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Co-inoculation effect of vermicompost and plant growth promoting rhizobacteria (*Azotobacter* Sp.) on the growth of chilli (*Capsicum annuum* L.)

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Abstract
The present investigation was aimed to determine the "Co-inoculation effect of Vermicompost & Plant Growth Promoting Rhizobacteria on the growth of chilli (*Capsicum annuum*)" by pot experiment method, which was carried out in green house of School of Forestry. The growth parameters selected for study were Plant height, Root length (cm), Number of leaves/plant, Number of branches/plant, Number of fruits/plant and Weight of fruit (g). Vermicompost were produced by Earthworms species, (*Lumbricus rubellus*) on vegetable waste. The experiment was conducted in Completely Randomized Design (CRD) with 6 replications. The treatment comprised of T_0: (Normal seed without any amendment), T_1: Vermicompost (1kg), T_2: 100% Recommended dose of NPK, T_3: PGPR (*Azotobacter* sp.) treated seed, T_4: Vermicompost (1kg) + PGPR (*Azotobacter* sp.) treated seed, T_5: Vermicompost (1kg)+ 50% Recommended dose of NPK +PGPR (*Azotobacter* sp.) treated seed. The treatment T_5 Vermicompost (1kg) + 50% Recommended dose of NPK +PGPR (*Azotobacter* sp.) treated seed. showed significantly the best result in plant height (151 cm), number of leaves/plant(330), number of branches/plant(82.40), number of fruits/plant (8.33), weight of fruits/plant (g) (2.75 gm), root length (cm)(17.50cm) followed by T4 Vermicompost(1kg)+ PGPR (*Azotobacter* sp.) treated seed, when compared with other treatments. *Azotobacter* sp. was shown to be a plant growth promoting agent for (*Capsicum annuum*). Hence, major research focus should be on the production of efficient and sustainable bio-fertilizers for crop plants, where inorganic fertilizer application can be reduced significantly to improve soil health.

Keywords: NPK, vermicompost, biofertilizer, PGPR, *Azotobacter* sp.

Introduction
Chilli (*Capsicum annuum* L.) is one of the important vegetable-cum-spices crop of India. It has different types of protein, vitamin, and ascorbic acid contents, and is good source of medicinal potential. This crop is very important for agricultural economy and is used in processing industries. It is rich in ascorbic acid and known for its pungency. According to the Food and Agriculture Organization (FAO) of the United Nations (FAO, 2003) [14], Vermicompost which contains microsite rich in available carbon and nitrogen (Sudhakar *et al.*, 2002) [33]. Worm cast incorporated soils are also rich in water soluble (Gratt, 1970) [16] and contain two to three times more available nutrients than surrounding soils (Sudhakar *et al*., 2002) [33] Evidence of the beneficial effects of PGPR has been accumulating for the past 150 years (Berg, 2009) [5]. Plant growth promoting rhizobacteria (PGPR) have been demonstrated to increase growth and productivity of many commercial crops including rice (Ashrafuzzaman *et al*., 2009) [3], wheat (Khalid *et al.*, 2004) [14], cucumber (Maleki *et al*., 2010) [23], maize (Sandhya *et al*., 2010) [32], cotton (Anjum *et al.*, 2007) [7] There is also evidence that humic acids extracted from vermicompost stimulated increase in the number of roots, giving the plant ability to scavenge nutrient from the growing environment for growth and development. (Densilin *et al.*, 2010) [10]
Nitrogen fixation is mainly responsible for improvement of crop yield. In this regard *Azotobacter* promotes plant growth as well as nitrogen fixation. Besides N_2 fixation they also produce Siderophores and antifungal substances and plant growth regulates such as hormones and vitamins.

Materials and Methods
Procurement and Identification of Earthworm Earthworms was identified by the given characteristics: Earthworm (*Lumbricus rubellus*) come under family Lumbricidae. It is a slightly medium sized (10 -15cm) partially their reddish-brown color.

The skin is semi – transparent flexible segmented into circular sections (Hendrix and Bohlen, 2002; Wironen and Moore, 2006) [34].

Preparation of the vermicompost

Plant waste part and weeds were collected. 5 kg of the waste was mixed with 500 ml of cow dung slurry and was kept for initial degradation in the drum (3feet in height), for the Vermicompost preparation. The drum was covered with gunny bag and water was sprinkled every day. The stirring of the drum was carried out every day to remove methane and the other gases from the drum. The initial degradation was carried out for 4 days. On fifth day, fifty earthworms (*Lumbricus rubellus*) were added in the drum along with one kilogram of fresh kitchen waste. Every day water was sprinkled on the drum. The completed decomposed biomass was screened to separate earthworms and Vermicompost and finally the prepared Vermicompost was further used for analysis and efficacy study.

