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Short Communication

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Effect of *Bacillus cereus* on Seed Germination and Overall Growth of *Amaranthus cruentus* L. Plants

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Amaranthus cruentus L. is a grain species and it belongs to the family amaranthaceae. It is diuretic and is used as tapeworm-expellant, laxative in case of infants. If this plant is grown on nitrogen rich soils it eventually concentrates nitrates in the leaves. This condition is predominantly found in chemical fertilizers treated agricultural lands. The excessive deposition of nitrates in the leaves and the digestion of these leaves by human body may result into stomach cancers, blue baby syndromes and other health hazards. So, it is advised to eat those red amaranth plants which are grown organically. Plant Growth Promoting Rhizobacteria (PGPR) is a diverse group of beneficial root inhabiting bacteria which increase plant growth and biocontrol of seed borne pathogens by a wide range of mechanisms (Bakker and Schipperes 1987, Bowen and Rovira 1999). In the context of ever-increasing hunger of global population, the utilization of PGPR for minimizing the application of chemical fertilizer in agricultural world is a potentially big issue (Kumar *et al*. 2012, Devi *et al*. 2015). *Amaranthus cruentus* is a fast-growing plant and it is used as leaf crop from ancient time. The leaves are great source of vitamin- A, C and several mineral elements like iron, calcium etc. The seeds are also very nutritious in nature. The plant is also of great medicinal importance specifically in the treatment of digestion (http://tropical.theferns.info).

Now a days, modern agriculture is dependent on excessive application of chemical fertilizers and other agrochemicals to increase the production rate of crops which is responsible for decreasing the qualities of soil health and overall environment (Lalande *et al*. 1989, Roy and Sengupta 2016a). However, the application of PGPR in agriculture in order to increase the plant growth is an ecofriendly way to minimize the usage of chemical fertilizers. PGPRs are a group of soil inhabiting rhizospheric beneficial bacteria which enhance plant growth by promoting host-microbes symbiotic interaction, solubilizing phosphate, IAA production, siderophore production, production of chitinase, cellulase, protease, antibiotics, ammonia and volatile organic compounds production and so on (Roy and Sengupta 2016b, Sandhya *et al*. 2010). *Bacillus cereus* is an example of potent PGPR which increased wheat plant growth tremendously. In this work the role of *Bacillus cereus* on seed germination and growth of *Amaranthus cruentus* is described.

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Collection of soil: Soil samples were collected from rhizospheric area of *Solanum melongena* L. grown in paper mill effluent infested zone of Nadia, West Bengal. During collection 10 cm. soils from uppermost layer was discarded and the lower soil layer beneath this was collected in clean polythene packets aseptically. Then these packets were brought to the laboratory and was stored in aseptic condition for further use.

Collection of seeds: The red amaranth seeds (Rani marka variety) were bought from Nadia Seed House, Chakdaha. The seeds were of uniform germplasm. After purchase the seeds were stored in cool dry place of laboratory for further use.

Bacillus cereus: The PGPR strain: Initially almost about 34 bacterial strains were isolated from the collected soil sample by conventional serial dilution technique employing Nutrient Agar Media (Beef extract- 3g; Peptone- 5g; Agar-5g; Distilled water-1000ml., Sodium chloride- 5g, pH-6.8). Plates were incubated at 28°C and after 3days of incubation the number of bacterial colonies grown on media

was recorded and inoculated separately in Nutrient Agar slants, maintained at 4°C for further work. After that PGPR characterization of all bacteria was done and, on the basis of best PGPR characters 5 bacterial isolates were selected initially. After that biochemical characterization and molecular characterization was done. Among 5 bacterial isolates, *Bacillus cereus* is one of those.

Seed germination test: At first the red amaranth seeds were surface sterilized with 0.01% $Hgcl_2$ for 2 mins. followed by successive washing with sterile distilled water. Seeds were kept into *Bacillus cereus* culture medium containing 10^6 cells/ml. for 10 mins. After that the seeds were transferred and kept on sterile petriplate containing wet cotton bed and incubated for 2-3 days. After 3 days seed germination data was recorded in comparison with control. The nature of seed germination was also checked by planting the imbibed seeds into pots using the same technique.

$$\text{Germination percentage} = \frac{\text{Total no. of germinated seeds}}{\text{Total no. seeds}} \times 100$$

Exploitation of Bacillus cereus on growth of red amaranth seedlings: *Amaranthus cruentus* L. (Rani marka variety) were sown in (the soil of the pot was sterilized for successive 3 days at 15 lbs pressure for 45 mins.) pot culture after proper imbibitions in the *Bacillus cereus* suspension for 24 hours and the set was kept in open environment for 3 months.

The impact of *Bacillus cereus* on seed germination and growth of *Amaranthus cruentus* plants were properly done and it is depicted below in (Table 1).

