

**Influence of Vermicomposted Corncob and *Rhizobium* on
Seedling Growth, Biometric, Biochemical and
Yield Parameters of Green Gram
(*Vigna radiata* L. Var. Co 9)**

**M. Ramya
(Reg. No. 13PBO005)**

**A Thesis Submitted to
Avinashilingam Institute for Home Science and Higher Education for Women,
Coimbatore – 641 043**

**In Partial Fulfilment of the Requirements for the
Degree of Master of Science in Botany**

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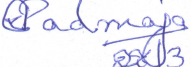
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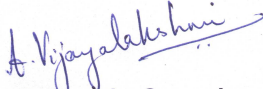
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Signature of the Head of the
Department


Signature of the Supervisor

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already existing in man”.**

- Swami Vivekananda.

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CHAPTER – I

INTRODUCTION

Agriculture is the science, art of producing crops and live stock. Agriculture depends on several resources, namely soil, water, nutrients and energy. Disposal of agro-industrial wastes is a major problem in many industries. Dumping of industrial wastes in the vicinity of industrial areas causes environmental hazards. Continuous use of inorganic fertilizers alone has been found to be harmful to both soil productivity and quality of produce. The application of organic manures and the use of bio-inoculants could minimise these problems, as they possess many advantages over chemical fertilizer. Recycling of industrial wastes is one way of disposal mechanism and another way of resource management.

Organic farming is gaining gradual momentum across the world. Application of organic manures improves the availability of micronutrients. Organic vegetable cultivation gets a special attention due to its bio-efficacy, sustainability and eco-friendly nature (Senthilkumar *et al.*, 2014). Organic system produced significant improvement in quality of soil mainly bulk density, maximum water holding capacity, infiltration rate, organic carbon, available nitrogen, phosphorus and potassium (Babalad *et al.*, 2009). Composting is the biological stabilization and decomposition of organic substrates by a mixed microbial population under thermophilic temperature. The final product of composting is stable for the storage and application to the land without any environmental effects. Proper composting stabilizes organics, destroys pathogens and provides significant drying of the substrates.

The role of earthworms in maintaining soil fertility is known since ancient times. Aristotle called them “The intestine of earth” and considered them as agents to restore soil fertility. Earthworms are organisms that by nature till the soil and also contribute nutrients and organic matter for the benefit of plants, by improving soil health. They play a major role in degrading

organic waste material and thus maintain the nutrient flux in the system (Divya, 2001).

Biofertilizers are carrier – based inoculants containing cells of efficient strains of specific microorganism used by farmers for enhancing the productivity of the soil by fixing atmospheric nitrogen or by solubilising soil phosphate or by stimulating plant growth for synthesis of growth promoting substances (Senthilkumar and Sivagurunathan, 2012). The biofertilizers an alternate low cost plant nutrient resource have gained prime importance in recent decades and they play a vital role in maintaining long-term soil fertility sustenance. At present, biofertilizers have emerged as an important component of Integrated Nutrient Supply System (INSS) which can improve the crop yields and nutrient supplies. Biofertilizer application is cheap, balanced environmentally safer than chemical fertilizers.

Rhizobium is the most well known species of a group of bacteria that acts as the primary symbiotic fixer of nitrogen. These bacteria can infect the roots of leguminous plants, leading to the formation of lumps or nodules where the nitrogen fixation takes place. The bacterium's enzyme system supplies a constant source of reduced nitrogen to the host plant and the plant furnishes nutrients and energy for the activities of the bacterium. The seeds treated with bacterial culture of *Rhizobium* increase nodulation and influence seed yield as well as economize the input cost of fertilizer.

In India, maize is emerging as third most important crop after rice and wheat. Its importance lies in the fact that it is not only used for human food and animal feed but at the same time it is also widely used for corn starch industry, corn oil production, baby corns etc. Corn production has nearly double from around 12.0 million tons in the early 2000s to around 22 million tons today. The increasing use of maize as feed, increasing interest of the consumers in nutritionally enriched products and raising demand for maize seed are the core driving forces behind emerging importance of maize crop in India.

The agro industrial waste corncob decomposes very slowly due to the high lignin (35%) α -cellulose (34.45%), β -cellulose (18.73%) and γ -cellulose (19.84%) content. Cobs are usually burnt after the removal of maize grains. When the cob is burnt, the environment is polluted by smoke, CO₂ and CO. All these undesirable effects on soil, environment, loss of nutrients etc. could be avoided by recycling the agrowaste through composting.

The pulses are the chief sources of protein in a balanced diet in Indian conditions and contribute about 15 per cent of diet (Sitaram Tak *et al.*, 2013). It contains 20 per cent of protein. Pulses are one of the important segments of Indian agriculture after cereals and oilseeds. The split grains of these pulses called dal are excellent source of high quality protein, essential amino acids, fatty acids, fibres, minerals and vitamins (Khan and Prakash, 2013).

Green gram (*Vigna radiata* L.) (Plate – I) commonly known as “moong” is an important short duration pulse crop in India. Green gram is a plant species in the legume family native to the Indian subcontinent. It is herbaceous annual plant, erect, 42-120 cm tall with a slight tendency to twining in its upper branches. Being a leguminous crop, green gram fixed 30-40 kg nitrogen ha⁻¹. After picking pods, it may be used as green manure. Green gram is a rich source of high quality protein. It contains about 2.5 per cent protein, 46-50 per cent starch, 2-4 per cent oil and vitamins. It contains amino acids such as arginine, histidine, lysine, tryptophane, etc. It has high digestability and palatability. In humanfood, its pods are used as green vegetables.

Hence green gram (*Vigna radiata* L. Var. Co 9) is selected for the present study.

PLATE – I
GREEN GRAM (*Vigna radiata* L. Var. Co 9) HABIT



The present study has the following objectives :

1. To examine the effect of vermicomposted corncob on the seedling growth of green gram.
2. To monitor the effect of vermicomposted corncob and *Rhizobium* on the mid vegetative growth and biometrical parameters of green gram.
3. To study the impact of vermicomposted corncob and *Rhizobium* in promoting the yield of green gram.
4. To analyze the efficacy of vermicomposted corncob and *Rhizobium* on chlorophyll, protein, carbohydrate and leghaemoglobin content of the green gram.

CHAPTER – II

REVIEW OF LITERATURE

The given literature pertaining to the influence of organic amendment such as vermicomposted corncob and *Rhizobium* on the growth and yield of green gram are reviewed and presented in this chapter.

Atiyeh *et al.* (2000) reported that combined application of chicken manure compost and (20%) vermicomposted pig wastes when added to green house container media (metro-mix 360) or soil improved plant growth of marigold and tomato seedlings.

Das *et al.* (2002) reported that application of 100 per cent recommended dose of fertilizers to green gram through vermicompost significantly produced taller plants, more leaf area, root volume, nodule number, fresh nodule, weight and dry matter yield as compared to control and 100 per cent recommended dose of fertilizer through farm yard manure.

Kumar *et al.* (2003) reported that application of vermicompost (5 t/ha) promoted the highest grain yield (16.5%) when compared to FYM (5 t/ha) in mungbean.

Gupta and Abraham (2003) reported that the inoculation of *Rhizobium* increase the yield attributes like number of pods/plant (31.15%), total grain weight/plant (33.71%) and use of seeds/pod (2.76%) in soybean.

Application of vermicompost (2.5 t/ha) + (75%) fertilizer significantly enhanced the nodulation in green gram (Rajkumar *et al.*, 2003). According to Arancon *et al.* (2004), peppers grown in potting mixtures containing (40%) food waste vermicomposts and (60%) metro-mix 360 enhanced fruit weight (45%) and number of fruits (17%) than the control.

Tippannavar *et al.* (2004) revealed that inoculation of GR-9 strain of *Rhizobium* enhanced the nodulation (42.51/plant), dry weight of nodules

(121.1 mg/plant), dry weight of plant (4.18 g/plant) compared to other GR strain of *Rhizobium* in bengal gram.

Arshad *et al.* (2004) revealed that the application of compost enriched with nitrogen and L-tryptophan in combination with (50%) additional dose of nitrogen fertilizer increase the growth and yield of hybrid maize. Abira (2005) reported that combined application of vermicomposted fruit waste (75 g) + biofertilizer increased a chlorophyll 'a' (0.2600 mg/g), chlorophyll 'b' (0.4316 mg/g) and 'total' chlorophyll (0.4249 mg/g) in soybean.

Arancon *et al.* (2006) stated that enhanced availability of plant growth influencing substances produced by microorganisms in vermicomposts increased fruit yield in peppers. Ramesh *et al.* (2006) concluded that combined application of vermicompost (3 t/ha), cattle dung (4 t/ha) and poultry manure (2 t/ha) increased the protein content (21.25%) of pigeon pea. According to Alam *et al.* (2007) combined application of vermicompost (10 t/ha) with NPKS fertilizers (50%) increased growth and yield of potato.

Prajapati *et al.* (2008) investigated that the combined inoculation of *Azotobacter chroococum* and *Piriformospora indica* with application of vermicompost increased the shoot length (37.38 cm), root length (17.08 cm), fresh and dry weight of shoot (1.74 g and 0.66 g) in rice.

Natchimuthu and Daniel (2008) reported that application of vermicompost (2.5 t) using (*Perionyx ceylansis* and *P. Longifolia*) + (1/2 dose) NPK increased the total chlorophyll content (1.83 mg/g) in leaf and fruit length (8.46 cm) of hyacinth bean (*Lablab purpureus* L.) sweet.

Singh and Chauhan (2009) reported that application of vermicompost (4 kg/bed) enhanced the growth and yield of french bean. Under the irrigated condition better than the comparative application of farm yard manure (6 kg/bed), chemical fertilizer NPK (0.10 kg/bed) and mixed treatments.

Samantara and Reddy (2009) stated that application of vermicomposted kitchen waste increased the seed germination percentage (90%) in fenugreek. Joshi and Vig (2010a) stated that application of vermicompost (15%) amended with soil enhanced the growth, yield and quality of tomato plants under field conditions. According to Joshi and Vig (2010b) a mixture of soil + vermicompost (15%) promoted the seed germination percentage in tomato.

Lazcano *et al.* (2010) reported that vermicompost (16%) incorporation into the germination media promoted the germinate of maritime pine (*Pinus pinaster* Ait.). Chanda *et al.* (2011) determined that combined application of vermicompost (50%) + (50%) NPK promoted the yield (338.7 q/ha) of tomato.

According to Verma and Decka (2011) combined application of vermicompost (3.75 kg/ha) + NP_2O_5 K_2O fertilizer (8:13:10 kg) promoted the pod length (12.8%) and pod weight (10.9%) in French bean. Dekhane and Chavan (2011) stated that inoculation of cowpea seeds with *Rhizobium* and (100%) recommended dose of fertilizers fertility level enhanced the (1439 kg/ha) growth and (1678 kg/ha) yield of cowpea.

Shadanpour *et al.* (2011) stated that combined application of vermicompost (40%) + sand (30%) + soil (30%) enhanced the highest fresh weight (230.5 g) and dry weight (19.7 g) of marigold.

Sharma *et al.* (2011) stated that groundnut seed inoculated with (6.8%) *Rhizobium* IRC-6 strain enhanced the number of pink coloured nodules and leghaemoglobin content (1.8 mg/g) at 50 days after sowing (DAS)

Narkhede *et al.* (2011) concluded that application of (20%) vermicompost in red chilli enhanced the chlorophyll content (2.9%) compared to the control (2.1%).

Jaime and Viola (2011) revealed that combined application of (30 t/ha) compost with (200 kg/ha) inorganic fertilizer NPK (10 : 30 : 10) increase the yield and quality of baby corn.

Upadhyay *et al.* (2012) revealed that combined application of NPK (40 : 20 : 20 kg/ha) + farm yard manure (5 t/ha) + vermicompost (2 t/ha) sustained the highest fresh yield (240.5 q/ha) and quality of mint (*Mentha arvensis* L.).

Patra and Sinha (2012) reported that application of neem cake (3.0 t/ha) is the best treatment to enhance the yield (847.50 kg/ha) of green gram (*Vigna radiata* L.) compared to farm yard manure (5 t/ha), vermicompost (2.5 t/ha), poultry manure (3.0 t/ha).

Patil *et al.* (2012) stated that the combined application of enriched compost (1/3) + vermicompost (1/3) + *Glyricidia* leaf manure (1/3) equivalent to (100%) recommended dose of nitrogen and foliar spray of panchagavya (3%) enhanced the growth and yield (1972 kg/ha) of chickpea (*Cicer arietinum* L.) invertisols. Hua (2012) concluded that combined application of corn cob (2 : 4) and sheep manure (1 : 2) increase the seedling emergence rate of pea.

Senthilkumar and Sivagurunathan (2012a) investigated that the seed of green gram and cow pea combined inoculated with bacterial biofertilizers like *Rhizobium*, phosphobacteria and *Azospirillum* it increased the growth and yield of cow pea than green gram.

Senthilkumar and Sivagurunathan (2012b) stated that combined inoculation of bacterial fertilizers (*Azospirillum* + *Rhizobium* + Phosphobacteria) increased the chlorophyll (4.04), protein (1.44), carbohydrate (15.74) in cow pea than green gram.

Mathivanan *et al.* (2012) reported that application of (200 g) vermicompost increased chlorophyll 'a' (0.764 mg/g), chlorophyll 'b'

(0.544 mg/g), 'total' chlorophyll (1.313 mg/g) and carotenoid (1.570 mg/g) content in groundnut seedlings.

Neral *et al.* (2012) concluded that application of vermicompost with soil mixture enhanced the chlorophyll content (1.996 mg/g) and yield (42.416 q/ha) of wheat.

Gupta and Ganagwar (2012) reported that combined inoculation of seeds (1.0 g/kg) with *Rhizobium* + phosphate solubilizing bacteria + recommended dose of fertilizer increased the grain yield of chickpea (1253 kg/ha).

Lallowmsanga *et al.* (2012) revealed that combined application of (80%) effluent of painting industry + vermicompost enhanced the chlorophyll 'a' (0.451 mg/g), chlorophyll 'b' (0.293 mg/g) and 'total' chlorophyll content (0.103 mg/g) in *Solanum melongena* L.

Shelke *et al.* (2012) reported that green gram fertilized with (75%) recommended dose of fertilizer conjugated with 8.12 per cent of *Rhizobium* + phosphate solubilizing bacterial (7.69%) promoted the yield (932.03 kg/ha).

According to Lenin *et al.* (2012a) combined application of (5 t/ha) vermicompost + arbuscular mycorrhizal fungi enhanced the shoot length (34.6 cm/plant), root length (30.4 cm/plant) and root nodules (404.6) of groundnut.

Lenin *et al.* (2012b) estimated that combined application of (5 t/ha) vermicompost + arbuscular mycorrhizal fungi enhanced the chlorophyll 'a' (0.986 mg/g fruit weight), chlorophyll 'b' (2.550 mg/g fruit weight) and 'total' chlorophyll content (5.400 mg/g fruit weight) in groundnut.

