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EFFECT OF EFFECTIVE MICRO-ORGANISMS ON THE DEVELOPMENT OF BLACK GRAM (*Vigna mungo* L)

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ABSTRACT

The important foods like black gram are very essential protein source for Indian population. The production of black gram is diminishing due to the infertile condition of Indian soil by the prolonged agricultural practices with chemical fertilizers. The present study is concerned with effective and alternative agricultural practices to chemical fertilizers on black gram production. The effective microorganism (EM) technology is used to evaluate the efficacy of beneficial microbes present in the EM solution against the black gram plant. The plants treated with EM showed good growth and yield also very much increased when compared with chemical fertilizers. The EM with vermicompost treatment increased the yield of black gram. The microbial population also counted in control and EM treated soils. The observation revealed that the EM treatment increased the microbial population. The present study suggests that the increased microbial population may be responsible for the increased growth and yield of black gram.

INTRODUCTION

Most of the Asian countries have rice as the main food which provides only carbohydrates. So the Asian people need protein rich food for their normal physiology and development. The black gram is one of the main food crops in India (Gupta and Seth, 2007). Black gram is one of the proteins rich food stuff largely cultivated in India. We are in need to develop alternative agricultural practices to obtain higher yield to fulfill the larger population (Cordell *et al.,* 2009). Many researchers suggested that the chemical fertilizers used for cultivation bring many ill effects to the environment and also to the living organisms. The interference of synthetic fertilizers in the normal physiological function of living organism leads to massive reduction of key organisms. Biodiversity needs to be protected from the synthetic fertilizers. Hence, a natural agricultural practice should be undertaken to restore the human population from the diseases. The Micro-organisms are extensively used for agricultural practices and there are plenty of evidences which supports for EM treated agriculture in most of the countries. Soil microorganisms have an important influence on soil fertility and plant health (Gianinazzi and Schuepp, 1994).

Indian soil have low amount of Phosphorus hence the farmers add artificial Phosphorus to the plants (Hegde *et al.*, 1999). Now a days, *Arbuscular mycorrhizal* fungi (AMF) and plant growth-promoting rhizobacteria (PGPR) are used to improve soil fertility and plant growth (Artursson *et al.*, 2006, Smith and Read, 2008 and Toro *et al.*, 1997). Mere addition of chemical fertilizers may cause serious soil infertility. Under such conditions, the microbial inoculants with chemical fertilizers and organic manure bring better yield and soil fertility (Hegde *et al.*, 1999).

Organic matters treatment brings more effects on plant growth and development which in turn results in higher yield (Ghosh *et al.*, 2004). The previous studies suggested that the application of biofertilizers is involved to convert nutritionally important element which are from complex to simple compounds. Organic fertilizers are good sources of nutrients for crop production and improving physical and chemical properties of soil. Microorganisms are important attributes in agriculture to promote the circulation of plant nutrients and reduce the need for chemical fertilizers (Chrispaul *et al.*, 2010). EMs enhance plant health and development by inducing photosynthesis, synthesis bioactive molecules like hormones, enzymes, accelerating decomposition of organic materials and controlling soil-borne diseases (Hussain *et al.*, 2002).

Now a day, the agricultural practices are controlled by synthetic chemicals in the form of fertilizers and pesticides. The prolonged usages of such toxic chemicals destroy the beneficial microbes which are in the soil. The absence of beneficial microbes leads to infertile soil

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condition and affects the normal growth of plants. So, the alternative agricultural practices should be undertaken to restore the soil fertility. The EM technology is the recent advancement in agriculture which is cost effective than the conventional synthetic fertilizers and easier to practice.

In the best of our knowledge, there are very low scientific evidences on EM treatment for the cultivation of black gram in India. Hence, the present study is formulated to assess the beneficial effect of commercial EMs on black gram.

MATERIALS AND METHODS

Source Materials

The black gram seeds, Effective Microorganisms (EMs) and NPK fertilizers were purchased from a local agricultural shop in Chidambaram, Tamil nadu, India.

Soil Preparation

The study was conducted in Annamalai University, Chidambaram, Tamil Nadu, India. The pot culture method was carried out in agricultural site of Annamalai University with 36 pots.

EM Preparation

Stock EM solution was diluted in the ratio of 1:1000 (EM: Distilled Water). The EM was applied by spraying to the targeted plant.

Seed Preparation

The seeds were soaked in distilled water and the seeds floating on the surface of water were removed. The seeds were soaked for overnight and planted on the pots on the day after.

