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# Study on Effectiveness of Various Biofertilizers on the Growth & Biomass Production of Selected Vegetables

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**Abstract:** The present study was carried out to investigate the effect of different biofertilizers on the growth and biomass production of Amaranthus and Harden pea. The biofertilizers were applied individually as well as in combination. There were altogether eight treatments including two sets of control; one without biofertilizers application and other with chemical fertilizer. It was found that combined applications of all biofertilizers were superior and enhanced the growth much better than when they are applied individually. The study clearly shows that a combined application of biofertilizers and biomanures is an essential requirement for the growth and biomass production of leafy vegetables like Amaranthus and Garden pea.

**Key words:** Green vegetables, Biofertilizers&Biomanures, Plot&Pot Experiment, Morphological parameters

## INTRODUCTION

Green vegetables are a major source of iron and calcium for any diet. Green vegetables are rich in beta-carotene, which can also be converted into vitamin A, and also improve immune function. Millions of children around the world have an increased risk of blindness, and other illnesses because of inadequate dietary vitamin A from green vegetables. They are useful in reducing the risk of cancer and heart disease since they are low in fat, high in dietary fiber, and rich in folic acid, vitamin C, potassium and magnesium, as well as containing a host of phytochemicals, such as *lutein*, *beta-cryptoxanthin*, *zeaxanthin*, and *beta-carotene*. Growth improvement and quality improvement of green vegetables is very necessary because it is used for the treatment of many diseases. To avoid the residual toxicity of chemical ferilizers, it is always advisable to raise these vegetables through organic cultivation practices.

Microorganism that are used as biofertilizers stimulate plant growth by providing necessary nutrients as a result of their colonisation at their rhizosphere (*Azotobacter*, *Azospirillum*, *Pseudomonas*, *Phosphate solubilising bacteria and Cyanobacteria*) or by symbiotic association *(Rhizobium*, *Mycorrhizae or Frankia*)[12]. Sustainable agriculture relies greatly on renewable resources like biologically fixed nitrogen.Next to nitrogen 'P' is important nutrient required by plants for its growth. It was estimated that 98% of Indian soil contain insufficient amounts of available phosphate to support maximum plant growth[3]. Application of phosphate fertilizer is therefore essential for optimum crop yield.

## MATERIALS AND METHODS

**Selected Vegetables:** Two vegetables namely one leafy vegetable Amaranthus (*Amaranthus retroflexus*), and another one Garden pea (*Pisum sativum*) was selected for the present study.

**Isolation of Microorganism:** *Azospirillum sp* and *Pseudomonas* sp were isolated from rhizosphere soil of selected vegetables of this study using Nitrogen Free Bromothymolblue medium (NFB) and King's medium respectively.

**Plot Experiment with Amaranthus:** The treatment as mentioned in Table 1 was given to the eight plots.

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**Table 1:** Biofertilizer treatment for Amaranthus

| Treatment Number | Biomanures used | Dilution |
|---|---|---|
| 1 | Control | No manure |
| 2 | Biogas slurry | 1 kg biogas slurry + 5 litre water (1:5 dilution) |
| 3 | Vermicompost | 1 kg Vermicompost + 5 litre water (1:5 dilution) |
| 4 | Chemical (18:18:18) | 100 g chemical + 5 litre water (0.1:5 dilution) |
| 5 | EM | 100 ml EM + 5 litre water (0.1:5 dilution) |
| 6 | *Azospirillum* | 100 ml *Azospirillum* + 5 litre water (0.1:5 dilution) |
| 7 | *Pseudomonas* | 100 g *Pseudomonas* + 5 litre water (0.1:5 dilution) |
| 8 | Combination of biofertilizers | 100 g biogas slurry + 100 g vermicompost + 10 g *Pseudomonas* + 10 ml *Azospirillum* + 10 ml EM in 5 litre water |

Observations were recorded after 15 days, 30 days and 45 days of first application. Data such as plant height, number of leaves, plant biomass, and root length were taken and tabulated. Five plants data were taken per treatment and the average is calculated. The first plot containing only soil was kept as control

**Pot Culture Experiment with Garden Pea:** A second set experimental design were done in pots with Garden pea. Here eight earthen pots of medium size were taken and filled with garden soil and sand (1:1) proportion. Duplicate pots were also maintained as a replication trial. All pots were sowed with 5 seeds of Garden pea and irrigated daily with1.5 litre of water twice a day. After 15 days of seed germination the treatments mentioned in Table 2 were applied to each pot. Data such as plant height, number of leaves, plant biomass, and root length were taken and tabulated.