Befrozfar *et al.* (2013) reported that application of vermicompost (5 t/ha) increased the chlorophyll 'a' (17.17%), chlorophyll 'b' (13.77%) and yield (24.84 %) of basil (*Ocimum basilicum* L.).

Mishra and Jain (2013) revealed that combined application of biofertilizers (250 g + 50% NPK + 5t) vermicompost promoted the chlorophyll (5.9 mg/g) and protein (7.2 mg/g) content in *Andrographis paniculata*.

Makky *et al.* (2013) determined that the production and optimization of L-asparaginase from *Bacillus* sp. KK2S4 by using corn cob waste as a substrate to reduce and managed the waste in environment.

Mahyati *et al.* (2013) revealed that degradation of lignin from corn cob by using white rot fungi (*Phanerd chrysoporum*, *Lentinus edodes* and *Pleurotus octreatus*) showed maximum lignin biodegradation (96.88%). According to Naveen *et al.* (2013) combined application of NPK (78.06 kg/ha nitrogen), (15.28 kg/ha phosphate), (101.67 kg/ha potassium) with *Azospirillum brasilense* + *Bacills megasterrum* + vermicompost promoted the growth and nutrient uptake of rice.

Pariari and Khan (2013) concluded that combined application of (1:1) vermicompost and urea promoted the yield (10.50 q/ha) of coriander than the application of cow dung manure.

Ghosh *et al.* (2013) reported that application of soil proportion (30-40%) with vermicompost (60-70%) enhanced the yield and quality of sweet corn.

Ranjan *et al.* (2013) determined that combined application of vermicompost (1.92 kg/bed) + *Biospirillum* (10 ml/kg of seed) + Biophos (10 ml/kg of seed) + biopotash (10 ml/kg of seed) sustained the yield (18.57 q/ha) and chlorophyll 'a' (3.055 mg/g), chlorophyll 'b' (0.556 mg/g) and 'total' chlorophyll (3.627 mg/g) of baby corn under the north-west Himalayan conditions.

Saritha *et al.* (2013) stated that the treatments containing panchagavya, biofertilizer (*Rhizobium*) and farm yard manure could be an

ideal and suitable potting mixture seedling and crop production in cluster bean (*Cyamopsis tetragonaloba* (L.) Taub.)

According to Tagore *et al.* (2013) stated that combined inoculation of *Rhizobium* + Phosphate solubilizing bacteria (PSB) enhanced the nodule number (27.66/plant), nodule fresh weight (144.90 mg/plant), nodule dry weight (74.30 mg/plant) and leghaemoglobin content (2.29 mg/g) in chick pea.

Pankaj *et al.* (2013a) indicated that combined application of (50%) recommended dosage of fertilizer + (50%) nitrogen through farm yard manure promoted the nutrient uptake and yield of rainfed rice. According to Pankaj *et al.* (2013b) integrated application of nitrogen through farm yard manure (100%) enhanced the protein (10.87%) content in rainfed rice.

Swarnam and Velmurugan (2013) determined that application of poultry manure (3.79 t/ha) and vermicompost (3.73 t/ha) increased the yield of maize better than the gliricidia and coconut husk compost. Khan and Prakash (2013) reported that presowing inoculation of uradbean seeds with *Rhizobium* enhanced the growth and yield attributes (21.3 q/ha) over the uninoculated control (19.31).

Beyravand *et al.* (2013) revealed that application of nitrogen and phosphate biofertilizer increased the yield and yield components of maize under Boroujer environmental condition. Tak *et al.* (2013) reported that combined application of vermicompost (5 t/ha) + foliar spray of zinc increased the total chlorophyll content (1.58 mg/g) of green gram as compared to control (1.42 mg/g).

Ueitele *et al.* (2014) reported that corn cob can be used as a substrate to cultivation of *Ganoderma* in Namibia. Singh *et al.* (2014a) stated that combined application of vermicompost (2.5 t/ha) + FYM (12.5 t/ha) + biofertilizer (2.5 kg/ha *Azospirillum* + 2.5 kg/ha phosphate solubilizing bacteria) enhanced the number of leaves (96.12), number of fruits (17.97), fresh weight of fruits (37.86 g), dry weight of fruit (18.02 g) in chillies.

Singh *et al.* (2014b) determined that combined application of vermicompost (2.5 t/ha) + FYM (12.5 t/ha) + biofertilizer (2.5 kg/ha *Azospirillum* + 2.5 kg/ha phosphate solubilizing bacteria) promoted the chlorophyll 'a' (0.59 mg/g), chlorophyll 'b' (0.9 mg/g) and protein content (0.25 mg/g) of chillies.

Saravanan *et al.* (2014) revealed that vermicomposted wastes like cow dung, leaf litter, flower waste and onion garlic waste enhanced the growth yield of cow pea.

Ananthkrishnasamy and Gunasekaran (2014) concluded that integrated application of (800 g) vermicomposted bedding materials (pressmud and cow dung) + 250 g vermicomposted municipal solid wastes promote the nutrient content, organic carbon, nitrogen (N), phosphorus (P) and potassium (K) of the compost which can be utilized for organic farming.

Gopinathan and Prakash (2014) concluded that application of vermicompost with plant growth promoting rhizobacteria enhanced the yield of green gram.

Pawar *et al.* (2014) revealed that *Rhizobium* can be used as bioinoculant. It enhanced the seed germination in Bengal gram (83%), moth beans (77%), green gram (83%) and peas (99%).

Bade *et al.* (2014) stated that application of (100%) recommended dose of fertilizer and seeds inoculated with *Rhizobium* enhanced the branches/plant (12-3), pods/plant (32-8), seeds/pod (6-9) and plant height (74.0 cm) of green gram.

Kumar *et al.* (2014) determined that combined application of vermicompost (50%) + poultry manure (50%) increased the growth and yield of radish var. Japanese white grown under Lucknow condition.

Kirar *et al.* (2014) investigated that combined application of (75%) NPK + vermicompost + *Azotobactor* + Phosphate solubilizing bacteria enhanced plant height (51.57 cm), number of leaves (1.54-22) of china aster.

Bahadur and Tiwari (2014) concluded that application of sulphur (30 kg/ha) and inoculants of *Rhizobium* + phosphate solubilizing bacteria enhanced the pods/plant (27-8), grains/pods (11-0), grain and storer yield (12.0 and 28.1 q/ha) of mung bean.

Verma *et al.* (2014) reported that the application of vermicompost (4 t/ha) enhanced the leghaemoglobin content in root nodules (1.94 mg/g) of fenugreek as compared to the control (1.07 mg/g).

Senthilkumar *et al.* (2014) stated that the organic fractions of vermicomposted flower waste and microorganism in the biofertilizers could be alternative to chemical fertilizers in improving the growth and yield of groundnut.

Murtaza *et al.* (2014) revealed that *Rhizobium* seed inoculation and phosphorus application (120 k/ha) enhanced the plant height (48.53 cm), number of branches/plant (10.80) and number of pods/plant (28.30) of mash bean (*Vigna mungo* L.).

Jahanshahi *et al.* (2014) concluded that seed sowing in early April along with (32 t/ha) vermicompost enhanced the growth and development of dill (*Anethum graveolens* L.).

Saravanan *et al.* (2014) reported that combined application of cow dung + *Lactobacillus sporogenes* (0.21 ± 0.06 $\mu\text{g/l}$) increased the chlorophyll 'a' content and leaf litter + *L. sporogenes* increased the chlorophyll 'b' (0.38 ± 0.41 $\mu\text{g/l}$) and 'total' chlorophyll content was highest in flower waste + essential microbes (0.42 ± 0.11 $\mu\text{g/l}$) in cowpea (*Vigna unguiculata* L.).

Bhardwaj (2014) revealed that medium of vermicompost + sand + pond soil (1:1:1) with 2 cm coco peat used as growing media enhanced highest germination percentage (7.15 and 7.22) in papaya seedling.

Banik and Sengupta (2014) revealed that application of farm compost (4.8 g/ha) increased the seed protein and leghaemoglobin content in mung bean over the control.

Dhanalakshmi *et al.* (2014a) revealed that application of vermicompost (50%) enhanced the seed germination percentage in okra (96.74%), brinjal (84.32%), chillies (92.35%).

Dhanalakshmi *et al.* (2014b) reported that application of vermicompost (50%) promote the root length in okra (13.03 cm) and chillies (10.90 cm), shoot length in okra (61.50 cm) and chillies (66.60 cm) and number of leaves in okra and chillies (14 and 27.33) respectively.

Suryapani *et al.* (2014) reported that combined application of potassium and (50 kg/ha) *Rhizobium* inoculation increased leghaemoglobin content (9.54%) of nodules in both seasons of lentil (*Lens culinaris* Medik).

Saraswathy and Prabhakaran (2014) stated that application of vermicompost (30%) mixed with (20%) soil enhanced the germination (90.8%), shoot length (9.19 cm), root length (2.95 cm), number of leaves (20.5), fresh weight (0.352 g) and dry weight (0.154 g) in tomato.

Sardoei (2014) concluded that application of vermicompost (50%) enhanced the chlorophyll 'a' (9.39 µg/ml), chlorophyll 'b' (6.25 µg/ml) and 'total' chlorophyll content (15.74 µg/ml) in marigold.

According to Chavan (2015) stated that application of vermicompost enhanced the number of leaves (3), number of seeds per pod (7.5) and weight of seeds (1.62 g), fresh and dry weight of plant (0.56 g and 0.17 g) in cluster bean.

CHAPTER – III

MATERIALS AND METHODS

The details regarding vermicomposting of corncob, inoculation of seeds with *Rhizobium*, incorporation of vermicomposted corncob on seedling growth, pot culture experiment, biometrical, biochemical, leghaemoglobin content and yield parameters in green gram (*Vigna radiata* L. Var. Co 9) were recorded and the statistical evaluation of the data were presented in this chapter.

COLLECTION OF AGRO-INDUSTRIAL WASTE

The agro industrial wastes corncob was collected in large amounts from Tamil Nadu Agricultural University, Coimbatore. The collected waste were chopped into small pieces. It was sun dried and stored in gunny bags.

VERMICOMPOSTING OF CORNCOB

Composting process consist of a pit of same dimension of 1.5 feet and 4 sq.ft. area. In the pit corncob waste, *Eudrilus eugeniae* and *Pleurotus sajor-caju* were sandwiched. Watering was done once in five days. Turning along with water was done once in ten days for aeration. During vermicomposting process, initially corncob was allowed to decompose partially along with cow dung. After 30 days the earthworms were inoculated into plastic trays (30 x 20 x 20 cm) which were filled with pre-processed corncob. The feed substrate was made upto 1 kg in a plastic tray of the composting unit for 60 days. The bedding was kept moist (50 – 60%) throughout the experiment by regular watering. At the end of the composting the compost changes from dark brown to black colour with uniformly disintegrated structure. At the end of composting earthworms were separated by sieving.

The compost was analysed for the following parameters :

- 1) pH
- 2) Electrical Conductivity
- 3) Organic Carbon (Walkey and Black, 1934)
- 4) Nitrogen (Subbiah and Asija, 1956)

ESTIMATION OF ORGANIC CARBON (Walkey and Black, 1934)

Principle

Organic carbon present in organic matter is oxidized by chromic acid in the presence of Con. H_2SO_4 potassium dichromate on reaction with H_2SO_4 provides nascent oxygen which combines with carbon and forms CO_2 . The H_2SO_4 enables easy digestion of organic matter by rendering heat of dilution. Only a certain quantity of chromic acid is used for oxidation. The excess chromic acid left unused by the organic matter is determined by back titration with 0.5 N ferrous sulphate or ferrous ammonium sulphate using diphenylamine indicator.

Reagents

1 N potassium dichromate (Exactly 49.04 g of $K_2Cr_2O_7$ was dissolved in one litre of distilled water) ; Diphenylamine indicator (0.5 g of diphenylamine was dissolved in 20 ml of water and 100 ml of con. H_2SO_4 was added) ; 0.5 N ferrous sulphate or ferrous ammonium sulphate (139.0 of ferrous sulphate or 196.1 g of ferrous ammonium was dissolved in 800 ml of distilled water. 20 ml of con H_2SO_4 was added and the volume was made upto one litre) ; con. H_2SO_4 and phosphoric acid (orthophosphoric acid 85%).

Procedure

0.5 of soil (passed through 0.22 mm sieve was weighed and transferred to a 500 ml conical flask) 10 ml of 1 N $K_2Cr_2O_7$ was added and mixed well by swirling the flask. Added 20 ml of con. H_2SO_4 mixed by gentle rotation for one minute to ensure complete contact of the reagent with the soil.

Allowed the contents to stand for 20 – 39 minutes, kept the flask on an asbestos sheet to avoid burning of table due to intense heat. 200 ml of water was added after 30 minutes. Then added 10 ml of phosphoric acid and 1 ml of diphenylamine indicator. Titrated the solution with 0.5 N ferrous ammonium sulphate. As the titration proceeds the dull green colour shifted to a turbid blue and at the end point green colour developed, conducted simultaneously a blank titration (without soil) and the volume of 0.5 N ferrous ammonium sulphate consumed was noted.

Calculation

Weight of soil taken	=	0.5 g
Volume of 1 N $K_2Cr_2O_7$ used	=	10 ml
Volume of 0.5 N ferrous ammonium sulphate used for blank titration	=	x ml (sample T.V.)
Volume of 0.5 N ferrous ammonium sulphate used for sample titration	=	Y ml (sample T.V.)
X ml of $FeSO_4$ reduce 10 ml of 1 N $K_2Cr_2O_7$		
Therefore Y ml of $FeSO_4$ reduces	=	$\frac{Y}{X} \times 10$ ml
Hence actual quantity of 1 N $K_2Cr_2O_7$ used for oxidation organic matter	=	$10 - (10 \times \frac{Y}{X})$ ml
1 ml of 1 N $K_2Cr_2O_7$	=	0.003 g of C
Therefore $10 - (10 \times \frac{Y}{X})$ ml of 1 $K_2Cr_2O_7$	=	$0 - (10 \times \frac{Y}{X}) \times 0.003$
This is present in 0.5 g of soil	=	$0 - (10 \times \frac{Y}{X}) \times 0.003 \times \frac{100}{0.5}$
Therefore in 100 g		
Organic matter (surface soil)	=	Organic carbon x 1.724
Organic matter (sub-surface soil)	=	Organic carbon x 2.5

ESTIMATION OF AVAILABLE NITROGEN IN SOIL (BY ALKALINE PERMANGANATE METHOD) (Subbiah and Asija, 1956)

Principle

A known weight of soil is mixed with excess of alkaline permanganate and distilled. Organic matter present in soil is oxidized by the nascent oxygen liberated by KMnO_4 in the presence of NaOH and thus ammonia is absorbed in a known volume of boric acid (2%) containing double indicator and converted to ammonium borate. The ammonium borate is titrated against standard H_2SO_4 .