Experimental Design

There pots were divided into six groups and each group has six pots. The experiment was carried out for 16 weeks. Group I: Control (The control group plants were not received any additives). Group II: Normal chemical fertilizer (NPK). These plants received synthetic chemical fertilizers as per the recommendations of Tamil Nadu Agricultural Department. Group III: EM 1% alone. These plants received only the EM solution which was diluted in distilled water as 1:1000. Group IV: EM 1% + poultry manure. These group plants received 1% EM solution and poultry manure (1 kg of poultry manure was mixed with 1 litre of 1% EM solution). Group V: EM 1% + vermicompost. These group plants received 1% EM solution and vermicompost (1 kg of vermicompost was mixed with 1 litre of 1% EM solution). Group VI: EM 1% + molasses. These group plants received 1% EM solution and molasses obtained from sugar industry (1 kg of molasses was mixed with 1 litre of 1% EM solution).

Analysis of EM treatment

The black gram plant growth parameters were measured such as shoot length, shoot weight (dry), root weight (dry), pod length, pod number, nodule number, nodule weight (fresh & dry) and yield of black gram were measured after 120 days. Direct plate counts were used to quantify total culturable bacteria, fungi and actinomycetes population. The population counting was measured periodically throughout the experiment duration on 0 day, 30^{th} day, 60^{th} day, 90^{th} day and 120^{th} day.

Statistical analysis

The data were statistically analyzed using ANOVA followed by DMRT and the values are expressed as mean ± S.D. The values were considered statistically significant if the p-value was less than 0.05.

RESULTS AND DISCUSSIONS

In the present study, the effect of commercially available Effective Micro-organisms (EMs) was evaluated against the growth of Black gram. The growth studies like shoot length, shoot weight (dry), root weight (dry), pod length, pod number, nodule number, nodule weight (fresh & dry) and yield of black gram were calculated in all EM and

Table 1 Effect of EM treatment with other manure on the growth of Black gram

Groups	Shoot Length (cm)	Shoot dry weight (g)	Root dry weight (g)	Pod length (cm)	Pod number
Group I (control)	22.5 ± 2.5[a]	2.15 ± 0.3[a]	0.29 ± 0.04[a]	2.6 ± 0.3[a]	17.0 ± 2.6[a]
Group II (chemical fertilizer)	31.6 ± 2.9[b]	3.2 ± 0.3[b]	0.40 ± 0.03[b]	3.7 ± 0.2[b]	25.3 ± 4.8[b]
Group III (EM 1% alone)	28.1 ± 2.0[b]	3.0 ± 0.3[b]	0.40 ± 0.03[b]	3.4 ± 0.4[b]	25.0 ± 3.0[b]
Group IV (EM 1% + poultry manure)	31.1 ± 2.8[b]	3.8 ± 0.4[c]	0.46 ± 0.04[c]	4.6 ± 0.3[c]	26.6 ± 3.2[b]
Group V (EM 1% + vermin compost)	37.6 ± 2.5[c]	4.6 ± 0.4[d]	0.52 ± 0.06[c]	4.9 ± 0.5[c]	33.0 ± 3.2[a]
Group VI (EM 1% + molasses)	31.5 ± 3.3[b]	3.9 ± 0.3[c]	0.48 ± 0.02[c]	4.6 ± 0.3[c]	24.6 ± 3.1[b]

Table 2 Effect of EM treatment with other manure on the growth of Black gram

Groups	Seed /Pod	Nodule number	Nodule weight (fresh) (g)	Nodule weight (dry) (g)	Yield (g)
Group I (control)	4.5 ± 0.5 a	96.0 ± 4.1 a	0.17 ± 0.02a	0.07 ± 0.005 a	2.2 ± 0.4 a
Group II (chemical fertilizer)	5.0 ± 0.6 a	103.0 ± 6.1 b	0.29 ± 0.04b	0.19 ± 0.03bc	3.4 ± 0.3c
Group III (EM 1% alone)	4.8 ± 0.7 a	100.0 ± 6.4 b	0.27 ± 0.03b	0.17 ± 0.01b	2.8 ± 0.3b
Group IV (EM 1% + poultry manure)	5.0 ± 0.6[a]	110.6 ± 5.4[c]	0.41 ± 0.02[c]	0.24 ± 0.03[d]	3.9 ± 0.2[d]
Group V (EM 1% + vermin compost)	5.3 ± 0.8[a]	123.8 ± 5.4[d]	0.49 ± 0.03[d]	0.29 ± 0.03[e]	5.0 ± 0.3[e]
Group VI (EM 1% + molasses)	4.8 ± 0.7[a]	113.0 ± 5.5[c]	0.41 ± 0.04[c]	0.23 ± 0.06[cd]	4.2 ± 0.3[d]

chemical fertilizers treated plants. The microbial population (Bacteria, Fungus and Actinomycetes) also calculated in all EM and chemical fertilizers treated plants. The results obtained were tabulated and statistically analyzed (Table 1 & 2).