## RESULT AND DISSCUSSION

After incubating the conical flasks for two days at $28^0$ to $30^0$C, pellicles of *Azospirillum* were seen 1-2 mm below the upper surface of the medium. After incubating the plates for two days at $28^0$C the colonies of *Pseudomonas sp* were found to be in green fluorescent shiny appearance Further biochemical tests were conducted for *Pseudomonas* and their results are as follows:

| Gram staining | Gram negative, rod shaped |
|---|---|
| Colony morphology | Small, rough colonies with green fluorescent shiny apperance. |
| Biochemical characteristics | Indole – negative<br>Methyl red – negative<br>Voges Proskauer – negative<br>Citrate – positive<br>Catalase test – positive<br>Oxidase test – positive<br>The absence of gas formation from glucose, glucose is oxidized in fermentation test. |

Among the eight treatments tried for Amaranthus shoot length, number of leaves, plant biomass and root length were maximum in Treatment 8 (Table 1) with dual inoculation of the two microbial biofertilizers, *Azospirillum* and *Pseudomonas* along with EM and organic manures, biogas slurry and vermicompost. The combination of all the microbial biofertilizers along with the biomanures gave the maximum growth (Graph 3). Similar results were recorded by Bagyaraj *et al*.[8,13,7]. The overall visual characters such as vigor, color of leaves and skin were also noticed and it was also best under Treatment 8 .The least plant growth was noticed in Treatment 1 and 4 with only soil and chemical application respectively (Table 3and 4). Next to combination it was the biofertilizer, *Azospirillum* that gave the increased growth (Graph 3). Similar results were obtained in a field experiment that revealed that *Azospirillum* inoculation increased the cane yield up to 4.47 tonnes/hectar and saved 25% nitrogen dose in medium black soil and Adsali planting[10]. In another study Kapulnik *et al*.,[9] reported increase in root and shoot weight of Sorghum with the inoculation of *Azospirillum*.. Sarig and Kapulnik[9] noticed more dry matter produced with *Azospirillum* inoculation as compared to control.

*Pseudomonas* application gave less growth than *Azospirillum* (Graph 1&2). Therefore it can be concluded that *Azospirillum* can be favoured over *Pseudomonas* as biofertilizer. However, Ahmed and Jha[1] and Mohammed *et al*.,[6] reported increased phosphorous uptake by wheat and gram with the inoculation of phosphobacteria. Chemical which was used for comparison did not have much effect and the shoot length, number of leaves, plant biomass and root length were much lower compared to the application of biofertilizers in combination and also individually . Moreover in organic farming the use of chemical fertilizers are totally rejected.

**Table 2:** Biofertilizer treatment for Garden pea

| Treatment Number | Biomanures used | Dilution |
|---|---|---|
| 1 | Control | No manure |
| 2 | Biogas slurry | 100 g biogas slurry + 500 ml water |
| 3 | Vermicompost | 100 g vermicompost + 500 ml water |
| 4 | Chemical (18:18:18) | 10 g chemical + 500 ml water |
| 5 | EM | 10 ml EM + 500 ml water |
| 6 | *Azospirillum* | 10 ml *Azospirillum* + 500 ml water |
| 7 | *Pseudomonas* | 10 g *Pseudomonas* + 500 ml water |
| 8 | Combination of biofertilizers | 10 g biogas slurry + 10 g vermicompost + 1 g *Pseudomonas* + 1 ml *Azospirillum* + 1 ml EM in 500 ml water |