Reagents

0.32 per cent KMnO_4 solution (3.2 g KMnO_4 dissolved in 1 litre of distilled water) ; 2.5 per cent NaOH solution (25 g of NaOH dissolved in 1 litre of distilled water) ; 2 per cent boric acid (20 g of boric acid dissolved in 1 litre of distilled water) ; N/50 H_2SO_4 (3 ml of con. H_2SO_4 is diluted to 1 litre with distilled water and standardized by titration with N/10 Na_2CO_3 . This gives N/10 H_2SO_4 . From this N/50 H_2SO_4 is prepared by dilution and double indicator bromocresol green (0.5 g) and methyl red (0.1 g) dissolved in 100 ml ethylalcohol.

Procedure

Weighed 20 g of soil was transferred into a distillation flask. 30 ml of distilled water were added and 1 ml of liquid paraffin to moist the soil. Added few pieces of glass beads to avoid frothing. Added 100 ml of freshly prepared 0.32 per cent KMnO_4 and 100 ml or 2.5 per cent NaOH to the soil in the distillation flask. A 100 ml beaker containing approximately 200 ml of 2 per cent boric acid with double indicator was kept below the delivery end of the condenser in the distillation set. Distilled the contents and the liberated ammonia was collected in boric acid. Distillation continued until the release of ammonia. Titrate the ammonia collected in boric acid with N/50 H_2SO_4 .

Calculation

Weight of the soil taken	=	20 g
Volume of N/50 H ₂ SO ₄	=	X ml (titre value)
1 ml of N/50 H ₂ SO ₄	=	0.0014 g N
∴ 1 ml of N/50 H ₂ SO ₄	=	0.00028 g N
X ml of N/50 H ₂ SO ₄	=	0.00028 x X g N

This is present in 20 g of soil.

$$\text{Therefore N present in kg/ha} = 0.00028 \left(\frac{X}{20}\right) \times 10^6$$

BIOASSAY ESTIMATION

A number of organic and inorganic substances that may accumulate in the liquid phase of composts early during composting process have the potential for inducing a phytotoxic response, particularly in seedlings. Hence in the present study, a bioassay using green gram as test plant to assess the impact of corncob compost maturity on seedling growth was carried out. The seeds of green gram were soaked in beakers containing equal amount of different concentration of compost extract for 12 hours respectively. One set was kept as control by soaking the seeds in water. The seeds were arranged in germination towels. The following concentrations of composts were used.

C	-	Control
T ₁	-	100 ppm (Vermicomposted corncob)
T ₂	-	200 ppm (Vermicomposted corncob)
T ₃	-	300 ppm (Vermicomposted corncob)
T ₄	-	400 ppm (Vermicomposted corncob)
T ₅	-	500 ppm (Vermicomposted corncob)

The following parameters were recorded on 7 DAS of growth.

1. Epicotyl length (cm)
2. Hypocotyl length (cm)

3. Root length (cm)
4. Number of lateral roots

Thus the influence of vermicomposted corncob on seedling growth were determined.

POT CULTURE EXPERIMENT

RHIZOBIUM TREATMENT

Rhizobium culture was collected from Tamil Nadu Agricultural University. 200 grams of the inoculant was mixed with 250 ml of cool rice kanji and a slurry is added over the seeds. The seeds were allowed to dry under shade for 30 minutes. The seeds were sown within 24 hours.

TREATMENTS APPLICATION AND CULTIVATION

The pots were filled with 7 kg of sandy clay loam soil. The compost was applied to the respective pots and mixed thoroughly. Viable seeds were selected *Rhizobium* treatment is given. Five seeds were sown in each pot with three replications.

After germination three healthy plants were maintained per pot. Plant protection measures and other cultural practices were followed as per recommendation of Tamil Nadu Agricultural University, Coimbatore.

TREATMENT DETAILS

C	-	Control
T ₁	-	Vermicomposted corncob (10 gms)
T ₂	-	Vermicomposted corncob (12.5 gms)
T ₃	-	Vermicomposted corncob (15 gms)
T ₄	-	Vermicomposted corncob (17.5 gms)
T ₅	-	Vermicomposted corncob (20 gms)

VEGETATIVE PARAMETERS

On the 25 DAS and 45 DAS and 55 DAS (green gram) plants were uprooted from the pot and the following vegetative characters were noted.

1. Shoot length (cm)
2. Root length (cm)
3. Number of leaves (gm)
4. Number of nodules (gm)
5. Plant fresh weight
6. Plant dry weight

BIOCHEMICAL ANALYSIS

Biochemical parameters analysed were in leaves and seeds.

1. Chlorophyll

Estimated on 25, 45 and 55 DAS in leaves (Arnon, 1949).

2. Protein

Estimated on 25, 45 and 55 DAS in leaves and 55 DAS in seeds (Lowry *et al.*, 1951).

3. Carbohydrate

Estimated on 25, 45 and 55 DAS in leaves and 55 DAS in seeds (Hedge and Hofriter, 1962).

4. Leghaemoglobin

Estimated on 45 and 55 DAS in the nodules (Appleby and Bergersen, 1980).

i. ESTIMATION OF CHLOROPHYLL CONTENT (Arnon, 1949)

Chlorophyll 'a', 'b' and 'total' chlorophyll were analysed following the method of Arnon (1949).

Materials

Diluted analytical grade acetone to 80 per cent acetone.

Procedure

1. Weighted 1 g of freshly cut sample of leaf was taken into a clean mortar.
2. The leaf bits were ground to a fine pulp with addition of 20 ml of 80 per cent acetone.
3. The mixture thus obtained was centrifuged (5000 rpm for 5 minutes).
4. The supernatant was transferred to 100 ml with 80 per cent acetone.
5. The procedure was repeated till the residue became colourless.
6. Made up the volume to 100 ml with 80 per cent acetone.
7. The absorbance of the solution was read in a spectrophotometer at 663 and 645 nm against the solvent (80 per cent acetone).

Calculation

Calculate the amount of chlorophyll present in the extract mg chlorophyll per 'g' tissue using the following equation.

1. mg of chlorophyll 'a'/g tissue = $12.7A_{663} - 2.69 A_{645} \times \frac{V}{1000 \times W}$
2. mg of chlorophyll 'b'/g tissue = $22.9 A_{645} - 4.68 A_{663} \times \frac{V}{1000 \times W}$
3. mg of total chlorophyll/g tissue = $20.2 A_{645} + 8.02 A_{663} \times \frac{V}{1000 \times W}$

Where

- A = Absorbance of specific wave length
 V = Final volume of chlorophyll extract in 80 per cent acetone.
 W = Fresh weight of tissue extract

ii. ESTIMATION OF TOTAL PROTEIN (Lowry *et al.*, 1951)

Principle

The blue colour developed by the reduction of the phosphomolybdic, phosphotungstic components in Folin-Ciocalteu reagents by the amino acids tyrosine and tryptophan present in the protein plus the colour developed by the biuret reaction of the protein in Lowry's method.

Materials

1. 2 per cent sodium carbonate in 0.1 N sodium hydroxide (Reagent A).
2. 0.5 per cent copper sulphate ($\text{CuSO}_4 \cdot 5 \text{H}_2\text{O}$) in 1 per cent potassium sodium tartarate (Reagent B).
3. Alkaline copper solution : mix 50 ml of reagent A and 1 ml of reagent B prior to use (Reagent C).
4. Folin-Ciocalteu reagent (Reagent D).
5. Protein solution (Stock standard) : Weighed accurately 50 mg of bovine serum albumin (fraction V) and dissolved in distilled water and made upto 50 ml in a standard flask.
6. Working Standard : Diluted 10 ml of stock solution to 50 ml with distilled water in a standard flask. One ml of this solution contains 200 mg protein.

Procedure

Extraction of Protein from Sample

Extraction is carried out with buffers used for the enzyme assay weighed 500 mg of the sample and ground well with a pestle and mortar in 5-10 ml of the buffer centrifuged and used the supernatant for protein estimation.

Estimation of Protein

1. Pipetted out 0.2, 0.4, 0.6, 0.8 and 1 ml of the working standard into a series of test tubes.

2. Pipetted out 0.1 and 0.2 ml of the sample extract in two other test tubes.
3. Made up the volume of 1 ml in all test tubes. A test tube with 1 ml of water served as the blank.
4. About 5 ml of reagent C to each test tube including the blank. Mixed well and allowed to stand for 10 min.
5. The added 0.5 ml of reagent D mixed well and incubated at room temperature in the dark for 30 min. Blue colour is developed.
6. Observe the readings at 660 nm.
7. Drawn a standard graph and calculated the amount of protein in the sample.

Calculation

Expressed the amount of protein mg/g sample

$$= \frac{\text{mg of protein}}{\text{Volume of test standard}} \times \text{Concentration of the standard}$$

iii. ESTIMATION OF CARBOHYDRATE CONTENT (Hedge and Horfriter, 1962)

Anthrone Method

Principle

Concentrated sulphuric acid hydrolyses the glycoside bond of carbohydrate to the given monosaccharides which were then dehydrated to furfural. The furfural reacted with anthrone (10-keto 9, 10-dihydro anthracene) to give the blue coloured complex which was measured colorimetrically at 630 nm.

Materials Required

- a. 2.5 N HCl
- b. Anthrone reagent was prepared by dissolving 200 mg anthrone in 100 ml of water.

- c. Stock standard solution : 100 mg of glucose was dissolved in 100 ml of water.
- d. Working standard : 5 ml of stock standard solution was diluted to 100 ml using distilled water (50 mg/ml).

Procedure

1. About 100 mg of the sample was taken in a boiling tube and was hydrolysed by keeping it in boiling water bath for three hours with 5 ml of 2.5 N HCl and cooled at room temperature.
2. Then it was neutralized with solid sodium carbonate until the effervescence ceases.
3. The volume was made up to 100 ml and centrifuged.
4. The supernatant was collected and 0.5 and 1 ml aliquots were taken for analysis.
5. The standard was prepared by taking 0, 0.2, 0.4, 0.6, 0.8 and 1 ml of the working standard and a blank was maintained.
6. The volume was made up to 1 ml in all the tubes including the sample test tubes by adding distilled water.
7. Then, 4 ml of ahrone reagent was added and heated for eight minutes in a boiling water bath.
8. Then it was cooled rapidly and blue-green colour developed was read at 630 nm.
9. A standard graph was drawn by plotting concentration of the standard on the X-axis versus absorbance on the Y-axis.
10. From the graph, the amount of carbohydrate present in the sample was calculated.

Calculation

$$\begin{aligned} &\text{Amount of carbohydrate present in 100 mg of the sample} \\ &= \frac{\text{mg of glucose}}{\text{volume of test sample}} \times 100 \end{aligned}$$

iv. ESTIMATION OF LEGHAEMOGLOBIN CONTENT (Appleby and Bergersen, 1980)

Principle

Leghaemoglobin reacts with pyridine in strong alkali to produce hemochrome. The hemochrome is measured at 556 nm.

Materials Required

- a) Diluents Buffer : 0.1 M sodium/potassium phosphate buffer (pH 7.4).
Alkaline pyridine reagent : Dissolved 0.8 g NaOH in 50 ml water and cool. Added 33.8 ml of pyridine (33.2), dissolved and diluted to 100 ml with water. This produces 4.2 M pyridine in 0.2 M NaOH.
- b) Sodium Dithionite : Ground finely and stored in small stoppered tubes in a dessicator.
- c) Potassium hexacyanoferrate.

Procedure

Extraction

1. Fresh or thawed nodules were mixed with 1-3 volumes of phosphate buffer and macerated in a mixer.
2. It was filtered through two layers of cheese cloth.
3. The nodules debris were discarded.
4. The turbid reddish brown filtrate was clarified by centrifugation at 10,000 rpm for 10-30 min. and diluted suitably.
5. To a suitable volume (2 to 5 ml) of the extract, an equal volume of alkaline pyridine reagent was added and mixed well.
6. The solution becomes greenish yellow due to the formation of ferric hemochrome.
7. The hemochrome was taken in equal quantity in two tubes.
8. To one portion, few crystals of sodium dithionite was added to reduce the hemochrome and stirred well without aeration.

9. The absorbance was measured at 556 nm after 2-5 minutes against a reagent blank in a spectrophotometer.
10. To the other portion, a few crystals of potassium hexacyanoferrate was added to oxidize the hemochrome and read at 539 nm in a spectrophotometer after 2-5 minutes against a reagent blank.

Calculation

$$\text{Leghaemoglobin concentration (mm)} = A_{556} - A_{539} \frac{2D}{23.4}$$

Where D is the initial dilution

(The calculation is based upon the equation $E = 23.4 \times 10^3 \text{ mol}^{-1} \text{ cm}^{-1}$).

YIELD PARAMETERS

On 55 DAS in green gram, the plants were uprooted from the pot and the following yield parameters were observed.

1. Length of the pod (cm)
2. Weight of the pod (gm)
3. Number of seeds per pod
4. Weight of the seeds per pod (gm)

STATISTICAL ANALYSIS

The data obtained from various biometrical observations, biochemical analysis, leghaemoglobin content and yield parameters, were subjected to the statistical analysis and based on the results, inferences were drawn. Whenever the treatment differences were significant critical differences were worked out.

CHAPTER – IV

RESULTS AND DISCUSSION

The experimental results pertaining to the influence of vermicomposted corncob on germination, biometric, biochemical parameters, leghaemoglobin content in the nodules and yield of green gram (*Vigna radiata* L. Var. Co 9) were presented in this chapter.

COMPOSITION OF RAW AND VERMICOMPOSTED CORNCOB (Table – I)

The pH of the raw corncob was 6.8, electrical conductivity 0.5 millimhos cm^{-1} , nitrogen 0.18 kg ha^{-1} and organic carbon 37.5 per cent.

The physical and chemical characteristics of vermicomposted corncob were pH 7.0, electrical conductivity 4.1 millimhos cm^{-1} , nitrogen 1.22 kg ha^{-1} and organic carbon 31.2 per cent.

SEEDLING GROWTH EXPERIMENTS

EFFECT OF VERMICOMPOSTED CORNCOB EXTRACT ON GREEN GRAM SEEDLING (7 DAS) (Table – II, Plate – II and Figures – I and II)

The vermicomposted corncob extract significantly influenced the seedling parameters of green gram. The epicotyl length was significantly increased in T₅ (17.1 cm) followed by T₄ (14.45 cm) when compared to control (9.21 cm). The hypocotyl length was also increased in the treatments of T₅ and T₄ (14.14 cm and 13.02 cm) when compared to control (9.65 cm). The root length was increased in T₅ (18.24 cm) followed by T₄ (16.82 cm) when compared to control (12.3 cm). The number of lateral roots were increased significantly in T₅ (35.80 cm) followed by T₄ (35.31 cm) over the control (25.14 cm). Similar result was reported by Lazcano *et al.* (2010) in maritime pinus (*Pinus pinaster* Ait) with the application of vermicompost (16%).