Procurement of PGPR bacterial culture

Bacterial Culture *Azotobacter* sp. (MCCB 461) was procured from Microbial Culture Collection Bank, Department of Industrial Microbiology, Jacob Institute of Biotechnology and Bioengineering, Sam Higginbottom University of Agriculture, Technology and Sciences Allahabad (UP) and maintained in Nutrient agar slant and routinely subculture at an interval of 15 days and stored at 4 ^{O}C for further use.

Preparation of bio fertilizer (PGPR)

The inoculum was prepared by inoculating selected rhizobacterial strain in 250 ml flasks containing DF minimal salt medium (Dworkin and Foster, 1998) [13] the medium was incubated at 28±1 °C for 48 h in an orbital shaking incubator at 100 rpm. Plating of the bio formulation was done on Nutrient Agar and plates were incubated at 37 ^{O}C for 24 h. The bacterial suspension gave final concentration of 10^6 colony forming units (CFU/ml=152* 10^6). Peats (from local market of Alopibhag) was ground and autoclaved at 121 °C for 20 minutes. A 100ml inoculum of the selected rhizobacteria was mixed with 100 g of peat before using for seed coating.

Preparation of the soil

1% formalin /kg soil was used for sterilizing the collected soil and left covered with gunny bag for two days. After successful sterilization, soil was transferred into 36 earthen pots and was labelled as per treatment and replicate numbers. Soil was air and sun dried.

Seed disinfection and inoculation

For surface sterilization seeds was momentary dipped in ethanol (95%) (Oyebanji *et al.* 2009) [26] and then in solution of $HgCl_2$ (0.2%) for 5 min and washed with distilled water. Then cell suspension of bacterial strain was mixed with seed dipped prepared in the ratio of 10:50. The seeds were dipped in suspension and kept immersed for about 12 hours. The seed were taken out from the suspension and dried on air. (Dhanasekar and Dhandapani, 2012) [12].

POT experiment

Chilli seeds of a local cultivar, popularly known as 'Suryamukhi', were separately sown in a seed bed and regularly maintained. After 15 days of sowing, seedlings were carefully uprooted. Pots (14-inch diameter) were prepared with fine soil and sand. The seedlings were subsequently transferred into pots and allowed to grow for 30 days. The plant-height (cm), number of fruits per plant, fruit weight (g), number of leaves/plants, number of branches/plants, root length(cm). were selected for further study in field based on their performance in the pot experiment.

Experimental detail

Plan of work

Number of replications:6
Number of treatments:6
Total no. ofpots:36
Seed rate: 1-2 seed /pots
Selected crop: Chilli
Variety: Suryamukhi
Azotobacter culture broth:10 ml/50 seed
Recommended dose of NPK for chilli:100: 50: 50 kg /ha

Treatments detail

The treatment details along with the control were as follows.

Table 1: Treatment detail

Treatments	Particulars		
T_0	Soil (2.5 kg)	Normal Seed (6 Seed)	Normal Seed (6 Seed)
T_1	Soil (2.5 kg)	Vermicompost (1kg)	Normal Seed (6 Seed)
T_2	Soil (2.5 kg)	100% Recommended dose of NPK	Normal Seed (6 Seed)
T_3	Soil (2.5 kg)	PGPR (*Azotobacter* sp.) treated seed	PGPR Treated Seed (6 Seed)
T_4	Soil (2.5 kg)	Vermicompost (1kg), PGPR (*Azotobacter* sp.) treated seed	PGPR Treated Seed (6 Seed)
T_5	Soil (2.5 kg)	Vermicompost (1kg), 50% RD of NPK, PGPR (*Azotobacter* sp.) treated seed	PGPR Treated Seed (6 Seed)

The fertilizer dose prescribe for chilli crop is N.P.K, 100:50:50kg / ha. (Sajan *et al.*, 2002) RDF = Recommended Dose of Fertilizer

Growth measurement of plants: 15 DAT, 30 DAT, 45 DAT, 60 DAT, 75 DAT, 90 DAT (DAT-Days after transplanting).

1. Plant Height (cm)
2. Root Length (cm)
3. Number of branches and leaves/plan
4. Number of fruits in Plant/plant
5. Weight of fruit (g)

Results and Discussion

Preparation of vermicompost

For decomposition and preparation of vermicompost it took 3 months. After 3 months, kitchen waste, cow dung slurry and weeds are converted into a rotten black material, which gave a earthy smell. The prepared Vermicompost was then further used for evaluating effect on Chilli plant alone and in combination with PGPR.