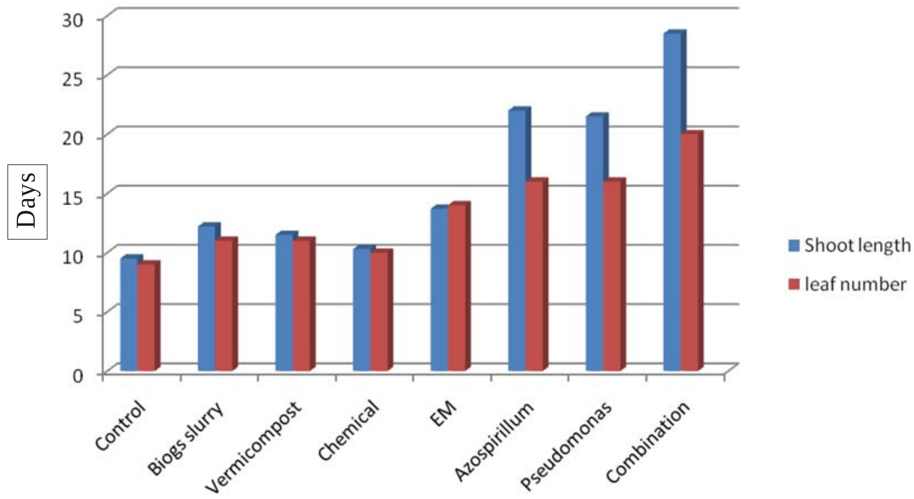
**Table 3:** Field trial experiment on application of various biofertilizers on vegetative growth of Amaranthus 15 and 30 days

| Treatment number | 15 days interval | | 30 days interval | |
|---|---|---|---|---|
| | Shoot length(cm) | No. of leaves | Shoot length(cm) | No. of leaves |
| 1.Control(no fertilizer) | 9.5 | 9 | 23 | 14 |
| 2.Biogas slurry | 12.2 | 11 | 49.3 | 28 |
| 3.vermicompost | 11.5 | 11 | 43 | 25 |
| 4.chemical(18:18:18) | 10.3 | 10 | 33 | 19 |
| 5.EM | 13.7 | 14 | 50 | 51 |
| 6.*Azospirillum* | 22 | 16 | 59.3 | 57 |
| 7.*Pseudomonas* | 21.5 | 16 | 55.5 | 54 |
| 8.Combination | 28.5 | 20 | 60.5 | 65 |

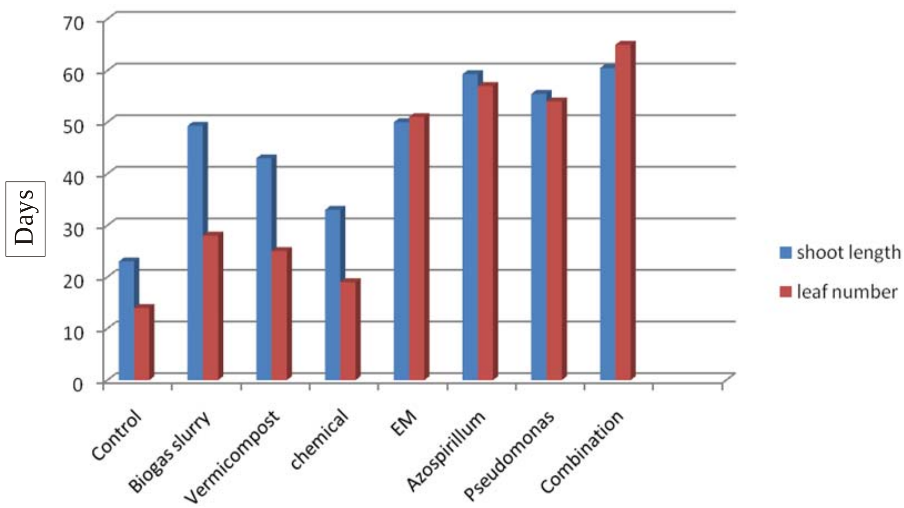
**Table 4:** Field trial experiment on application of various biofertilizers on vegetative growth of Amaranthus on 45 days

| Treatment number | 45 days interval | | | |
|---|---|---|---|---|
| | Shoot length(cm) | No. of leaves | Plant biomass(g) | Root length(cm) |
| 1.Control(no fertilizer) | 32.3 | 25 | 19.7 | 6.5 |
| 2.Biogas slurry | 58.2 | 40 | 80 | 22.6 |
| 3.vermicompost | 55.4 | 36 | 43 | 21.6 |
| 4.chemical(18:18:18) | 44.7 | 30 | 33 | 13 |
| 5.EM | 62 | 56 | 50 | 24.3 |
| 6.*Azospirillum* | 71.5 | 64 | 59.3 | 27.9 |
| 7.*Pseudomonas* | 68.9 | 60 | 55.5 | 25.3 |
| 8.Combination | 85 | 80 | 60.5 | 35 |