TABLE – I
PHYSICO-CHEMICAL CHARACTERISTICS OF RAW AND VERMICOMPOSTED CORNCOB

Physico-Chemical Parameters	Raw Corncob	Vermicomposted Corncob
pH	6.8	7.0
Electrical Conductivity (millimhos cm ⁻¹)	0.5	4.1
Nitrogen (Kg ha ⁻¹)	0.18	1.22
Organic Carbon (%)	37.5	31.2

TABLE – II
EFFECT OF VERMICOMPOSTED CORNCOB EXTRACT ON GREEN GRAM SEEDLING (7 DAS)

Treatment	Epicotyl length (cm)	Hypocotyl length (cm)	Root length (cm)	Number of lateral root
Control	9.21 ± 0.01	9.65 ± 0.05	12.3 ± 0.01	25.14 ± 0.02
T ₁ – 100 ppm	10.07 ± 0.05	9.96 ± 0.10	13.82 ± 0.02	25.45 ± 0.05
T ₂ – 200 ppm	12.42 ± 0.02	10.70 ± 0.03	14.94 ± 0.04	29.82 ± 0.02
T ₃ – 300 ppm	13.51 ± 0.01	11.71 ± 0.01	15.1 ± 0.04	32.14 ± 0.03
T ₄ – 400 ppm	14.45 ± 0.05	13.02 ± 0.02	16.82 ± 0.02	35.31 ± 0.01
T ₅ – 500 ppm	17.1 ± 0.02	14.14 ± 0.01	18.24 ± 0.03	35.80 ± 0.05
SEd	0.0258	0.0391	0.0236	0.0265
CD (P < 0.01)	0.0789**	0.1195**	0.0720**	0.0810**

Values are mean ± SD of three samples in each group.

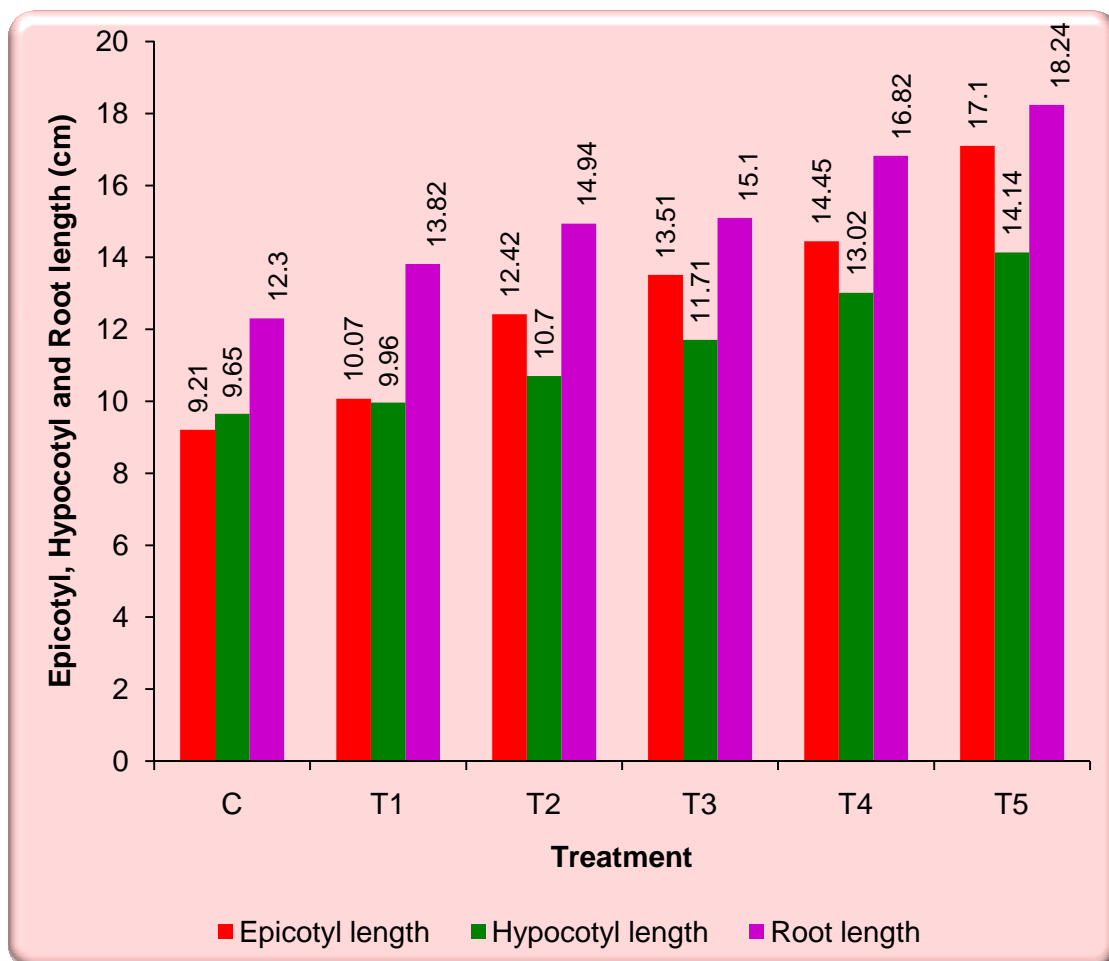
** - Significant at 1% level (P < 0.01).

PLATE – II
VERMICOMPOSTED CORNCOB EXTRACT ON
GREEN GRAM SEEDLING (7 DAS)



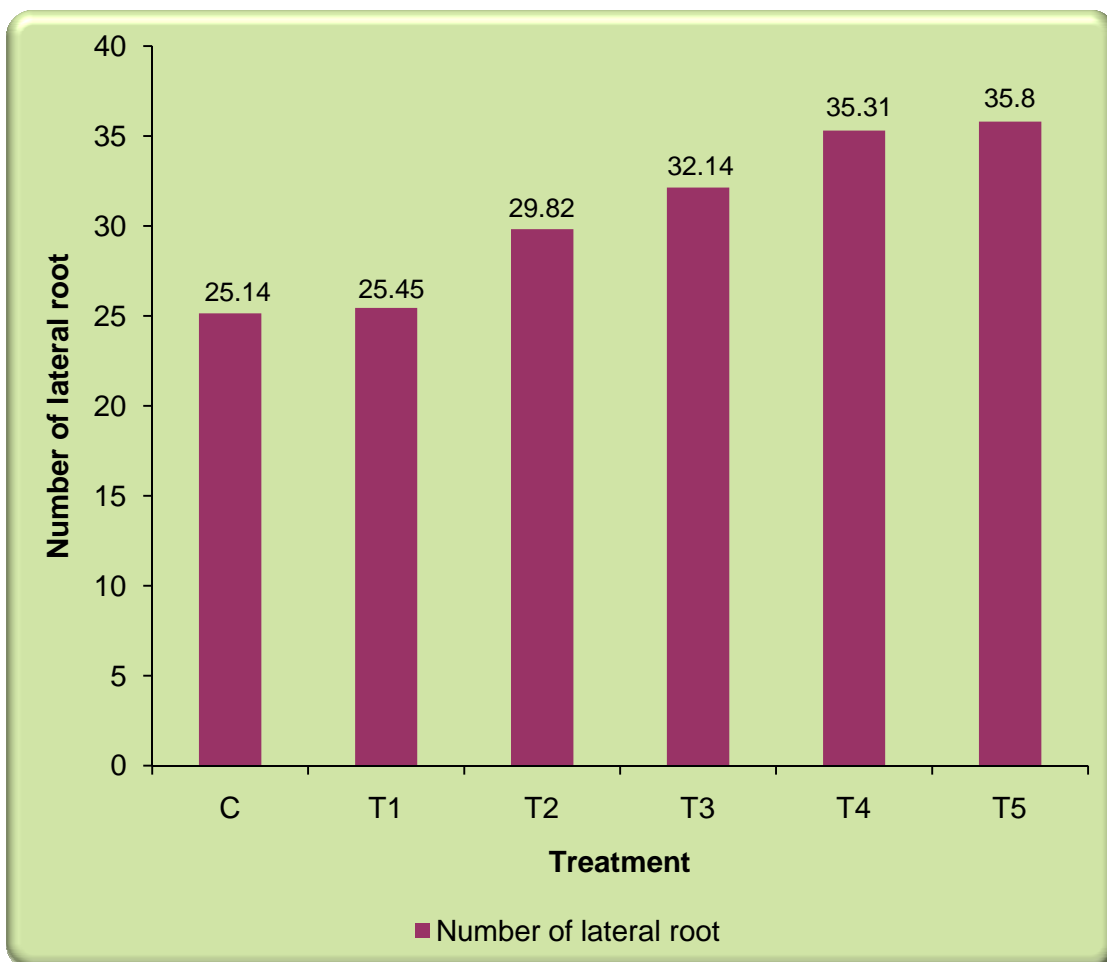
- | | | |
|----------------------|---|---|
| C | - | Control |
| T₁ | - | 100 ppm (Vermicomposted corncob) |
| T₂ | - | 200 ppm (Vermicomposted corncob) |
| T₃ | - | 300 ppm (Vermicomposted corncob) |
| T₄ | - | 400 ppm (Vermicomposted corncob) |
| T₅ | - | 500 ppm (Vermicomposted corncob) |

FIGURE – I
EFFECT OF VERMICOMPOSTED CORNCOB EXTRACT ON
GREEN GRAM SEEDLING (EPICOTYL LENGTH,
HYPOCOTYL LENGTH AND ROOT LENGTH)



- C** - **Control**
T₁ - **100 ppm (Vermicomposted corncob)**
T₂ - **200 ppm (Vermicomposted corncob)**
T₃ - **300 ppm (Vermicomposted corncob)**
T₄ - **400 ppm (Vermicomposted corncob)**
T₅ - **500 ppm (Vermicomposted corncob)**

FIGURE – II
EFFECT OF VERMICOMPOSTED CORNCOB EXTRACT ON GREEN GRAM
SEEDING (NUMBER OF LATERAL ROOTS)



- C** - **Control**
T₁ - **100 ppm (Vermicomposted corncob)**
T₂ - **200 ppm (Vermicomposted corncob)**
T₃ - **300 ppm (Vermicomposted corncob)**
T₄ - **400 ppm (Vermicomposted corncob)**
T₅ - **500 ppm (Vermicomposted corncob)**

According to Javed and Panwar (2013) in soybean, maximum seed germination (82%) was found in biofertilizer treated soil and in case of urad (*Vigna mungo*) seed germination (88%) was more in (1/g) vermicompost treated soil.

Similar results were positively corrected with the findings of Bhardwaj (2014) in papaya with the combined application of vermicompost + sand + pond soil (1 : 1 : 1) enhanced the germination (95.25%).

Results were also in accordance with Joshi and Vig (2010) who reported highest germination (23%) in seeds of tomato plant treated with (15%) vermicompost.

According to Mathivanan *et al.* (2012) in groundnut, application of vermicompost (200 g/pot) promotes the germination (100%) and seedling length (9.5 cm).

The studies conducted by Dhanalakshmi *et al.* (2014) was in accordance with the present study which showed an increase in seed germination in okra (96.74%), brinjal (84.32%), chillies (92.35%) due to application of vermicompost (50%).

The increase in seedling growth might be due to the nutrient content and possible growth promoting ingredients present in the extract of vermicompost corncob.

EFFECT OF VERMICOMPOSTED CORNCOB EXTRACT ON PROTEIN CONTENT OF GREEN GRAM SEEDLING (7 DAS) (Table – III)

Protein is one of the reserve food material utilized by plants for the growth of the seedling. The highest protein content was noticed in the treatment T₅ (24.47 mg/g) followed by T₄ (23.76 mg/g) over the control (18.45 mg/g).

TABLE – III
EFFECT OF VERMICOMPOSTED CORNCOB EXTRACT
ON PROTEIN CONTENT OF GREEN GRAM SEEDLING (7 DAS)

Treatment	Protein content (mg / g tissue)
Control	18.45 ± 0.16
T ₁ – 100 ppm	20.12 ± 0.05
T ₂ – 200 ppm	20.64 ± 0.10
T ₃ – 300 ppm	23.30 ± 0.05
T ₄ – 400 ppm	23.76 ± 0.05
T ₅ – 500 ppm	24.47 ± 0.21
SEd	0.0981
CD (P < 0.01)	0.2996**

Values are mean \pm SD of three samples in each group.

** - Significant at 1% level (P < 0.01).

The increase in the total protein upto 7 DAS of seedling growth might be due to the increased organic carbon content in extract which resulted to higher availability of nitrogen which resulted in significant improvement in the protein content.

EFFECT OF VERMICOMPOSTED CORNCOB EXTRACT ON CARBOHYDRATE CONTENT OF GREEN GRAM SEEDLING (7 DAS) (Table – IV)

The carbohydrate content was maximum in the treatment T₅ and T₄ (168.25 mg/g and 155.73 mg/g). The carbohydrate content control was 101.68 mg/g on 7 DAS seedling growth of green gram.

The increase in carbohydrate content might be due to the enormous amount of organic carbon present in the vermicomposted corncob which enhanced the carbohydrate content in the green gram.

POT CULTURE EXPERIMENT

EFFECT OF VERMICOMPOSTED CORNCOB AND RHIZOBIUM ON SHOOT AND ROOT LENGTH OF GREEN GRAM (Table – V ; Plates – III, IV and V)

Shoot Length

Shoot length was increased in T₃ (22.83 cm, 30.20 cm and 59.3 cm) as compared to control (13.27 cm, 21.83 cm and 28.33 cm). This is accordance with the results of Alam *et al.* (2007) who observed maximum growth of potato with the combined application of vermicompost (10 t/ha) + 100% NPKS.

Similar results were positively correlated with the findings of Gopinathan and Prakash (2014) in green gram with the application of Plant Growth Promoting Rhizobacteria (PGPR) isolated from vermicompost which increased in shoot length (39.9 cm).

TABLE – IV
EFFECT OF VERMICOMPOSTED CORNCOB EXTRACT
ON CARBOHYDRATE CONTENT OF GREEN GRAM SEEDLING (7 DAS)

Treatment	Carbohydrate content (mg / g tissue)
Control	101.68 \pm 0.16
T ₁ – 100 ppm	107.30 \pm 0.11
T ₂ – 200 ppm	113.28 \pm 0.17
T ₃ – 300 ppm	121.90 \pm 0.17
T ₄ – 400 ppm	155.73 \pm 0.06
T ₅ – 500 ppm	168.25 \pm 0.16
SEd	0.1181
CD (P < 0.01)	0.3607**

Values are mean \pm SD of three samples in each group.