Fig 1: Earthworm (*Lumbricus rubellus*)

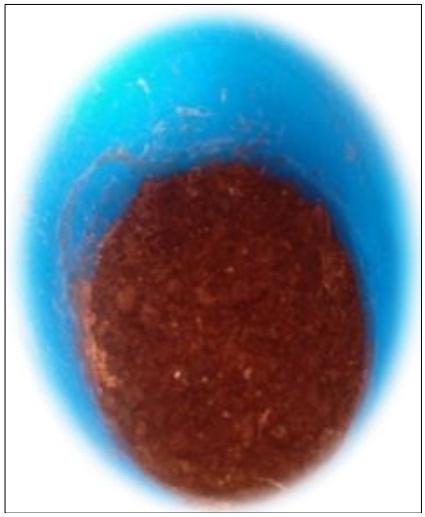

Fig 2: Prepared vermicompost

Effect of various treatments of vermicompost and PGPR on average plant height of chilli

Plant height was recorded at 6 different intervals of 15DAT, 30DAT, 45DAT, 60DAT, 75DAT and 90DAT highest plant height (151cm) was recorded with combined treatment of Vermicompost (1kg) + (50%) Recommended dose of NPK + PGPR (*Azotobacter* sp.). This was followed by biofertilizer enriched Vermicompost T_4 (147.6 cm). Results for single inoculation with *Azotobacter* sp. (T_3) showed better results as compared to treatment with inorganic fertilizer (T_2) and vermicompost gave the least growth in terms of plant height. The results when analyzed statistically gave significant results for effect of combined treatment T_5 on plant height.

In agreement with the present investigation use of PGPR like *Azotobacter* has been shown to significantly increase the plant height (Sajan *et al*., 2002; Khan and Pariari, 2012 [20]; Ramakrishnan and Selve Kumar, 2012). Further, use of organic fertilizer like FYM (Khan and Pariari, 2012) [20] and vermicompost (Rao *et al.*, 2010) has shown significant impact on growth and yield of plant like *Allium* crop, with overall increase in plant height and yield of crop irrespective of treatments and duration. Also in a study conducted by Manivannan *et al*. (2009) [24] it was shown that increased growth and yield of beans results on application of vermicompost which indirectly influences the physical conditions of soil. Similar finding in term of plant height have been reported by Paramaguru and Natarajan (1993) [27], Amirthalingam (1988) [1], Dekha *et al*. (1996) [9], Chandrappa *et al.* (2007) [8] in chilli crop using FYM, NPK, and PGPR strains of *Azotobacter* and *Azospirillium. S*ynergistic relation between the nutrients of the Vermicompost and NPK available from chemical fertilizers which might have boosted the mobility of mineral nutrients for better production of the crop plant

Table 2: Effect of vermicompost and PGPR on plant height (cm)

Treatment		Plant height (cm)					
		15 DAT	30 DAT	45 DAT	60 DAT	75 DAT	90 DAT
T0	Normal Seed (6 Seed)	63.12	64.60	68.10	75.50	60.50	97.60
T1	Vermicompost (1kg)	81.16	83.80	89.40	92.60	102.70	113.00
T2	100% RD of NPK	84.26	86.80	93.90	104.00	116.40	128.00
T3	PGPR (*Azotobacter* sp.) treated seed	86.50	94.00	106.60	112.26	125.50	136.40
T4	Vermicompost (1kg) + PGPR (*Azotobacter* sp.) treated seed	103.74	113.60	119.00	130.80	137.00	147.60
T5	Vermicompost (1 kg) + 50%RD of NPK+ PGPR (*Azotobacter* sp.) treated seed	112.30	119.00	124.40	132.00	139.60	151.00