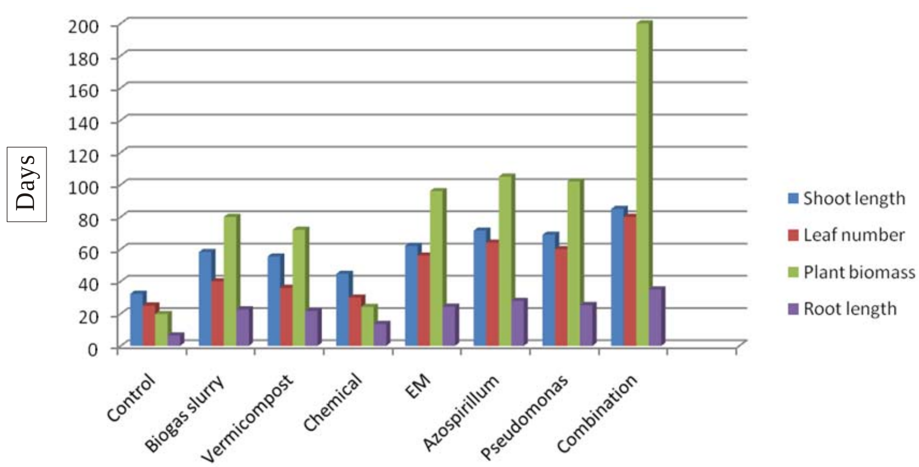
In the pot culture trial with the treatments using Garden pea a similar trend of observation noticed for Amaranthus were obtained (Table 4 and 6). However, there is a slight difference with respect to the Treatment 3 and 2 for vermicompost and biogas slurry application respectively. Dual inoculation favouring the biomass production and yield aspects on various crop with nutritive mobility was also documented earlier [2,4,5,11]. Vermicompost application favoured increased plant growth that is shoot height, number of leaves, plant biomass and root length for Garden pea (Graph 6) where as it was biogas slurry for Amaranthus (Graph 3).