** - Significant at 1% level (P < 0.01).

TABLE – V
EFFECT OF VERMICOMPOSTED CORNCOB AND RHIZOBIUM ON SHOOT AND ROOT LENGTH OF GREEN GRAM

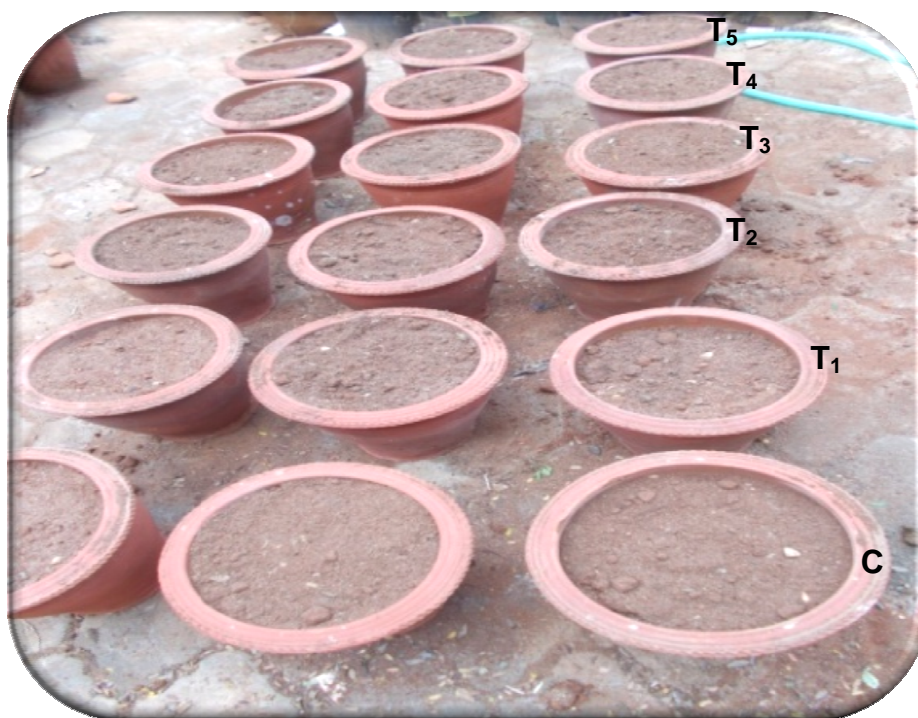
Treatment	Shoot length (cm)			Root length (cm)		
	25 DAS	45 DAS	55 DAS	25 DAS	45 DAS	55 DAS
Control	13.27 ± 0.46	21.83 ± 1.15	28.33 ± 0.58	4.67 ± 0.29	5.43 ± 0.45	13.50 ± 0.50
T ₁ – 10 g	16.20 ± 1.21	23.47 ± 0.46	33.67 ± 0.58	5.60 ± 0.78	6.50 ± 0.30	16.20 ± 3.04
T ₂ – 12.5 g	18.67 ± 0.29	26.00 ± 0.50	35.50 ± 0.50	6.23 ± 1.25	8.43 ± 1.91	16.50 ± 1.32
T ₃ – 15 g	22.83 ± 1.04	30.20 ± 0.46	59.23 ± 0.87	8.63 ± 0.49	12.60 ± 0.36	21.03 ± 5.32
T ₄ – 17.5 g	19.73 ± 0.25	27.57 ± 0.60	37.90 ± 1.85	7.53 ± 1.19	8.67 ± 1.85	17.57 ± 0.60
T ₅ – 20 g	21.47 ± 0.84	28.90 ± 0.40	53.33 ± 0.76	7.93 ± 0.45	9.23 ± 2.67	19.67 ± 6.11
SEd	0.6621			1.88601		
CD (P < 0.05)	1.34317*			3.82543*		
CD (P < 0.01)	1.80102**			5.12943**		

Values are mean ± SD of three samples in each group.

* - Significant at 5% level (P < 0.05).

** - Significant at 1% level (P < 0.01).

PLATE – III
COMPOST MIX



- | | | |
|----------------------|---|--|
| C | - | Control |
| T₁ | - | 10 g (Vermicomposted corncob) |
| T₂ | - | 12.5 g (Vermicomposted corncob) |
| T₃ | - | 15 g (Vermicomposted corncob) |
| T₄ | - | 17.5 g (Vermicomposted corncob) |
| T₅ | - | 20 g (Vermicomposted corncob) |

PLATE – IV

A. POT CULTURE EXPERIMENT



B. EFFECT OF VERMICOMPOSTED CORNCOB ON VEGETATIVE STAGE OF GREEN GRAM (25 DAS)



PLATE – V

A. EFFECT OF VERMICOMPOSTED CORNCOB ON VEGETATIVE STAGE OF GREEN GRAM (45 DAS)



B. EFFECT OF VERMICOMPOSTED CORNCOB ON VEGETATIVE STAGE OF GREEN GRAM (55 DAS)



The findings were in close conformity with that of Senthilkumar and Sivagurunathan (2012), who reported maximum shoot length (31.0 cm) of cowpea with the combined inoculation of *Rhizobium* + Phosphobacteria + *Azospirillum*.

The increase nutrient availability due to the application of vermicompost in the soil would have produced such an increase in plant growth.

Root Length

Root length was increased in T₃ (8.63 cm, 12.60 cm and 21.03 cm) followed by T₅ (7.93 cm, 9.23 cm and 19.67 cm) on 25, 45 and 55 DAS as compared to control (4.67 cm, 5.43 cm and 13.50 cm). Similar findings were also reported by Ranjan *et al.* (2013) who observed maximum root length (19.88 cm) in baby corn plant at 30 days with the combined application of vermicompost (1.92 kg/bed) + biospirillum (10 ml/kg of seed) + biophosphate (10 ml/kg of seed) + biopotash (10 ml/kg of seed).

Similar results were correlated with Ghosh *et al.* (2013) wherein the highest root length (58 cm) of sweet corn was observed with (100%) vermicompost. Similar results were positively correlated with the findings of Sharma *et al.* (2011) in groundnut with inoculation of IRG-40 strain of *Rhizobium* which enhanced the root length (9.3 cm).

Results were also in accordance with Senthilkumar *et al.* (2014) wherein the highest root length (28.82 cm) of groundnut was observed with combined application of vermicomposted flower waste + cowdung + *Rhizobium*. Similar results were correlated with the findings of Gopinathan and Prakash (2014) in green gram with the application of plant growth promoting rhizobacteria (PGPR) isolated from vermicompost increase the root length (23.9 cm).

The present results are in accordance with Kumar *et al.* (2014) who observed maximum root length (18.77 cm) of radish with the combined application of vermicompost (50%) + farm yard manure (50%).

The increase in root length might be due to the application of organic manures which play an important role in root development.

EFFECT OF VERMICOMPOSTED CORNCOB AND RHIZOBIUM ON NUMBER OF LEAVES AND NUMBER OF NODULES OF GREEN GRAM (Table – VI)

Number of Leaves

Number of leaves significantly increased in T₃ (9.00, 11.33 and 17.33) followed by T₅ on 25, 45 and 55 DAS (8.67, 11.00 and 16.33) as compared to control (5.33, 8.67 and 11.33). Similar result was found by Singh and Chauhan (2009) who observed that the number of leaves (30) in French bean was increased due to the application of vermicompost (4 kg/bed).

Results were correlated with Saraswathy and Prabhakaran (2014) wherein the number of leaves (20.5) was increased with the application of vermicompost (30%) mixed with soil (70%).

Similar results were positively correlated with the findings of Bhardwaj (2014) in papaya with the combined application of vermicompost + sand + pond soil (1 : 1 : 1) which enhanced the number of leaves (10.02). Results were correlated with Sharma *et al.* (2011) wherein the number of leaves (62.9) of groundnut were increased with inoculation of IRG-40 strain of *Rhizobium*.

Similar results were correlated with the findings of Senthilkumar and Sivagurunathan (2012) in cowpea with the application of *Rhizobium* + phosphobacteria + *Azospirillum* which increase the number of leaves (10.6).

TABLE – VI
EFFECT OF VERMICOMPOSTED CORNCOB AND RHIZOBIUM ON NUMBER OF LEAVES AND NODULES OF GREEN GRAM

Treatment	Number of leaves			Number of nodules	
	25 DAS	45 DAS	55 DAS	45 DAS	55 DAS
Control	5.33 ± 1.53	8.67 ± 0.58	11.33 ± 2.08	6.00 ± 1.00	7.00 ± 1.00
T ₁ – 10 g	6.67 ± 2.52	9.00 ± 1.00	12.00 ± 0.00	6.67 ± 2.89	8.33 ± 0.58
T ₂ – 12.5 g	7.67 ± 0.58	9.67 ± 2.08	12.33 ± 0.58	7.67 ± 2.52	9.67 ± 0.58
T ₃ – 15 g	9.00 ± 1.00	11.33 ± 1.15	17.33 ± 1.15	15.67 ± 2.52	18.00 ± 5.29
T ₄ – 17.5 g	8.00 ± 0.00	10.00 ± 1.73	13.33 ± 1.53	10.33 ± 0.58	11.00 ± 1.00
T ₅ – 20 g	8.67 ± 1.15	11.00 ± 1.00	16.33 ± 4.16	13.67 ± 1.53	15.67 ± 4.51
SEd	1.33333			1.86256	
CD (P < 0.05)	2.70443*			3.77787*	
CD (P < 0.01)	3.62630**			5.06566**	

Values are mean ± SD of three samples in each group.

* - Significant at 5% level (P < 0.05).

** - Significant at 1% level (P < 0.01).

The presence of available nitrogen and organic matter improved the physico-chemical and biological properties of the soil thus resulting in better vegetative growth and photosynthesis.

Number of Nodules

Number of nodules was increased in T₃ (15.67 and 18.00) followed by T₅ (13.67 and 15.67) on 45 and 55 DAS as compared to control (6.00 and 7.00). Similar result was found by Verma *et al.* (2014) in fenugreek the combined application of vermicompost at 4 t/ha increased the root nodules (27.48) over the control (18.86).

According to Tagore *et al.* (2013) in chickpea the combined inoculation of *Rhizobium* + Phosphate solubilizing bacteria promotes the number of nodules (27.66). Similar results were positively correlated with the findings of Senthilkumar and Sivagurunathan (2012) in cowpea with combined inoculation of *Rhizobium* + Phosphobacteria + *Azospirillum* which enhanced the number of nodules (23.2).

The findings were in close conformity with that of Khan and Prakash (2013) who observed the number of root nodules (25.78) in urdbean with the inoculation of *Rhizobium*. Similar result was found by Singh and Chauhan (2009) in french bean the application of vermicompost (4 kg/bed) increased the root nodules (67.2) over the control (60.6).

Nitrogen fixing microorganisms enhances the nutrient level in the soil proliferating in better nodules formation and nitrogen fixation by supplying assimilates to the root.

EFFECT OF VERMICOMPOSTED CORNCOB AND RHIZOBIUM ON PLANT FRESH AND DRY WEIGHT OF GREEN GRAM (Table – VII)

Plant Fresh and Dry Weight

Plant fresh weight was increased in T₃ (0.62 g, 1.13 g and 4.16 g) followed by T₅ on 25, 45 and 55 DAS (0.56 g, 1.04 g and 3.76 g) as compared to control (0.31 g, 0.43 g and 0.87 g). Plant dry weight was increased in T₃ (0.23 g, 0.44 g and 1.71) followed by T₅ on 25, 45 and 55 DAS (0.19 g, 0.35 g and 1.24 g) as compared to control (0.04 g, 0.06 g and 0.13 g). The maximum fresh weight (230.5 g) and dry weight (19.7 g) of marigold was found by the Shadanpour *et al.* (2011) due to the application of vermicompost (40%) + sand (30%) + soil (30%) which is in accordance with the present study.

Prajapati *et al.* (2008) observed fresh and dry weight of shoot (1.74 g and 0.668 g) in rice with the combined inoculation of *Azotobacter chroococum* and *Pirifomospora indica* + vermicompost application.

Results were also in accordance with Saraswathy and Prabhakaran (2014) wherein the maximum fresh and dry weight (0.352 g and 0.154 g) was observed in tomato with the application of vermicompost (30%) mixed with (70%) soil.

The increase may be due to the availability of nitrogen and phosphorus through the mechanism of reduction, chelation and favourable changes in soil.

EFFECT OF VERMICOMPOSTED CORNCOB AND RHIZOBIUM ON CHLOROPHYLL 'a', CHLOROPHYLL 'b' AND 'TOTAL' CHLOROPHYLL CONTENT OF GREEN GRAM (Table – VIII and Figures – III, IV, V)

On the 25 DAS the highest content of chlorophyll 'a', chlorophyll 'b' and 'total' chlorophyll of green gram was noticed in treatment T₃ (2.027 mg/g, 0.944 mg/g and 2.971 mg/g) followed by T₅ (1.772 mg/g, 0.924 mg/g and 2.696 mg/g) respectively. The lowest content was observed in control (1.265 mg/g, 0.691 mg/g and 1.955 mg/g).

TABLE – VII
EFFECT OF VERMICOMPOSTED CORNCOB AND RHIZOBIUM ON PLANT FRESH AND DRY WEIGHT OF GREEN GRAM

Treatment	Plant fresh weight (g)			Plant dry weight (g)		
	25 DAS	45 DAS	55 DAS	25 DAS	45 DAS	55 DAS
Control	0.31 ± 0.02	0.43 ± 0.16	0.87 ± 0.02	0.04 ± 0.01	0.06 ± 0.03	0.13 ± 0.03
T ₁ – 10 g	0.36 ± 0.02	0.72 ± 0.12	0.94 ± 0.03	0.07 ± 0.01	0.09 ± 0.01	0.15 ± 0.03
T ₂ – 12.5 g	0.41 ± 0.04	0.85 ± 0.18	1.24 ± 0.02	0.10 ± 0.02	0.19 ± 0.12	0.54 ± 0.12
T ₃ – 15 g	0.62 ± 0.09	1.13 ± 0.18	4.16 ± 0.04	0.23 ± 0.04	0.44 ± 0.09	1.71 ± 0.09
T ₄ – 17.5 g	0.45 ± 0.04	0.98 ± 0.24	2.81 ± 0.15	0.12 ± 0.03	0.29 ± 0.17	0.82 ± 0.13
T ₅ – 20 g	0.56 ± 0.04	1.04 ± 0.08	3.76 ± 0.21	0.19 ± 0.03	0.35 ± 0.03	1.24 ± 0.21
SEd	0.09648			0.07177		
CD (P < 0.05)	0.19569*			0.14557*		
CD (P < 0.01)	0.26240**			0.19519**		

Values are mean ± SD of three samples in each group.

* - Significant at 5% level (P < 0.05).