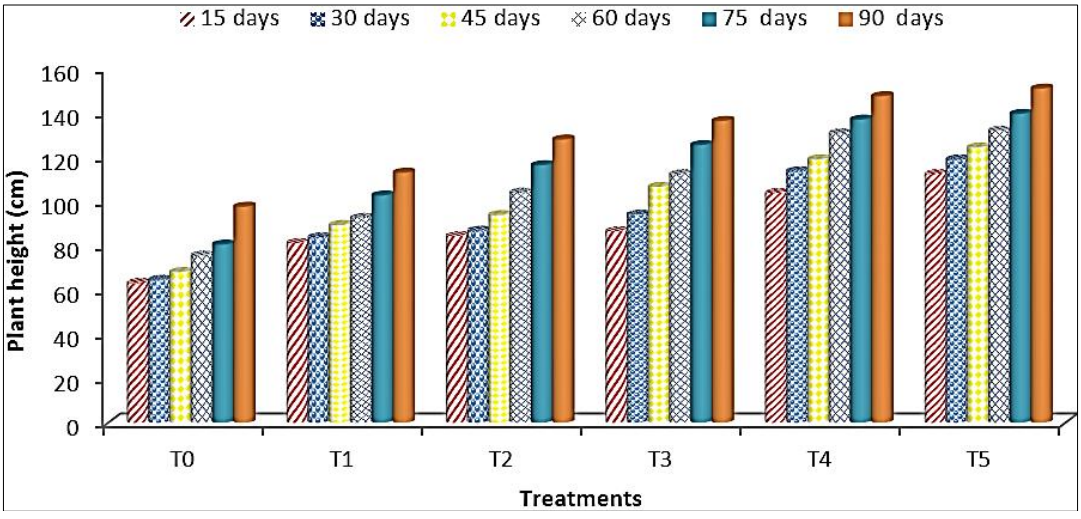

Fig 3: Effect of vermicompost and PGPR on plant height (cm)

Fig 4: Effect of vermicompost and PGPR on plant height (cm)

Effect of various treatments of vermicompost and PGPR on average number of leaves of chilli

On analyzing effect of different treatment of vermicompost and PGPR on number of leaves of *Capsicum annuum* L. It was observed that Highest number of leaves (330) was recorded in treatment T_5 (Vermicompost + 50% Recommended dose of NPK + PGPR *Azotobacter* sp.). Followed by T_4 (Vermicompost + PGPR *Azotobacter* sp.) i.e. (307) as compared to T_0 (Control.) i.e. (187). Single inoculation with T_3 (PGPR *Azotobacter* sp.) performed better than T_1 (Vermicompost 1kg) and Inorganic fertilizer (T_2) in terms of number of leaves.). The results when analyzed statistically gave significant results.

Activities of the vermicompost and plant growth promoting bacteria are comparable to the findings by Dhanalakshmi *et al.* (2014) [11] who demonstrated maximum number of leaves in okra and chilli treated with Vermicompost. Pathak *et al.* (2013) [28] also demonstrated the increased number of leaves in guava while incorporating phosphate solubilizing bacteria with vermicompost. Similarly, Densilin *et al.* (2010) [10] reported with individual and combined treatment of chilli with vermicompost, *Azospirillum* and Phosphobacteria to give highest number of leaves. Gopinath and Prakash (2014) [15] have also recorded vermicompost with microbial fertilizers to significantly influence the number of leaves of plants. The influence of combined effect of various ingredients of vermicompost such as macro and micro nutrients and plant growth hormones alongwith superior chlorophyll content of leaves are responsible for the improvement in number of leaves in chilli.

Table 3: Effect of Vermicompost and PGPR on Number of Leaves/Plant

Treatment		Number of Leaves/Plant					
		15 DAT	30 DAT	45 DAT	60 DAT	75 DAT	90 DAT
T0	Normal Seed (6 Seed)	102.36	117.60	140.00	180.00	182.00	187.00
T1	Vermicompost (1kg)	102.60	118.00	148.00	195.00	211.00	237.00
T2	100% RD of NPK	120.60	131.00	157.00	206.00	237.00	270.00
T3	PGPR (*Azotobacter* sp.) treated seed	141.00	156.00	177.00	224.00	245.00	277.00
T4	Vermicompost (1 kg) + PGPR (*Azotobacter* sp.) treated seed	146.00	165.00	190.00	243.00	286.00	307.00
T5	Vermicompost (1 kg) + 50% RDF of NPK+ PGPR (*Azotobacter* sp.) treated seed	180.20	214.00	246.00	272.00	300.00	330.00

