial inoculants on the growth and yield of Beetroot (*Beta vulgaris* L.) was carried out in the Biofertilizer Scheme of the Department of Agricultural Microbiology, with a field experiment at the Olericulture Section of the Department of Horticulture, University of Agricultural Sciences, GKVK, Bangalore, during *Rabi* season 2005-2006. The details of the experiment are presented below :

Mass production of microbial inoculants:

The microbial cultures used in the experiment were obtained from the Biofertilizer scheme of the Department of Agricultural Microbiology, University of Agricultural Sciences, GKVK, Bangalore.

The microbial inoculants used in the study are as follows:

N fixing microbial inoculants:

Glucanobacter diazotrophicus :

It was grown on *Glucanobacter diazotrophicus* broth for 8-10 days and after attaining sufficient microbial population, it was mixed in presterilized lignite powder neutralized with $CaCO_3$. The final product had a population of 9×10^7 cfu. g^{-1} carrier and was applied to the field at the rate of 10 kg/ha.

Azotobacter chroococcum :

It was grown on Ashby's broth for 8-10 days and after attaining the desired population the culture was mixed aseptically in presterilized lignite powder neutralized with calcium carbonate. The final product had a population of 8×10^7 cfu. g^{-1} carrier and was applied as soil application at the rate of 10 kg/ha.

P solubilizers:

Bacillus megaterium:

Bacillus megaterium was mass multiplied on Pikovaskaya's broth for 8-10 days and after attaining sufficient microbial population, it was mixed in presterilized lignite powder neutralized with $CaCO_3$. The final product had a population of 8×10^8 cfu. g^{-1} carrier and was applied to the field at the rate of 10 kg/ha.

Trichoderma harzianum:

It was grown on Trichoderma specific broth for 10 days on a mechanical shaker with frequent agitation. After sufficient growth, the mycelial mat formed at the scum was macerated along with the broth using a homogenizer. Fully grown broth culture was mixed with presterilized lignite powder earlier neutralized with $CaCO_3$. The final product had a population of 4×10^6 cfu. g^{-1} and the inoculum was added at the rate of 5 kg/ha.

Details of the field experiment:

Location of the field experimental site:

The field experiment was conducted during the *Rabi* season of 2005-2006 in the month of Nov.-Dec. at the Horticulture Research Station, University of Agricultural Sciences, GKVK, Bangalore under protective irrigated conditions. The study site was located at 12^0 58| north latitude and 77^0 35| east longitude with an elevation of 930m above the mean sea level.

Land preparation:

The experimental area was ploughed and harrowed to bring to a fine tilth. The experimental plot was divided in to plots of size 1.7m × 1.3m with 20 cm bunds between the plots.

Collection of soil samples for chemical analysis:

The soil samples were collected from the field experimental site before sowing and after the harvest of the crop by collecting 12^{11} top soil and were analyzed for physical and chemical properties. The results of the soil analysis and the methods employed are presented in Appendix III.

Weather parameters:

Weather data prevailed during the cropping season (Nov.-Dec.) *viz*., temperature, rainfall, mean relative humidity are given in appendix I.

The weather data was collected from the Meteorological observatory of the University of Agricultural Sciences, G.K.V.K., Bangalore.

Treatments details of the field experiment:

T_1- 50% NP + 100 % K + *Azotobacter chroococcum*

T_2- 50% NP + 100% K + *Glucanobacter diazotrophicus*

T_3- 50% NP + 100% K + *Azotobacter chroococcum* + *Gluconobacter diazotrophicus*

T_4- 50% NP + 100% K + *Azotobacter chroococcum* + *Gluconobacter diazotrophicus* + *Bacillus megaterium* (PSB).

T_5- 50% NP + 100% K + *Azotobacter chroococcum* + *Glucanobacter diazotrophicus* + *Bacillus megaterium* + *Trichoderma harzianum*

T_6- 75% NP + 100% K + Azotobacter chroococcum

T_7- 75% NP + 100% K + *Glucanobacter diazotrophicus*

T_8- 75% NP + 100% K + *Azotobacter chroococcum* + *Glucanobacter diazotrophicus*

T_9- 75% NP + 100% K + *Azotobacter chroococcum* + *Glucanobacter diazotrophicu* + *Bacillus megaterium*

T_{10}- 75% NP + 100% K + *Azotobacter chroococcum* + *Glucanobacter diazotrophicus* + *Bacillus megaterium* + *Trichoderma harzianum*

T_{11}- 50% NP + 100% K

T_{12}- 75% NP + 100% K

T_{13}- 100% NPK (Reccommended dose)

T_{14}- FYM alone

Note : (FYM is common to all the treatments)

Cultural operations:

Seeds and sowing:

Beetroot variety ruby queen seeds were sown directly on main experimental plot at the rate of 7.5 kg/ha, at a spacing of 22.5 cm between plants and 30 cm between rows.