** - Significant at 1% level (P < 0.01).

TABLE – VIII
EFFECT OF VERMICOMPOSTED CORNCOB AND RHIZOBIUM ON CHLOROPHYLL ‘a’, CHLOROPHYLL ‘b’
AND ‘TOTAL’ CHLOROPHYLL CONTENT OF GREEN GRAM

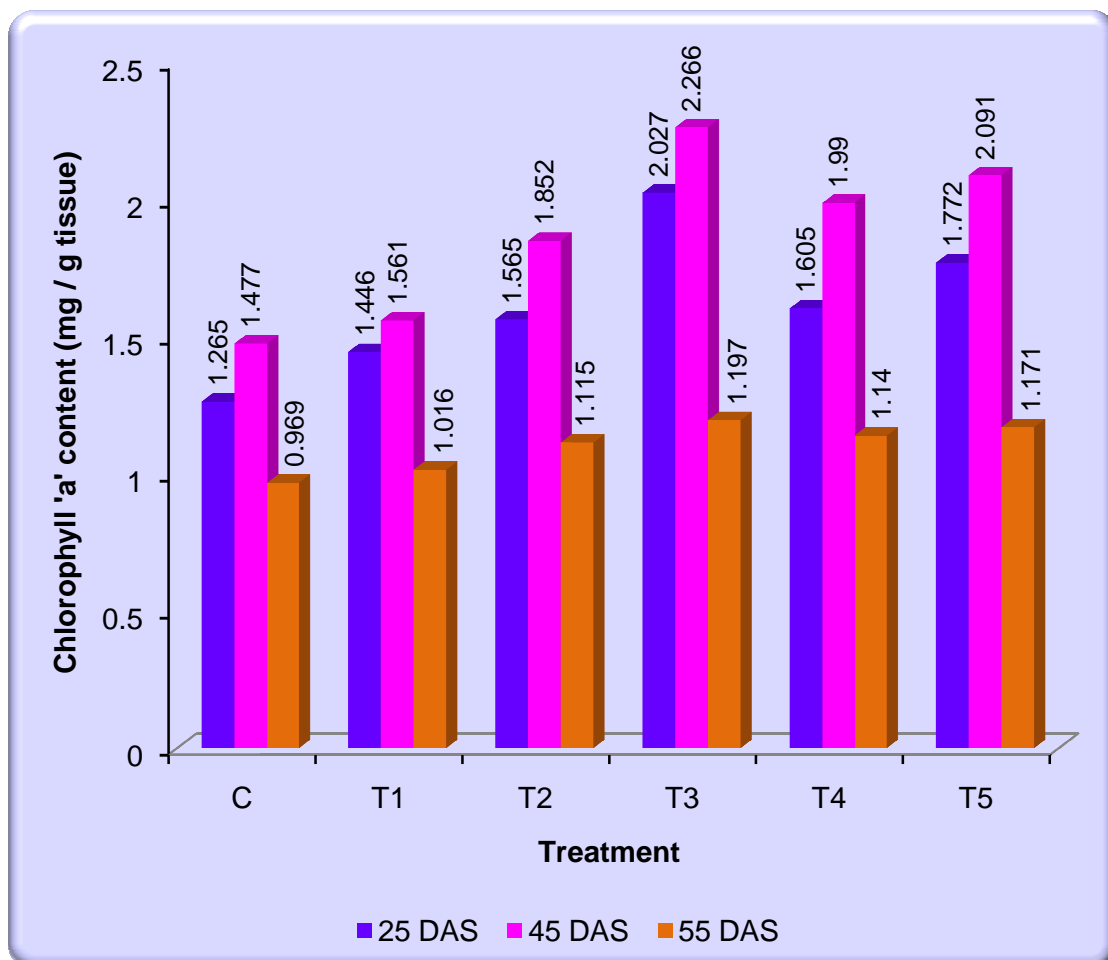
Treatment	Chlorophyll ‘a’ (mg / g tissue)			Chlorophyll ‘b’ (mg / g tissue)			‘Total’ chlorophyll (mg / g tissue)		
	25 DAS	45 DAS	55 DAS	25 DAS	45 DAS	55 DAS	25 DAS	45 DAS	55 DAS
Control	1.265	1.477	0.969	0.691	0.910	0.599	1.955	2.387	1.564
T ₁ – 10 g	1.446	1.561	1.016	0.720	0.941	0.738	2.166	2.501	1.754
T ₂ – 12.5 g	1.565	1.852	1.115	0.747	0.947	0.772	2.311	2.799	1.886
T ₃ – 15 g	2.027	2.266	1.197	0.944	1.391	1.101	2.971	3.656	2.298
T ₄ – 17.5 g	1.605	1.990	1.140	0.898	0.976	0.886	2.503	2.965	2.025
T ₅ – 20 g	1.772	2.091	1.171	0.924	1.271	0.997	2.696	3.362	2.167
SEd	0.00699			0.02933			0.01093		
CD (P < 0.05)	0.01417			0.05949			0.02217		
CD (P < 0.01)	0.01901			0.07976			0.02972		

Values are mean \pm SD of three samples in each group.

* - Significant at 5% level (P < 0.05).

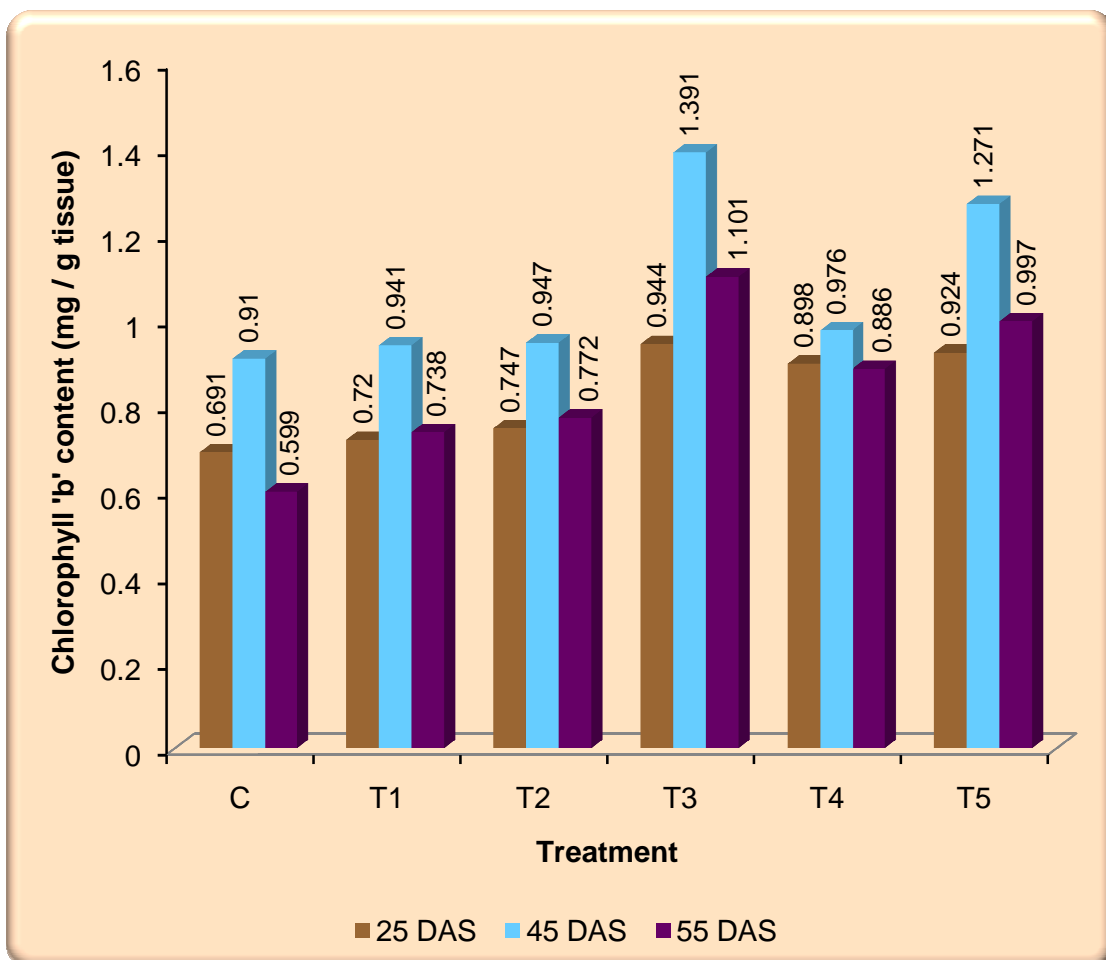
** - Significant at 1% level (P < 0.01).

FIGURE – III
EFFECT OF VERMICOMPOSTED CORNCOB AND RHIZOBIUM ON
CHLOROPHYLL 'a' CONTENT OF GREEN GRAM



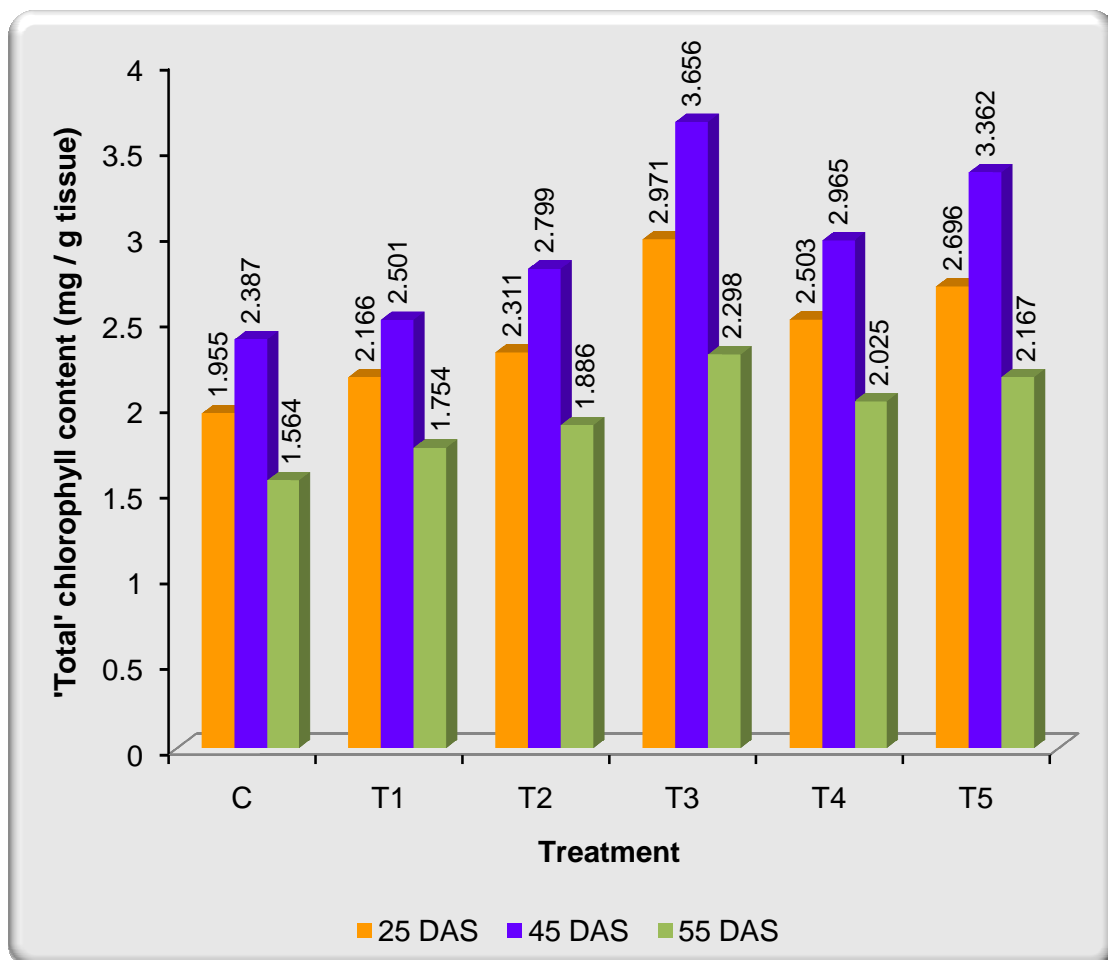
- C** - **Control**
- T₁** - **10 g Vermicomposted corncob + *Rhizobium***
- T₂** - **12.5 g Vermicomposted corncob + *Rhizobium***
- T₃** - **15 g Vermicomposted corncob + *Rhizobium***
- T₄** - **17.5 g Vermicomposted corncob + *Rhizobium***
- T₅** - **20 g Vermicomposted corncob + *Rhizobium***

FIGURE – IV
EFFECT OF VERMICOMPOSTED CORNCOB AND RHIZOBIUM ON
CHLOROPHYLL 'b' CONTENT OF GREEN GRAM



- C** - **Control**
- T₁** - **10 g Vermicomposted corncob + *Rhizobium***
- T₂** - **12.5 g Vermicomposted corncob + *Rhizobium***
- T₃** - **15 g Vermicomposted corncob + *Rhizobium***
- T₄** - **17.5 g Vermicomposted corncob + *Rhizobium***
- T₅** - **20 g Vermicomposted corncob + *Rhizobium***

FIGURE – V
EFFECT OF VERMICOMPOSTED CORNCOB AND RHIZOBIUM ON
‘TOTAL’ CHLOROPHYLL CONTENT OF GREEN GRAM



- C** - **Control**
- T₁** - **10 g Vermicomposted corncob + *Rhizobium***
- T₂** - **12.5 g Vermicomposted corncob + *Rhizobium***
- T₃** - **15 g Vermicomposted corncob + *Rhizobium***
- T₄** - **17.5 g Vermicomposted corncob + *Rhizobium***
- T₅** - **20 g Vermicomposted corncob + *Rhizobium***

On the 45 DAS the highest content of chlorophyll 'a' and chlorophyll 'b' and 'total' chlorophyll was noted in treatment T₃ (2.266 mg/g, 1.391 mg/g and 3.656 mg/g) followed by T₅ (2.091 mg/g, 1.271 mg/g and 3.362 mg/g).

On the 55 DAS the highest content of chlorophyll 'a', 'b' and 'total' chlorophyll was noted in treatment T₃ (1.197 mg/g, 1.101 mg/g and 2.298 mg/g) followed by T₅ (1.171 mg/g, 0.997 mg/g and 2.167 mg/g) respectively. The lowest content was observed in control (0.969 mg/g, 0.599 mg/g and 1.564 mg/g). Similar result was reported by Abira (2005) in soy bean (*Glycine max* L.) who observed increase in chlorophyll 'a', 'b' and 'total' chlorophyll (0.2600 mg/g, 0.4316 mg/g and 0.4249 mg/g) when compared to control (0.1268 mg/g, 0.3636 mg/g and 0.2872 mg/g) with the combined application of vermicomposted fruit waste (75 g) + biofertilizer.

Similar results were correlated with the findings of Mathivanan *et al.* (2012) in groundnut with application of vermicompost (200 g/pot) promoted the chlorophyll 'a' (0.764 mg/g), chlorophyll 'b' (0.549 mg/g) and 'total' chlorophyll (1.313 mg/g) content.