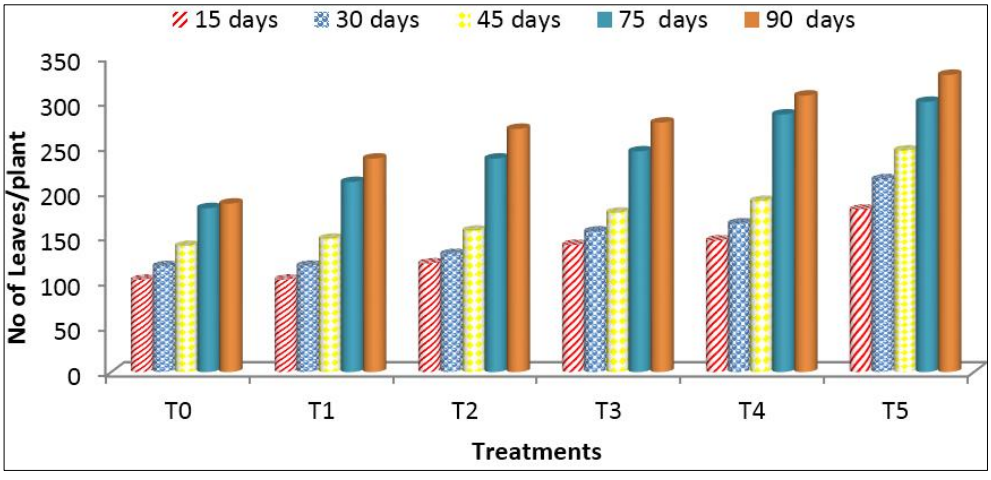

Fig 3: Effect of Vermicompost and PGPR on number of leaves/plants

Fig 4: Effect of vermicompost and PGPR on number of leaves/plants

Effect of various treatments of vermicompost and PGPR on average number of branches of chilli.

Effect of treatment with vermicompost and PGPR and NPK alone and in combination on *Capsicum annuum* L. showed maximum average number of branches (82.40) in treatment T_5 (Vermicompost (1kg) + 50% Recommended dose of NPK+ PGPR *Azotobacter* sp.) followed by T_4 (Vermicompost (1kg) + PGPR *Azotobacter* sp.) i.e. (80.40) which in turn was better than T_0 (control.) i.e. (65.60). Treatment (T_1) containing only vermicompost gave the lowest result when compared with other treatments. T_3 (PGPR *Azotobacter* sp. 10ml) performed better than T_1 (vermicompost 1kg) in terms of number of branches. The results when analyzed statistically gave significant results.

Dhanalakshmi *et al*. (2014) [11] showed maximum number of branches in brinjal and tomato using vermicompost. Also okra and chilli recorded higher number of branches using vermicompost when compared to control. Vermicompost enhances soil fertility and nutrient uptake leading to better plant growth. Co-inoculation of vermicompost with biofertilizer was shown to increase plant growth in term of maximum number of branches in *Rumex* and *Capsicum annuum* (Khan and Pariari, 2012; Biswas, 2014) [7]. Biofertilizer combined with organic compost has the potential to increase productivity wide range of crops.

Table 4: Effect of Vermicompost and PGPR on Number of branches/plants

Treatment		Number of branches/plants					
		15 DAT	30 DAT	45 DAT	60 DAT	75 DAT	90 DAT
T0	Normal Seed (6 Seed)	5.80	10.80	34.00	52.20	59.60	65.60
T1	Vermicompost (1kg)	12.40	16.80	22.80	49.00	55.40	66.80
T2	100% RD of NPK	13.60	20.00	27.60	53.20	61.60	70.00
T3	PGPR (*Azotobacter* sp.) treated seed	8.60	15.00	23.20	60.60	70.00	78.40
T4	Vermicompost (1kg) + PGPR (*Azotobacter* sp.) treated seed	14.40	19.60	24.20	63.00	73.60	80.40
T5	Vermicompost (1kg) + 50% RD of NPK+ PGPR (*Azotobacter* sp.) treated seed	16.80	25.60	34.00	52.50	67.60	82.40

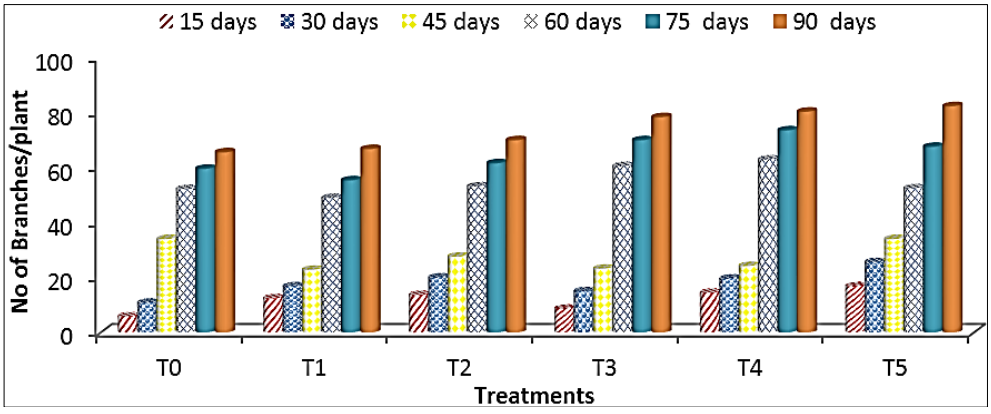

Fig 5: Effect of vermicompost and PGPR on Number of branches/plants

Effect of Various treatments of vermicompost and PGPR on average number of fruits of chilli