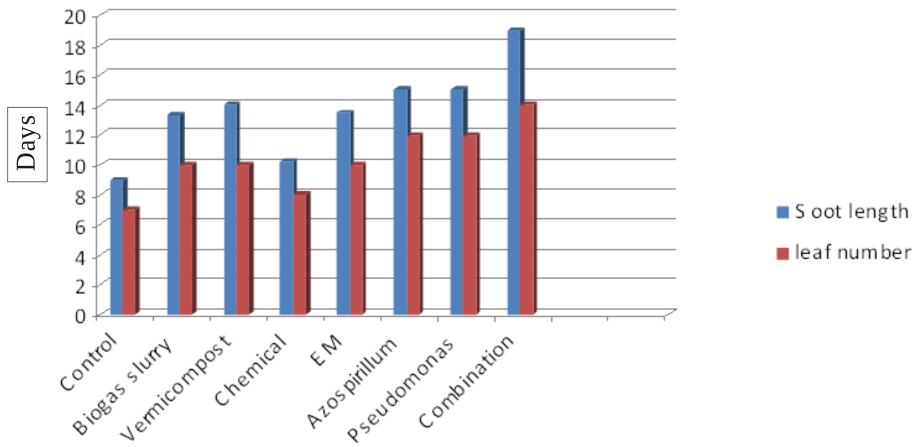

**Graph 1:** Growth of Amaranthus after 15 days interval



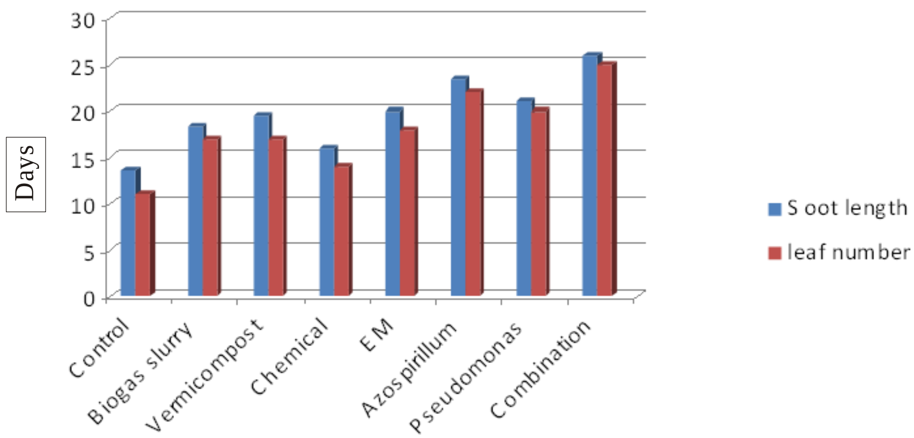

**Graph 2:** Growth of Amaranthus after 30 days interval



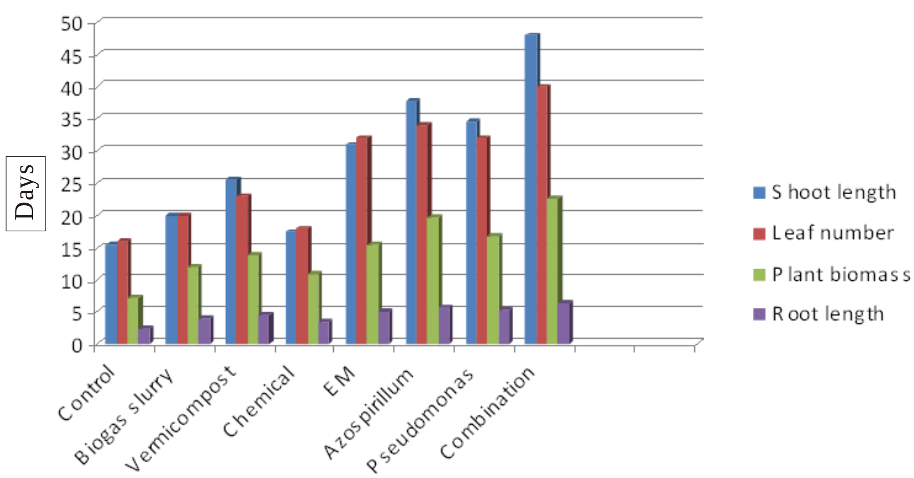

**Graph 3:** Growth of Amaranthus after 45 days interval




**Graph 4:** Growth of Garden pea after 15 days interval




**Graph 5:** Growth of Garden pea after 30 days interval




**Graph 6:** Growth of Garden pea after 45 days interval

**Table 5:** Effect of biofertilizer application on vegetative growth of Garden pea on 15 and 30 days

| Treatment number | 15 days interval | | 30 days interval | |
|---|---|---|---|---|
| | Shoot height(cm) | No. of leaves | Shoot height(cm) | No. of leaves |
| 1.Control(no fertilizer) | 9.0 | 7 | 13.6 | 11 |
| 2.Biogas slurry | 13.3 | 10 | 18.3 | 17 |
| 3.vermicompost | 14.0 | 10 | 19.5 | 17 |
| 4.chemical(18:18:18) | 10.2 | 8 | 16 | 14 |
| 5.EM | 13.5 | 10 | 20 | 18 |
| 6.*Azospirillum* | 15 | 12 | 23.5 | 22 |
| 7.*Pseudomonas* | 15 | 12 | 21.0 | 20 |
| 8.Combination | 19 | 14 | 26.0 | 25 |

**Table 6:** Effect of biofertilizer application on vegetative growth of Garden pea on 45 days

| Treatment number | 45 days interval | | | |
|---|---|---|---|---|
| | Shoot height(cm) | No. of leaves | Plant biomass(g) | Root length(cm) |
| 1.Control(no fertilizer) | 15.5 | 16 | 7.2 | 2.5 |
| 2.Biogas slurry | 20 | 20 | 12 | 4 |
| 3.vermicompost | 25.5 | 23 | 13.8 | 4.5 |
| 4.chemical(18:18:18) | 17.4 | 18 | 11 | 3.5 |
| 5.EM | 31 | 32 | 15.4 | 5 |
| 6.*Azospirillum* | 37.8 | 34 | 19.7 | 5.7 |
| 7.*Pseudomonas* | 34.5 | 32 | 16.8 | 5.3 |
| 8.Combination | 48 | 40 | 22.6 | 6.4 |

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