The findings wherein close conformity with that of Befrozfar *et al.* (2013) who observed increase in chlorophyll 'a' (17.17%) and chlorophyll 'b' (13.77%) of basil (*Ocimum basilicum* L.) with the application of vermicompost (5 t/ha).

Similar result was found by Sardoei *et al.* (2014) in marigold the application of vermicompost (50%) increased the chlorophyll 'a' (9.39 mg/g), chlorophyll 'b' (6.25 mg/g) and 'total' chlorophyll content (15.14 mg/g).

Results were also in accordance with Tak *et al.* (2013) wherein the maximum 'total' chlorophyll content (1.58 mg/g) of green gram was observed due to vermicompost + foliar spray of zinc.

Similar results were positively correlated with the findings of Ranjan *et al.* (2013) in baby corn with the combined application of

vermicompost (1.92 kg/bed) + Biospirillum (10 ml/kg of seed) + Biophos (10 ml/kg of seed) + Biopotash (10 ml/kg of seed) increased in chlorophyll 'a' (3.055 mg/g), chlorophyll 'b' (0.556 mg/g) and 'total' chlorophyll content (3.62 mg/g) of baby corn.

The vermicompost improved the physico-chemical and biological properties of the soil, thus resulting in increased chlorophyll content.

EFFECT OF VERMICOMPOSTED CORNCOB AND RHIZOBIUM ON PROTEIN CONTENT OF GREEN GRAM (Table – IX)

Protein Content in Leaves and Seeds (Figures – VI, VII)

Protein content in leaf was increased in T₃ (40.55 mg/g, 43.36 mg/g and 64.91 mg/g) followed by T₅ (36.81 mg/g, 41.64 mg/g and 61.36 mg/g) on 25, 45 and 55 DAS as compared to control (21.90 mg/g, 30.36 mg/g and 47.36 mg/g). On the 55 DAS the highest protein content in seeds was noticed in the treatment T₃ (89.82 mg/g) followed by T₅ (82.73 mg/g) when compared to control (68.27 mg/g). Similar results were observed by Vasanthi and Subramanian (2004) in treatments that received (vermicompost + FYM) showed higher protein content (18 – 21%) in black gram. Similar results was found by Senthilkumar and Sivagurunathan (2012) in cowpea due to inoculation of biofertilizers.

Similar result was found by Mathivanan *et al.* (2012) in groundnut. The present study is in accordance with Ramesh *et al.* (2006) who observed increase in protein content (21.25%) of pigeon pea due to combined application of vermicompost (3 t/ha), cattle dung (4 t/ha) and poultry manure (2 t/ha).

TABLE – IX
EFFECT OF VERMICOMPOSTED CORNCOB AND RHIZOBIUM ON PROTEIN CONTENT OF GREEN GRAM

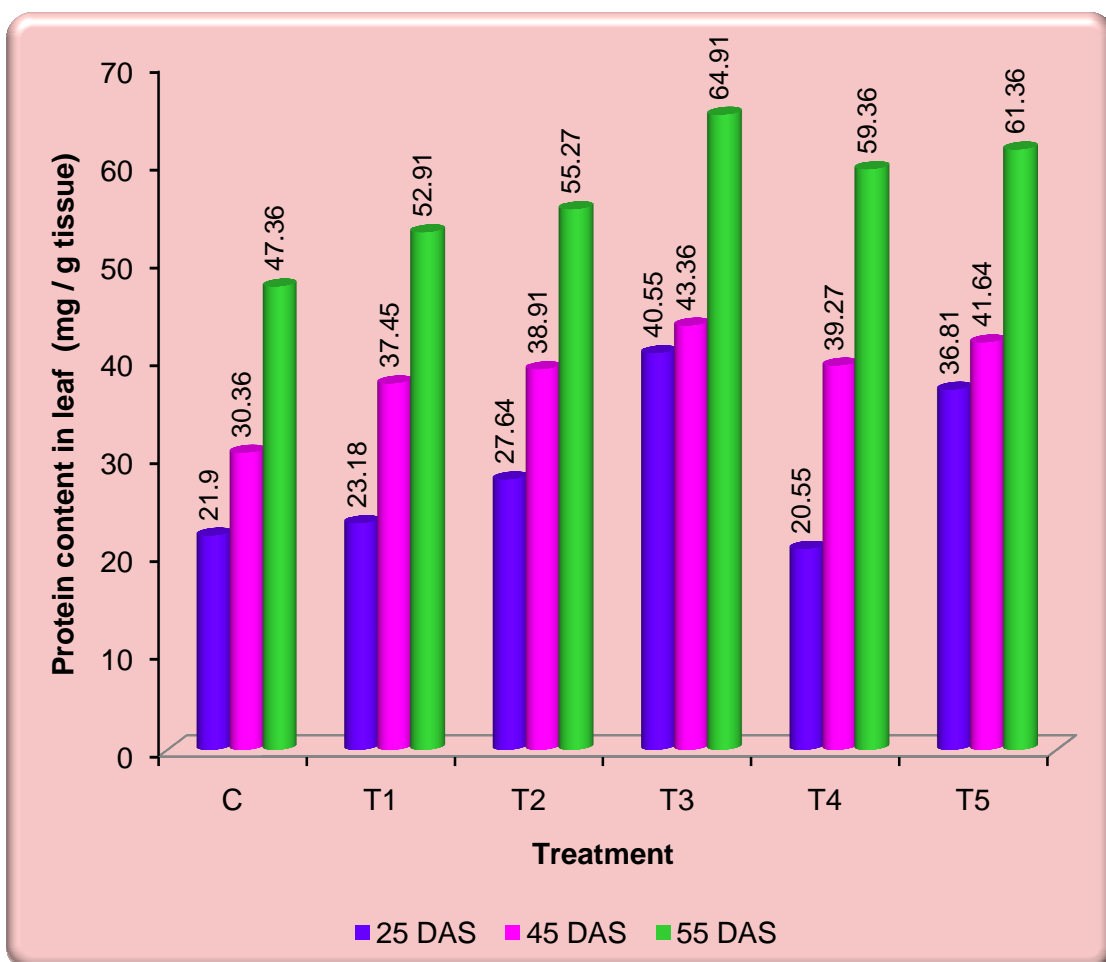
Treatment	Protein content in leaf (mg / g tissue)			Protein content in seed (mg / g tissue)
	25 DAS	45 DAS	55 DAS	55 DAS
Control	21.90	30.36	47.36	68.27
T ₁ – 10 g	23.18	37.45	52.91	74.45
T ₂ – 12.5 g	27.64	38.91	55.27	77.91
T ₃ – 15 g	40.55	43.36	64.91	89.82
T ₄ – 17.5 g	29.55	39.27	59.36	78.64
T ₅ – 20 g	36.81	41.64	61.36	82.73
SEd	0.05873			-
CD (P < 0.05)	0.11913*			0.0548*
CD (P < 0.01)	0.15973**			0.1673**

Values are mean \pm SD of three samples in each group.

* - Significant at 5% level (P < 0.05).

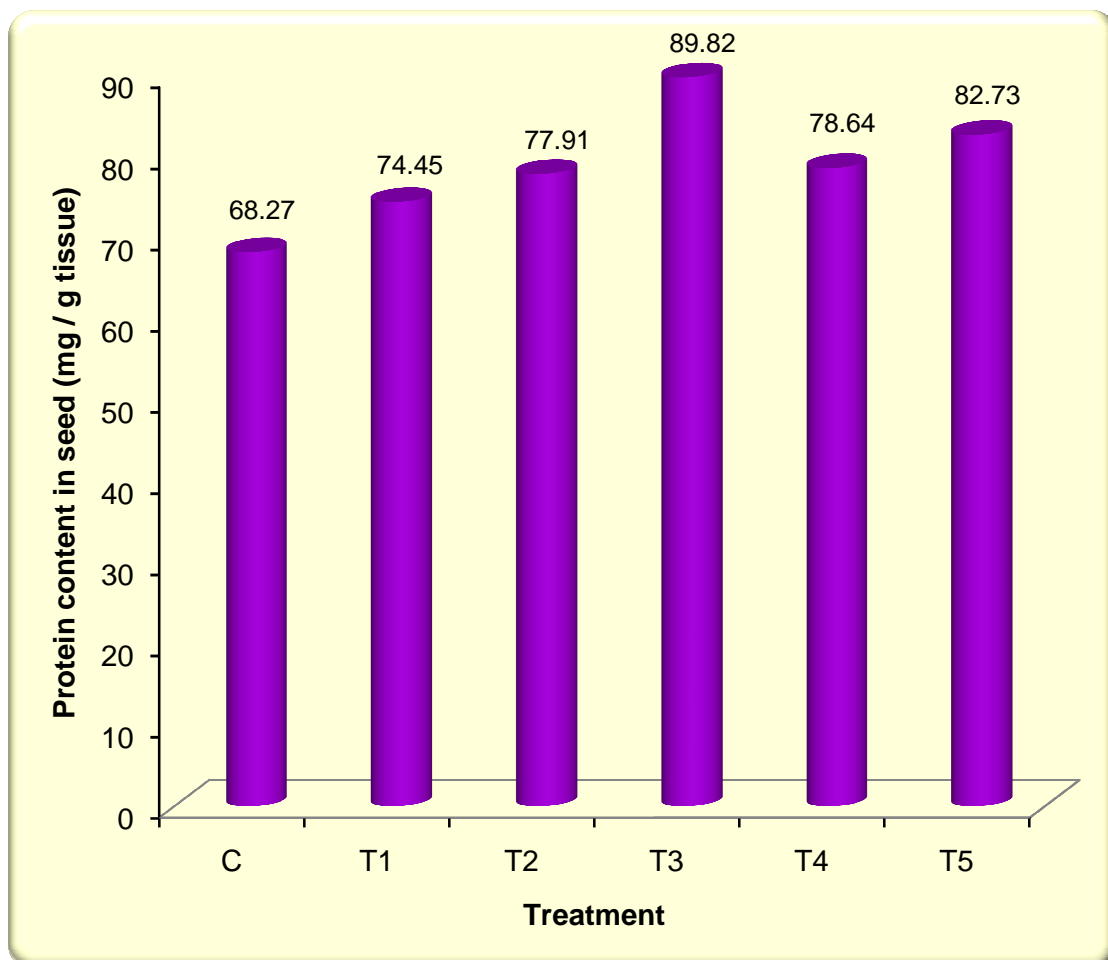
** - Significant at 1% level (P < 0.01).

FIGURE – VI
EFFECT OF VERMICOMPOSTED CORNCOB AND RHIZOBIUM ON
PROTEIN CONTENT IN LEAF OF GREEN GRAM



- C** - **Control**
T₁ - **10 g Vermicomposted corncob + *Rhizobium***
T₂ - **12.5 g Vermicomposted corncob + *Rhizobium***
T₃ - **15 g Vermicomposted corncob + *Rhizobium***
T₄ - **17.5 g Vermicomposted corncob + *Rhizobium***
T₅ - **20 g Vermicomposted corncob + *Rhizobium***

FIGURE – VII
EFFECT OF VERMICOMPOSTED CORNCOB AND RHIZOBIUM ON
PROTEIN CONTENT IN SEED OF GREEN GRAM



- C** - **Control**
T₁ - **10 g Vermicomposted corncob + *Rhizobium***
T₂ - **12.5 g Vermicomposted corncob + *Rhizobium***
T₃ - **15 g Vermicomposted corncob + *Rhizobium***
T₄ - **17.5 g Vermicomposted corncob + *Rhizobium***
T₅ - **20 g Vermicomposted corncob + *Rhizobium***

The present findings were in close conformity with that of Singh *et al.* (2014) who observed increase protein content (0.25 mg/g) in chillies with combined, application of vermicompost (2.5 t/ha) and farm yard manure (12.5 t/ha) + biofertilizer (2.5 kg/ha) *Azospirillum* + 2.5 kg/ha phosphate solubilizing bacteria.

The reason for higher nitrogen content might be due to increased activity of nitrate reductase in synthesis of protein content in leaves and seeds because it is a primary component of amino acids which are the building blocks of protein molecules.

Protein in leaf was significantly enhanced due to application of vermicomposted corncob which might be the result of increased availability of nitrogen, phosphorus, potassium and sulphur to plant.

EFFECT OF VERMICOMPOSTED CORNCOB AND RHIZOBIUM ON CARBOHYDRATE CONTENT OF GREEN GRAM (Table – X and Figures – VIII, IX)

Carbohydrate content in leaf was increased in T₃ (34.38 mg/g, 47.51 mg/g and 93.83 mg/g) followed by T₅ (21.89 mg/g, 44.56 mg/g and 75.22 mg/g) on 24, 45 and 55 DAS as compared to control (16.97 mg/g, 35.36 mg/g and 45.22 mg/g). On the 55 DAS the highest carbohydrate content in seed was noticed in the T₃ (34.38 mg/g) followed by T₅ (32.41 mg/g) when compared to control (19.71 mg/g). Similar result was found by Senthilkumar and Sivagurunathan (2012) in cowpea due to combined inoculation of bacterial fertilizers (*Rhizobium* + Phosphobacteria + *Azospirillum*).

The present study is in correlation with Vijayakumari *et al.* (2009) who observed maximum carbohydrate content (22.44) in radish with the application of vermicomposted parthenium (43.75 g).