The influence of vermicompost and PGPR on Number of fruits/plants showed maximum average number of fruits (8.33) in treatment T_5 (Vermicompost (1kg) + 50% Recommended dose of NPK+ PGPR *Azotobacter sp.*(10ml), followed by T_4 Vermicompost (1kg) + PGPR *Azotobacter* sp. i.e. (6.17). Treatment (T_1) containing only vermicompost gave the lowest result when compared with other treatments. T_3 (PGPR *Azotobacter* sp. 10ml) performed better than T_1 (vermicompost 1kg) in terms of plant height. The results when analyzed statistically gave significant results.

Similar trend was noticed by Kumar *et al*. (2015) who reported significantly higher number of fruits per plant in chilli on application of organic manure. The increased number of fruits is influenced by more numbers of fruits and reduced

shedding of flower and fruits. Khan and Pariari (2012) [20] also demonstrated increased number of fruits/plants on using *Azotobacter* and *Azospirillium*. These bacteria not only provide nitrogen but also synthesize Indol Acitic Acid and Gibbralic Acid that promote plant growth. Also reported significant increase in number of fruits/plants with vermicompost and inorganic fertilizer. Application of binary/multiple mixture of PGPR and organic manure in addition to enhancing soil fertility also may expand the spectrum of biocontrol activity showing remarkable increase in growth characteristics.

Table 5: Effect of vermicompost and PGPR on number of fruits/plants

Treatment		Number of fruits/plants
		90 DAT
T0	Normal Seed (6 Seed)	2.67
T1	Vermicompost (1kg)	2.68
T2	100% RD of NPK	3.17
T3	PGPR (*Azotobacter* sp.) treated seed	4.33
T4	Vermicompost (1kg) + PGPR (*Azotobacter* sp.) treated seed	6.17
T5	Vermicompost (1kg) + 50% RDF of NPK+ PGPR (*Azotobacter* sp.) treated seed	8.33

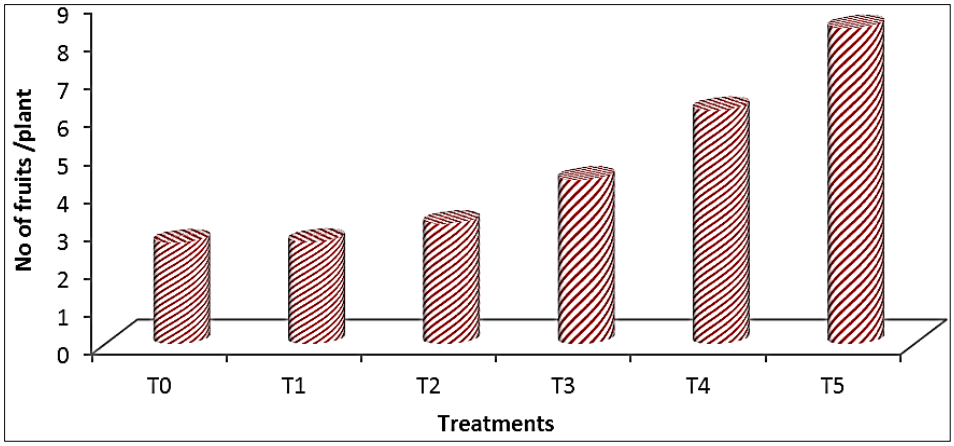

Fig 6: Effect of vermicompost and PGPR on number of fruits/plants

Fig 7: Number of fruits/plants after harvesting

Effect of various treatments of vermicompost and PGPR average fruit weight (g) of chilli

Highest fruit weight (g) (2.75) was recorded in treatment T_5 Vermicompost (1kg) + (50% Recommended dose of NPK+ PGPR *Azotobacter* sp. 10ml) followed by T_4(Vermicompost (1kg) + PGPR *Azotobacter* sp.) i.e. (2.33) which in turn was better than T_0 (control.) i.e. (1.17). Treatment (T_1) containing only vermicompost gave the lowest result when compared with other treatments. T_3 (PGPR *Azotobacter* sp.) performed better than T_1 (vermicompost 1kg) in terms of fruit weight. The results when analyzed statistically gave nonsignificant results.