The microbial population (bacteria, fungus and actinomycetes) in the EM treated is higher than the other plants such as control and chemical fertilizer treated plants. The EM with vermicompost treated plants showed good soil profile. The microbial diversity especially beneficial microbes are very rich in the EM with vermicompost treated soil (Tables 3, 4 & 5). The EM treated with other fertilizers like poultry manure and molasses also showed good microbial diversity.

Table 3 Bacterial population in the Effective micro-organisms treated soil

Groups	0 day	30 days	60 days	90 days	120 days
Group I (control)	208.1 ± 5.6^{b}	213.1 ± 5.9^{c}	229.3 ± 5.8^{b}	258.6 ± 5.7^{d}	275.5 ± 4.8^{c}
Group II (chemical fertilizer)	224.1 ± 9.5^{c}	234.5 ± 8.5^{d}	244.5 ± 6.0^{c}	265.3 ± 7.9^{de}	270.0 ± 8.0^{c}
Group III (EM 1% alone)	232.8 ± 9.3^{c}	244.5 ± 9.7^{e}	239.0 ± 8.1^{c}	244.1 ± 5.4^{c}	272.8 ± 8.6^{c}
Group IV (EM 1% + poultry manure)	192.6 ± 8.5^{a}	199.3 ± 7.0^{ab}	216.1 ± 9.1^{a}	230.0 ± 6.8^{b}	253.0 ± 7.7^{b}
Group V (EM 1% + vermin compost)	195.6 ± 8.5^{a}	206.5 ± 5.3^{bc}	212.8 ± 7.1^{a}	267.6 ± 6.1^{e}	291.1 ± 11.0^{d}
Group VI (EM 1% + molasses)	193.3 ± 13.9^{a}	196.1 ± 9.4^{a}	212.1 ± 5.7^{a}	211.5 ± 7.8^{a}	233.5 ± 4.2^{a}

Table 4 Fungal population in the Effective micro-organisms treated soil

Groups	0 day	30 days	60 days	90 days	120 days
Group I (control)	95.0 ± 12.4^{b}	93.1 ± 6.8^{bc}	100.0 ± 4.0^{a}	107.8 ± 8.1^{a}	123.6 ± 6.6^{a}
Group II (chemical fertilizer)	90.1 ± 9.4$^{a b}$	88.6 ± 4.4^{ab}	96.5 ± 9.5^{a}	120.5 ± 5.6^{b}	136.3 ± 6.2^{b}
Group III (EM 1% alone)	80.8 ± 11.9^{a}	87.3 ± 3.2^{ab}	92.3 ± 7.3^{a}	101.8 ± 4.5^{a}	123.1 ± 5.2^{a}
Group IV (EM 1% + poultry manure)	97.8 ± 10.14^{b}	99.1 ± 6.8^{c}	110.6 ± 6.0^{b}	119.8 ± 5.8^{b}	118.6 ± 5.3^{a}
Group V (EM 1% + vermin compost)	78.8 ± 9.3^{a}	84.0 ± 4.9^{a}	96.3 ± 9.0^{a}	101.5 ± 9.1^{a}	134.3 ± 3.9^{b}
Group VI (EM 1% + molasses)	101.5 ± 7.1^{b}	112.6 ± 5.3^{d}	120.5 ± 6.3^{b}	129.6 ± 5.6^{c}	146.8 ± 5.5^{c}

Table 5 Actinomycetes population in the Effective micro-organisms treated soil

Groups	0 day	30 days	60 days	90 days	120 days
Group I (control)	13.1 ± 2.6^{ab}	14.6 ± 3.7^{a}	17.5 ± 2.4$^{a b}$	20.6 ± 4.1$^{a b}$	28.8 ± 2.1^{bc}
Group II (chemical fertilizer)	10.8 ± 3.3^{a}	12.3 ± 2.9^{a}	14.1 ± 2.8^{a}	17.0 ± 3.5^{a}	21.5 ± 3.9^{a}
Group III (EM 1% alone)	17.6 ± 3.3^{bc}	20.1 ± 3.4^{b}	21.0 ± 3.1^{bc}	21.8 ± 2.5^{b}	27.8 ± 3.7^{b}
Group IV (EM 1% + poultry manure)	11.0 ± 2.8^{a}	16.0 ± 3.1^{a}	18.8 ± 2.7^{bd}	22.1 ± 3.0^{b}	33.0 ± 4.cd
Group V (EM 1% + vermin compost)	18.6 ± 4.0^{c}	21.0 ± 2.3^{b}	25.3 ± 3.1^{d}	29.6 ± 2.6^{c}	40.3 ± 3.1^{e}
Group VI (EM 1% + molasses)	16.0 ± 3.1^{bc}	19.8 ± 3.0^{b}	23.3 ± 3.2^{c}	29.1 ± 2.3^{c}	37.1 ± 5.1^{de}