Table 1 Effects of *Bacillus cereus* on seed germination and growth of *Amaranthus cruentus* seedling in Chakdaha

Experimental set	Total number of seeds used	No. of seeds germinated	Seed germination %	Internodal length (cm.)	Root length (cm.)	Shoot length (cm)	Fresh weight (gm)	Dry weight (gm)	No. of leaves
Control	05	02	40%	1.1	2.1	10.3	1.35	0.53	06
Treated	05	04	80%	1.3	3.2	33.5	3.54	1.01	11

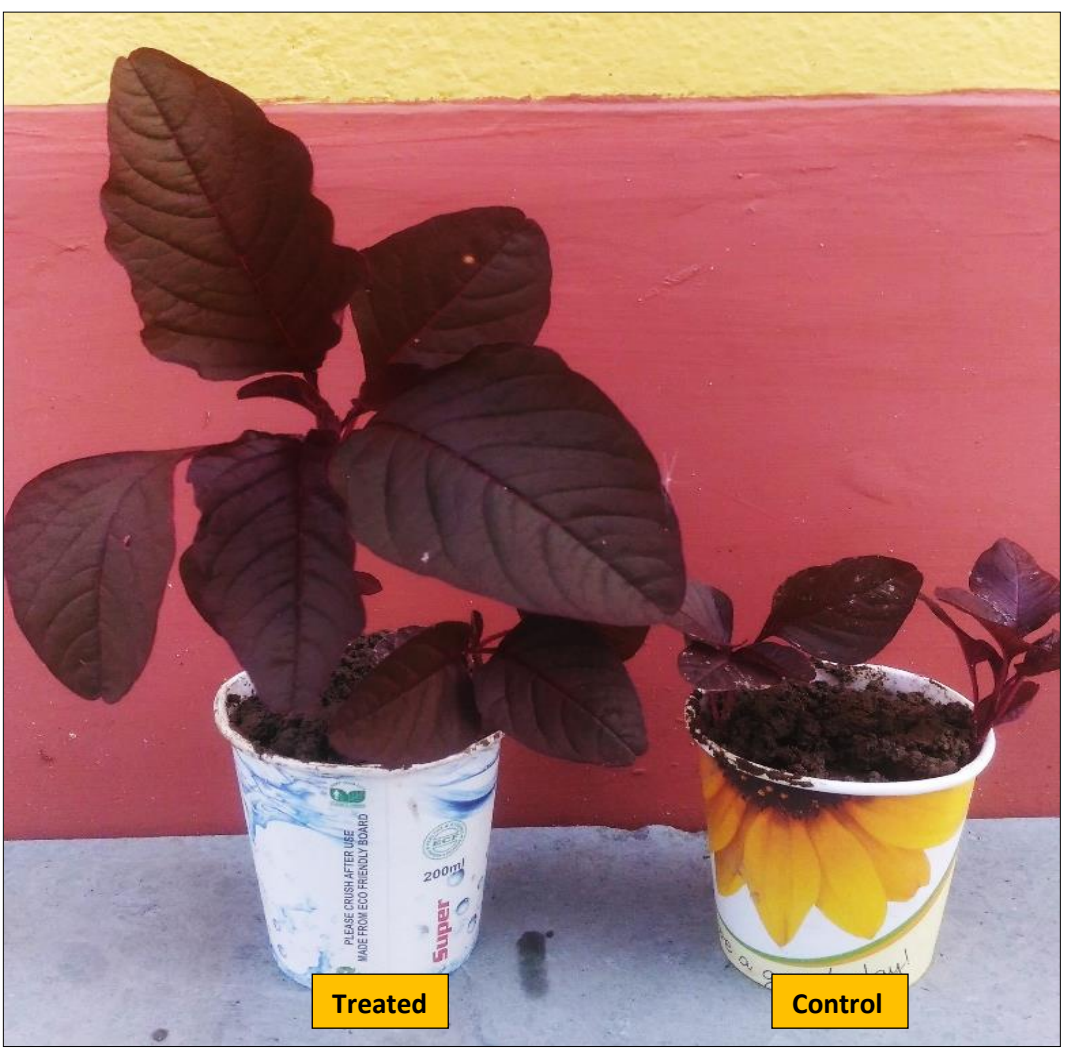

Fig 1 One month grown plant

In this study the role of *Bacillus cereus* was investigated on the seed germination % and growth improvement of red amaranth plant. There were two sets: Control and treated. In control set, there was no inoculation of PGPR, only distilled water was sprayed over the set and in treated set, the seeds were sown after imbibing in the bacterial broth and the soils were also mixed with the culture. From the result it is clear that in case of treated set the seed germination % was 80% whereas in case of control set the seed germination % was only 40%. After that the internodal length, root length, shoot length, fresh weight. Dry weight, number of leaves were counted accordingly.

All the data recorded from the experimental sets reveal that the *Bacillus cereus* treated set was better in performance in comparison to control set. *Bacillus cereus* increased all the physiological parameters in *Amaranthus cruentus* plants.

So, from this experiment it can be concluded that if *Bacillus cereus* is used as plant growth stimulant in red amaranth plant, it can enhance its seed germination % as well was its overall growth pattern. So, it further indicates that *Bacillus cereus* can be used as biofertilizer, although, further study needs to reach any firm conclusion.

SUMMARY

Bacillus cereus is a major type of Plant Growth Promoting Rhizobacteria (PGPR) which can tremendously enhance plant growth and represent a symbiotic plant-microbe interaction. Plant Growth Promoting Rhizobacterias (PGPRs) stimulate plant growth and yield by direct as well as indirect mechanisms which include fixation of nitrogen, siderophore production, indole acetic acid (IAA) production, HCN production, biocontrol of seed borne pathogen, increasing of nutrients in the soil etc. So, in this article it is focused on the functional aspect of *Bacillus cereus* as Plant Growth Promoting Rhizobacteria (PGPR) on seed germination and overall growth of *Amaranthus cruentus* plant which may open a new gateway for organic agriculture. From the above study it can be concluded that if *Bacillus cereus* is applied on *Amaranthus cruentus* L. plants it can enhance seed germination, plants overall growth and development as well. Without any application of chemical fertilizers, the red amaranth plant growth can be increased by the application of *Bacillus cereus*-the PGPR strain. So, there is a scope of using *Bacillus cereus* as good biofertilizer in future.

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