In agreement to the present study Ramakrishnan and Selva Kumar (2012), Mirzakhani *et al.* (2009) and Berova *et al.* (2010) have reported both biofertilizers and organic fertilizers to enhance fruit weight of Tomato, Safflower and *Capsicum annuum* (Chilli) respectively. Nitrogen is the chief constituent of protein, essential for protoplasm formation which leads to cell enlargement, cell division and therefor yield of fruits in greatly in fluenzed by used of nitrogen fixing bacteria. Accelerated growth of vegetative organs is also accompanied by increased development generative organs, Atiyeh *et al.* (2000); Hashemimajid *et al.*, 2004) and Berova *et al.* (2010) also showed the vermicompost to positively influence yield with a clear tendency for increase in average fruit mass and pericarp thickness.

Table 6: Effect of vermicompost and PGPR on weight of fruit/plant (g).

Treatment		Weight of fruit/plant(g)
		90 DAT
T0	Normal Seed (5 Seed)	1.17
T1	Vermicompost (1kg)	1.42
T2	100% RD of NPK	1.50
T3	PGPR (*Azotobacter* sp.) treated seed	1.92
T4	Vermicompost (1kg) + PGPR (*Azotobacter* sp.) treated seed	2.33
T5	Vermicompost (1kg) + 50% RD of NPK+ PGPR (*Azotobacter* sp.) treated seed	2.75

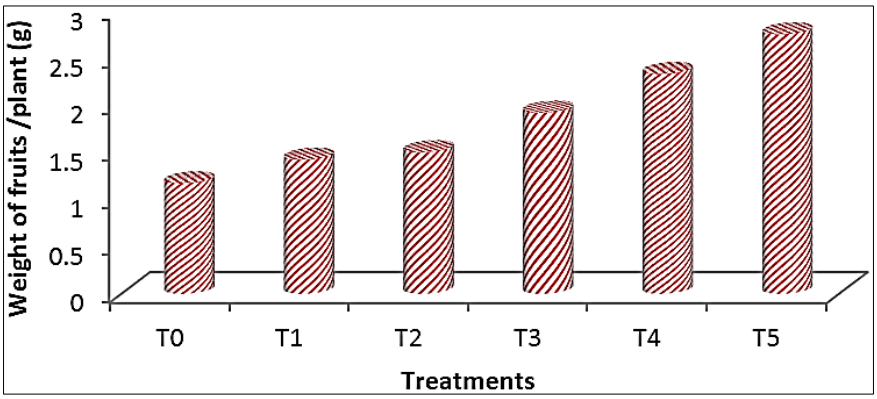

Fig 8: Effect of vermicompost and PGPR on weight of fruit/plant (g).

Effect of various treatments of vermicompost and PGPR on average root length of chilli.

Highest root length (17.50cm) was recorded in treatment T_5 Vermicompost (1kg) + (50% Recommended dose of NPK+ PGPR *Azotobacter* sp. 10ml). Followed by T_4Vermicompost (1kg) + (PGPR *Azotobacter sp*.10ml) i.e. (16.17cm) which in turn was better than T_0 (control.) i.e. (7.33cm). Treatment (T_1) containing only vermicompost gave the lowest result when compared with other treatments. T_3 (PGPR *Azotobacter* sp. 10ml) performed better than T_1(vermicompost 1kg) in terms of Root length. The results when analyzed statistically gave significant results

Similarly, Biswas (2014) [7] demonstrated vermicompost enriched with Bioinoculants to result in increased root length. The biofertilizers in conjunction with organic manure, influence plant by enhancing root biomass, total root surface facilitates higher absorption of nutrients and increase in yield by reducing consumption of natural sources of energy.

Vermicompost plays an important role on improving soil texture, aeration, compaction thereby enhancing water and nutrient uptake by plant from root zone.

Kumar *et al.* (2014) [21] also reported biofertilizer enriched vermicompost to show increased growth attributes in Groundnut by improving nutrient content of roots.