Fertilizer application:

The recommended dose of fertilizer 100 kg nitrogen, 50 kg phosphorus and 70 kg potassium per hectare (UAS

Table 1 : Influence of microbial inoculants on total soluble solids of beetroot

Treatments	TSS (%)
T_1 – *A. chroococcum* + 50% N, P	11.43
T_2 – *G. diazotrophicus* + 50% N, P	11.70
T_3 – *A. chroococcum* + *G. diazotrophicus* + 50% N, P	11.93
T_4 – *A. chroococcum* + *G. diazotrophicus* + *B. megaterrium* + 50% N, P	14.03
T_5 – *A. chroococcum* + *G. diazotrophicus* + *B. megaterium* + *T. harzianum* + 50% N, P	14.40
T_6 – *A. chroococcum* + 75% N, P	12.67
T_7 – *G. diazotrophicus* + 75% N, P	13.37
T_8 – *A . chroococcum* + *G. diazotrophicus* + 75% N, P	13.80
T_9 – *A. chroococcum* + *G. diazotrophicus* + *B. megaterium* + 75% N, P	14.73
T_{10} – *A. chroococcum* + *G. diazotrophicus* + *B. megaterium* + *T. harzianum* + 75% N, P	16.03
T_{11} - 50% N, P	10.83
T_{12} - 75% N, P	12.13
T_{13} - 100% N, P	15.57
T_{14} - FYM alone	10.00
F-test	*
S.E. ±	0.39
C.D. (P=0.05)	1.18

Note: Recommended K is common to all the treatments except T_{14}.
FYM is common to all the treatments at recommended dose.

package of practice for vegetable cultivation) was applied in the form of urea, single super phosphate and muriate of potash respectively as per the treatments requirement. Half of the nitrogen and entire dosage of P and K were applied as basal dose while the remaining half of the nitrogen was applied 30 days after sowing. FYM was applied uniformly to all the treatments at the rate 25 tons/ ha, 15 days prior to seed sowing and mixed well with the soil.

Weeding and irrigation:

Periodic hand weeding was done to keep the plots free from weeds. Irrigation was given at an interval of 3 to 4 days depending on the soil moisture condition.

Statistical analysis :

The experimental data obtained were subjected to statistical analysis as per Fischer's method of variance as given by Panse and Sukatme (1967).

RESULTS AND DISCUSSION

The results pertaining to the field study "Effect of microbial inoculants on growth and yield of Beetroot. (*Beta vulgaris* L.)" conducted during *Rabi* season 2005-06 are presented below.

Quality parameters:

TSS (^{0}Brix) :

The total soluble solids in the beetroot differed significantly among the treatments Table 1. Maximum TSS was recorded in the tubers of 75 per cent N, P plus full dose of K with *Azotobacter chroococcum, Glucanobacter diazotrophicus, Bacillus megaterium* and *Trichoderma harzianum* (16.03 ^{0}Brix). Minimum TSS was recorded in the bulbs obtained from the treatment of un inoculated control (10 ^{0}Brix).

Quality parameters:

Quality is one of the important factor next to yield, excellence of the product is determined by its quality attributes. The maximum TSS was recorded in the beetroot tubers treated with combined inoculation of *Azotobacter chroococcum, Glucanobacter diazotrophicus, Bacillus megaterium* and *Trichoderma harzianum* with 75 per cent N, P plus full dose of K (16.03 ^{0}B) and minimum TSS was recorded in the tubers of plants treated only with recommended FYM (10.00 ^{0}B). Higher TSS can be attributed to increased uptake of NPK and other micronutrients which inturn enhanced the photosynthetic activity in the plant system thereby leading to better accumulation of carbohydrates in plant parts including tubers.

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