Nitrogen (N) is the most important plant nutrient required for plant growth which is more abundant in the earth's atmosphere (Muthukumarasamy *et al.*, 2002). The continuous use of synthetic fertilizers causes adverse effect on N fixation i.e. fixing of atmospheric N into plant absorbable nitrogen. Biological nitrogen fixation is one way of converting elemental nitrogen into plant usable form. Many microbes are involving in the process of biological nitrogen fixation and the enrichment of microbes is the alternative source for N (Postgate, 1998). Dubey (1998) obtained highest grain yield in soybean when host plant was inoculated with *Bradyrhizobium* in combination with NPK fertilizers. Effective microbe's treatment brings better yield in the plants. EM treatment increases more leaf chlorophyll content and which increases the protein synthesis (Hendry *et al*., 1987). EM treatment enhances the nitrogen fixation into the soil. Fixed nitrogen is used by the plant readily and used them for synthesizing the biomolecules like amino acids, nucleic acids and proteins (Sharma *et al*., 1995). The growth medium of the plant directly involves in protein synthesis (Grant and Bailey, 1993). Studies on EM technology proved their effectiveness in agricultural practices (Higa, 1991).

The microorganisms improve crop growth and yield by increasing photosynthesis, producing bioactive substances such as hormones and enzymes, controlling soil diseases and accelerating decomposition of lignin materials in the soil (Hussain *et al.*, 2002).

Application of EM is known to enhance crop growth and yield in many crops both leguminous and non-leguminous (Javaid, 2009 and Daiss *et al.*, 2008). Bacteria, fungi and actinomycetes are known Plant growth promoting microorganisms which are survives in and around the root rhizosphere. These microbes enhance the plant growth and yield either directly or indirectly (Hariprasad *et al.*, 2009). In the present study, the microbes such as bacteria, fungus and actinomycetes are increased in their population when treated with Effective Micro-organisms. The healthier growth of plant always depends on the solubilization or mobilization of important nutrients (phosphorous, potash, zinc, sulphur and iron) or fixing atmospheric nitrogen for the uptake of plants. The inoculated microbes produce various plant growth promoting hormones like indole acetic acid, gibberlic

acid, cytokinins and ethylene (Arshad and Frankenberger, 1993). The beneficial microbes also indirectly reduce the deleterious effect of phytopathogens. The beneficial microbes are attached mutually with rhizosphere and cope up with biotic and abiotic stresses and eventually increase the plant growth in a healthier way (Maiyappan *et al.*, 2010). Phosphorus is also an important plant nutrient along with N. Phosphorus has significant effect on plant growth (Hargrove *et al*., 1984). Only 10- 20% of fertilizer phosphorus can be utilized by the plants, while the major part is deposited in the soil as Ca-, Fe-, or Al-phosphates (Roemer *et al.,* 1953). Khaliq *et al.* (2006) reported that EM application in combination with organic matter or mineral NPK significantly increases cotton yield. Hussain *et al.* (1999) observed that the EM application with farmyard manure or mineral NPK increases the wheat and rice grains. The increased yield of the plants may by the actions of photosynthetic bacteria such as *Rhodopseudomonas palustris* and *Rhodobacter sphaeroides* in EM solution which synthesizes useful substances from secretions of plant roots, organic matter and harmful gases such as hydrogen sulfide with the help of sunlight and the heat of soil as sources of energy (Kim *et al.,* 2004). The production of bacteria such as amino acids, polysaccharides, nucleic acids, bioactive substances and sugars are directly enhances the plant growth and development (Kin and Lee 2000 & Ranjith *et al*., 2007).

CONCLUSION

The present study reveals that the application of EM to black gram brings fruitful results. The soil quality is improved by the beneficial actions of microbes. The good fertile quality of soil is inferred from the plant growth. The fertility of soil decides the growth of any plant. The increased yield of EM treated plants shows that the soil is improved by the beneficial actions of microbes. The shoot, pod and nodule are well grown in EM treated plants. Hence, we suggest that the application of Effective micro-organism may provide higher yield in the black gram.

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