Table 7: Effect of Vermicompost and PGPR on Root length (cm)

Treatment		Root length (cm)
		90DAT
T0	Normal Seed (5 Seed)	7.33
T1	Vermicompost (1kg)	8.67
T2	100% RD of NPK	11.50
T3	PGPR (*Azotobacter* sp.) treated seed	15.50
T4	Vermicompost (1kg) + PGPR (*Azotobacter* sp.) treated seed	16.17
T5	Vermicompost (1kg) + 50% RD of NPK+PGPR (*Azotobacter* sp.) treated seed	17.50

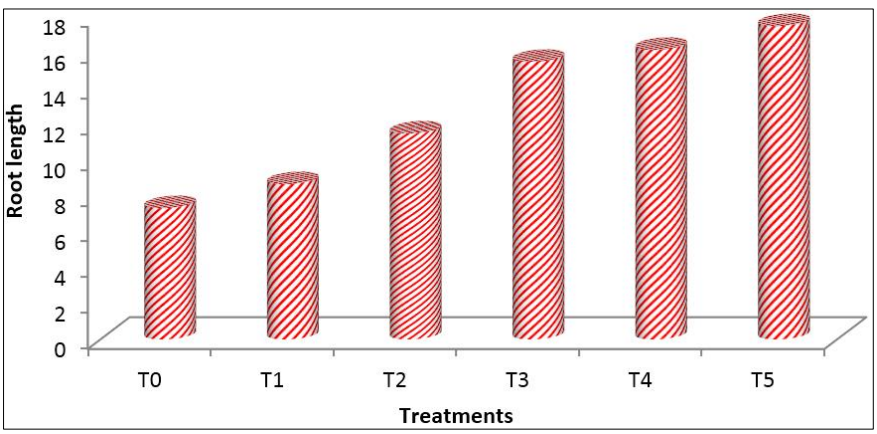

Fig 9 Effect of Vermicompost and PGPR on Root length (cm)

Fig 10: Root length after harvesting

Summary and Conclusion

The present study entitled "Co-inoculation effect of vermicompost and PGPR on the growth of chilli (*Capsicum annuum*) was conducted at PG laboratory, Department of Industrial Microbiology Jacob Institute of Biotechnology and Bioengineering, Sam Higginbottom University of Agriculture, Technology and Sciences, Allahabad-211007 (UP). Pot experiment has conducted to study the effect in growth and yield of different treatments on the chilli plant (*Capsicum annuum*), in Completely Randomized Design (CRD) with 6 replications. The treatment comprised: T_0 (Normal seed without any amendment), T_1Vermicompost (1kg), T_2 100% Recommended dose of NPK, T_3 PGPR (*Azotobacter* sp.) treated seed, T_4 Vermicompost (1kg) PGPR (*Azotobacter* sp.) treated seed, T_5 Vermicompost (1kg) 50% Recommended dose of NPK, PGPR (*Azotobacter* sp.) treated seed. Data on growth and yield parameters including plant height (cm), number of leaves, number of branches, Root length (cm), number of fruit/plant fruit weight/gm, were recorded.

From the study the following observations were made and conclusions drawn

1. Single inoculation with the treatment T_3 consisting of PGPR (*Azotobacter* sp.) treated seed gave highest growth and yield (Plant height (136.40cm), number of leaves (277), number of branches (78.40), number of fruits/plant (4.33), weight of fruits/plant (1.92), root length (15.50cm) as compared to single inoculation with vermicompost and chemical fertilizer.
2. Combined treatment T_5 comprising Vermicompost (1kg), 50% Recommended dose of NPK and PGPR (*Azotobacter* sp.) treated seed demonstrated highest growth and yield of Chilli plant as compared to all the other treatments (Plant height (151cm), number of leaves (330), number of branches (82.40), number of fruits/plant (8.33), weight of fruits/plant (2.75), root length (17.50 cm).
3. Combined treatment T_4 showed the second highest result after T_5 i.e. T_4 plant height (147.60cm), number of leaves (307) number of branches (80.40),number of fruits/plant (6.17), weight of fruits/plant (2.33), root length (16.17cm), which intern was better than control i.e. plant height (97.60cm), number of leaves(187), number of branches (65.60), number of fruits/plant (2.67), weight of fruits/plant (1.17), root length (7.33cm).

Therefore, it was concluded that combined treatment of Chilli Plant with Vermicompost, PGPR (*Azotobacter* sp.) and 50% Fertilizer gave highest growth and yield of Chilli plant. PGPR (*Azotobacter* sp.) showed promising result in growth enhancement of chilli plant as compared to vermicompost and even as compared to recommended dose of fertilizer.

Appropriate combination of biofertilizer, chemical fertilizer, and Vermicompost would be conductive for greater nutrient uptake by the crop and also would improve the soil fertility status. Major research focus should be on the production of efficient and sustainable bio-fertilizers for crop plants, where inorganic fertilizer application can be reduced significantly to improve soil health. The performance of co-inoculation treatment may also be tested in various climatic and soil conditions to determine effect on plant under stress condition. Before recommending the field applicability of the mentioned treatments and the application of the crops the response of chilli plant to combined treatment in varying dose may further need to be validated under field condition.

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