TABLE – X
EFFECT OF VERMICOMPOSTED CORNCOB AND RHIZOBIUM ON CARBOHYDRATE CONTENT OF GREEN GRAM

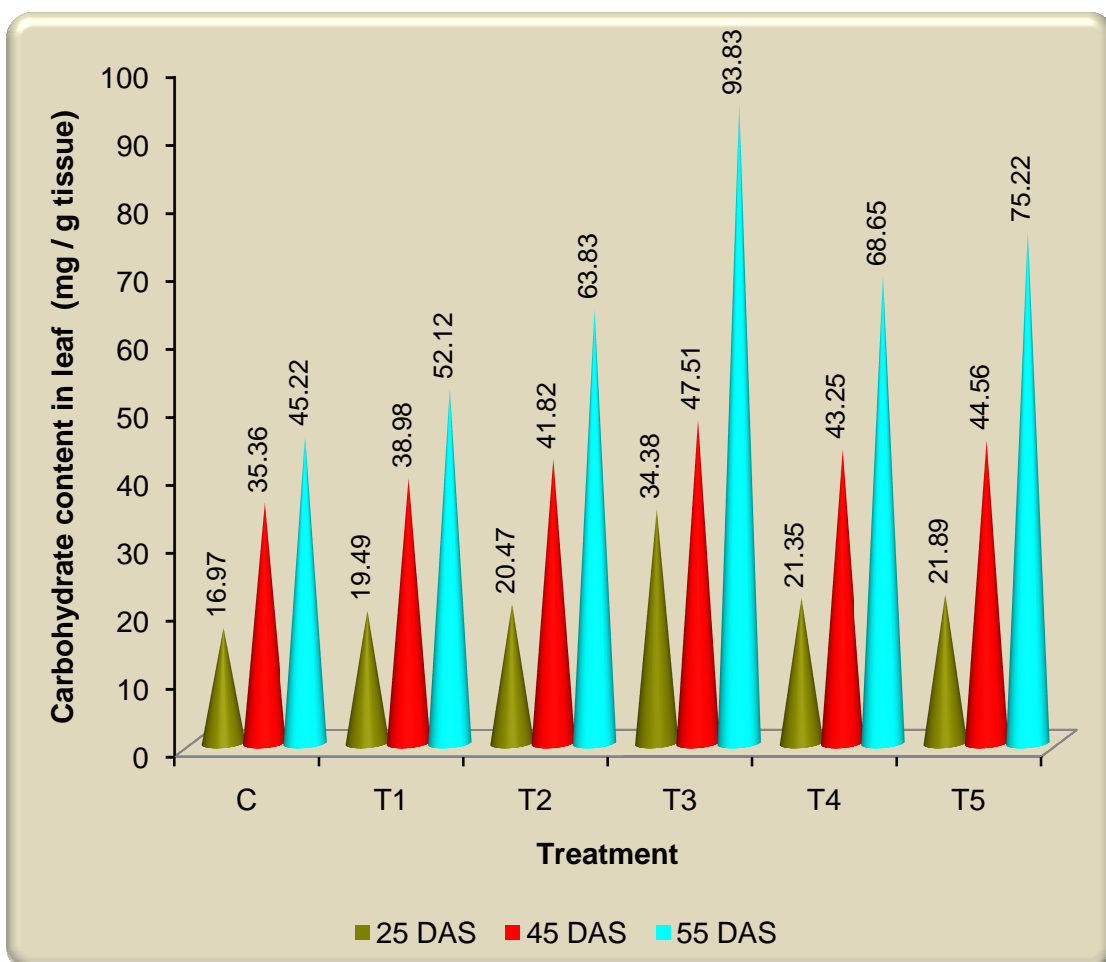
Treatment	Carbohydrate content in leaf (mg / g tissue)			Carbohydrate content in seed (mg / g tissue)
	25 DAS	45 DAS	55 DAS	55 DAS
Control	16.97	35.36	45.22	19.71
T ₁ – 10 g	19.49	38.98	52.12	22.77
T ₂ – 12.5 g	20.47	41.82	63.83	26.50
T ₃ – 15 g	34.38	47.51	93.83	34.38
T ₄ – 17.5 g	21.35	43.25	68.65	30.44
T ₅ – 20 g	21.89	44.56	75.22	32.41
SEd	0.07501			
CD (P < 0.05)	0.15214*			0.0702*
CD (P < 0.01)	0.20400**			0.2145**

Values are mean \pm SD of three samples in each group.

* - Significant at 5% level (P < 0.05).

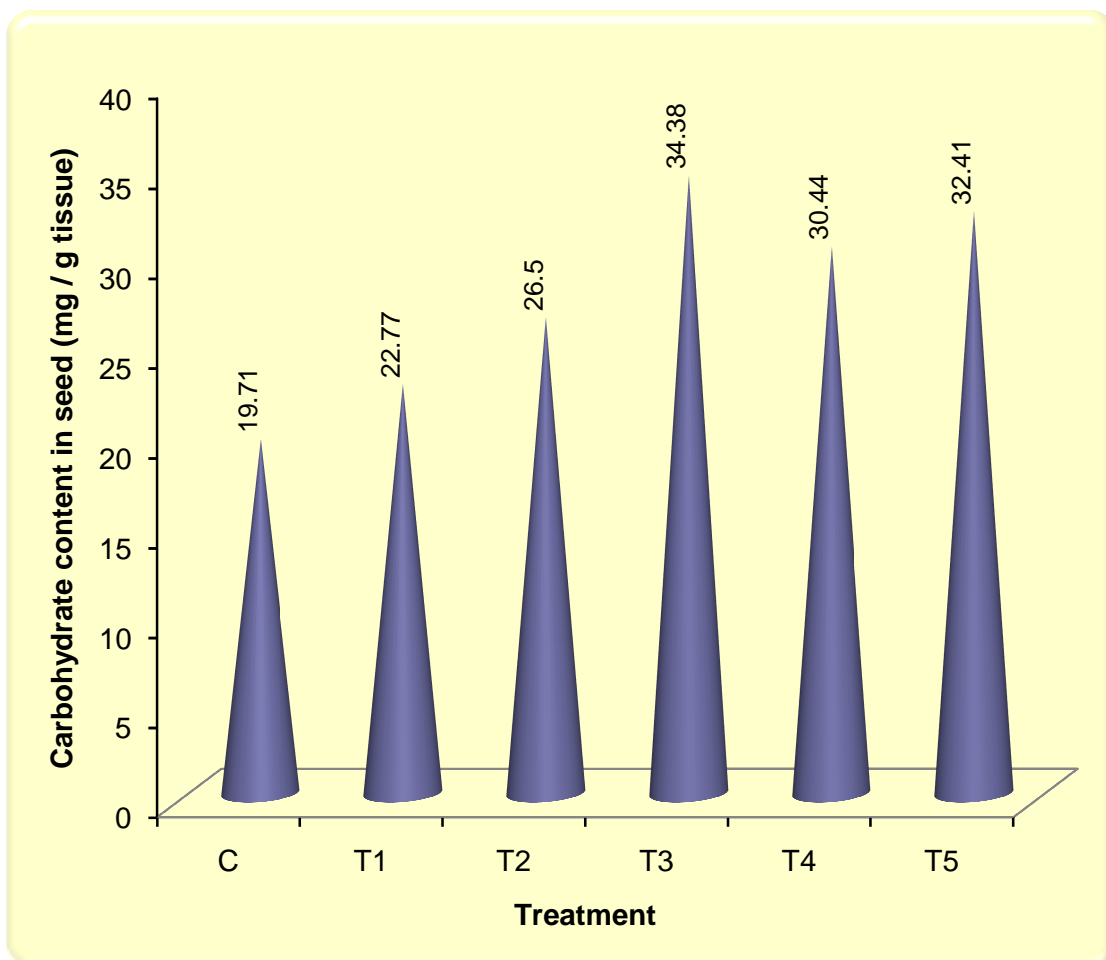
** - Significant at 1% level (P < 0.01).

FIGURE – VIII
EFFECT OF VERMICOMPOSTED CORNCOB AND RHIZOBIUM ON
CARBOHYDRATE CONTENT IN LEAF OF GREEN GRAM



- C** - **Control**
T₁ - **10 g Vermicomposted corncob + *Rhizobium***
T₂ - **12.5 g Vermicomposted corncob + *Rhizobium***
T₃ - **15 g Vermicomposted corncob + *Rhizobium***
T₄ - **17.5 g Vermicomposted corncob + *Rhizobium***
T₅ - **20 g Vermicomposted corncob + *Rhizobium***

FIGURE – IX
EFFECT OF VERMICOMPOSTED CORNCOB AND RHIZOBIUM ON
CARBOHYDRATE CONTENT IN SEED OF GREEN GRAM



- C** - **Control**
T₁ - **10 g Vermicomposted corncob + *Rhizobium***
T₂ - **12.5 g Vermicomposted corncob + *Rhizobium***
T₃ - **15 g Vermicomposted corncob + *Rhizobium***
T₄ - **17.5 g Vermicomposted corncob + *Rhizobium***
T₅ - **20 g Vermicomposted corncob + *Rhizobium***

The increase in carbohydrate content might be due to the enormous amount of organic carbon present in the vermicomposted corncob which enhances the carbohydrate content in the green gram.

EFFECT OF VERMICOMPOSTED CORNCOB AND RHIZOBIUM ON LEGHAEMOGLOBIN CONTENT OF GREEN GRAM (Table – XI)

On the 45 DAS leghaemoglobin content was highest in T₃ (0.055 mg/g) when compared to control (0.032 mg/g). On the 55 DAS the leghaemoglobin content was highest in treatment T₃ (0.518 mg/g) when compared to control (0.127 mg/g). Similar result was found by Verma *et al.* (2014) an enhancement in leghaemoglobin content in root nodules (1.94 mg/g) of fenugreek due to the application of vermicompost (4 t/ha).

Similar results were positively correlated with the findings of Sharma *et al.* (2011) in groundnut with the inoculation of *Rhizobium* (6.8%) strain IRC – 6 an enhancement in leghaemoglobin content (1 – 8 mg/g) was found. Results were also in accordance with Tagore *et al.* (2013) who reported maximum leghaemoglobin content (2-55 mg/g) in chickpea due to combined inoculation of *Rhizobium* + phosphate solubilising bacteria. Increase leghaemoglobin content might be due to increased nitrogen in the root nodules by the nitrogen fixing bacteria.

EFFECT OF VERMICOMPOSTED CORNCOB AND RHIZOBIUM ON YIELD PARAMETERS OF GREEN GRAM (Table – XII and Plate – VI)

Length and Weight of the Pod (Figures – X and XI)

At the harvested stage (55 DAS) the length of pod was increased in the treatments T₃ (9.47 cm) followed by T₅ (8.70 cm) and T₄ (7.27 cm) when compared to the control (4.50 cm). The weight of the pod increased in the treatment T₃ (0.94 g) followed by T₅ (0.86 g) when compared to the control (0.47 g). The present results are in agreement with work of Verma and Decker (2011) who observed increased pod length (12.8%) and pod weight (10.9%)

TABLE – XI
EFFECT OF VERMICOMPOSTED CORNCOB AND RHIZOBIUM
ON LEGHAEMOGLOBIN CONTENT OF GREEN GRAM

Treatment	Leghaemoglobin content (mg / g tissue)	
	45 DAS	55 DAS
Control	0.032	0.127
T ₁ – 10 g	0.036	0.167
T ₂ – 12.5 g	0.040	0.190
T ₃ – 15 g	0.055	0.518
T ₄ – 17.5 g	0.044	0.237
T ₅ – 20 g	0.046	0.298
SEd		
CD (P < 0.05)	0.0702*	
CD (P < 0.01)	0.2145**	

Values are mean \pm SD of three samples in each group.

* - Significant at 5% level (P < 0.05).

TABLE – XII
EFFECT OF VERMICOMPOSTED CORNCOB AND RHIZOBIUM ON YIELD PARAMETERS OF GREEN GRAM

Treatment	Length of pods (cm)	Weight of pods (g)	Number of seeds per pod	Weight of seeds per pod (g)
Control	4.50 ± 0.10	0.47 ± 0.03	5.00 ± 0.12	0.34 ± 0.02
T ₁ – 10 g	5.40 ± 0.10	0.52 ± 0.03	5.67 ± 0.38	0.40 ± 0.03
T ₂ – 12.5 g	6.33 ± 0.15	0.66 ± 0.02	6.67 ± 0.43	0.47 ± 0.03
T ₃ – 15 g	9.47 ± 0.15	0.94 ± 0.02	11.65 ± 0.58	0.79 ± 0.04
T ₄ – 17.5 g	7.27 ± 0.25	0.75 ± 0.03	7.33 ± 0.57	0.56 ± 0.02
T ₅ – 20 g	8.70 ± 0.20	0.86 ± 0.02	9.67 ± 0.59	0.72 ± 0.02
SEd	0.1374	0.0191	0.4303	0.0208
CD (P < 0.01)	0.4198**	0.0582**	1.3145**	0.0636**

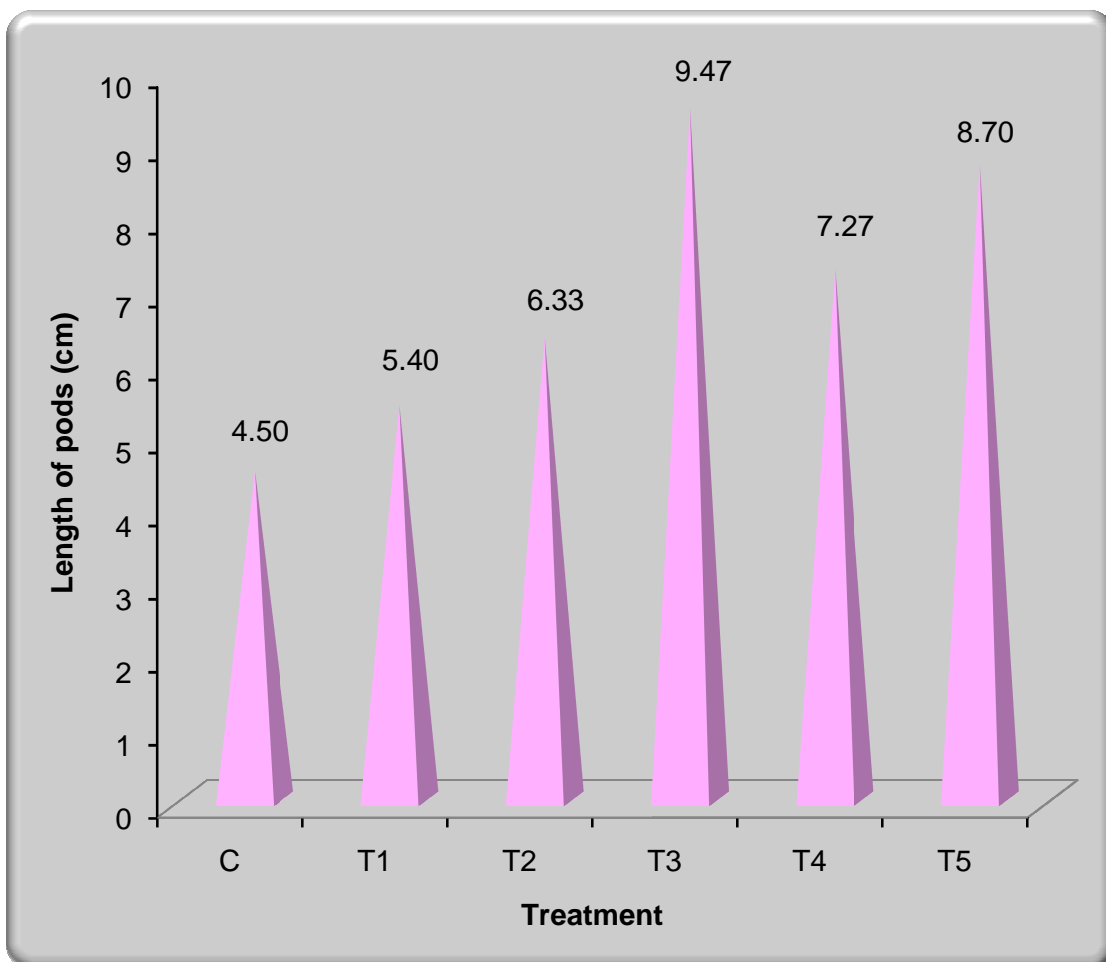
Values are mean ± SD of three samples in each group.

** - Significant at 1% level (P < 0.01).

PLATE – VI
EFFECT OF VERMICOMPOSTED CORNCOB ON
PODS OF GREEN GRAM

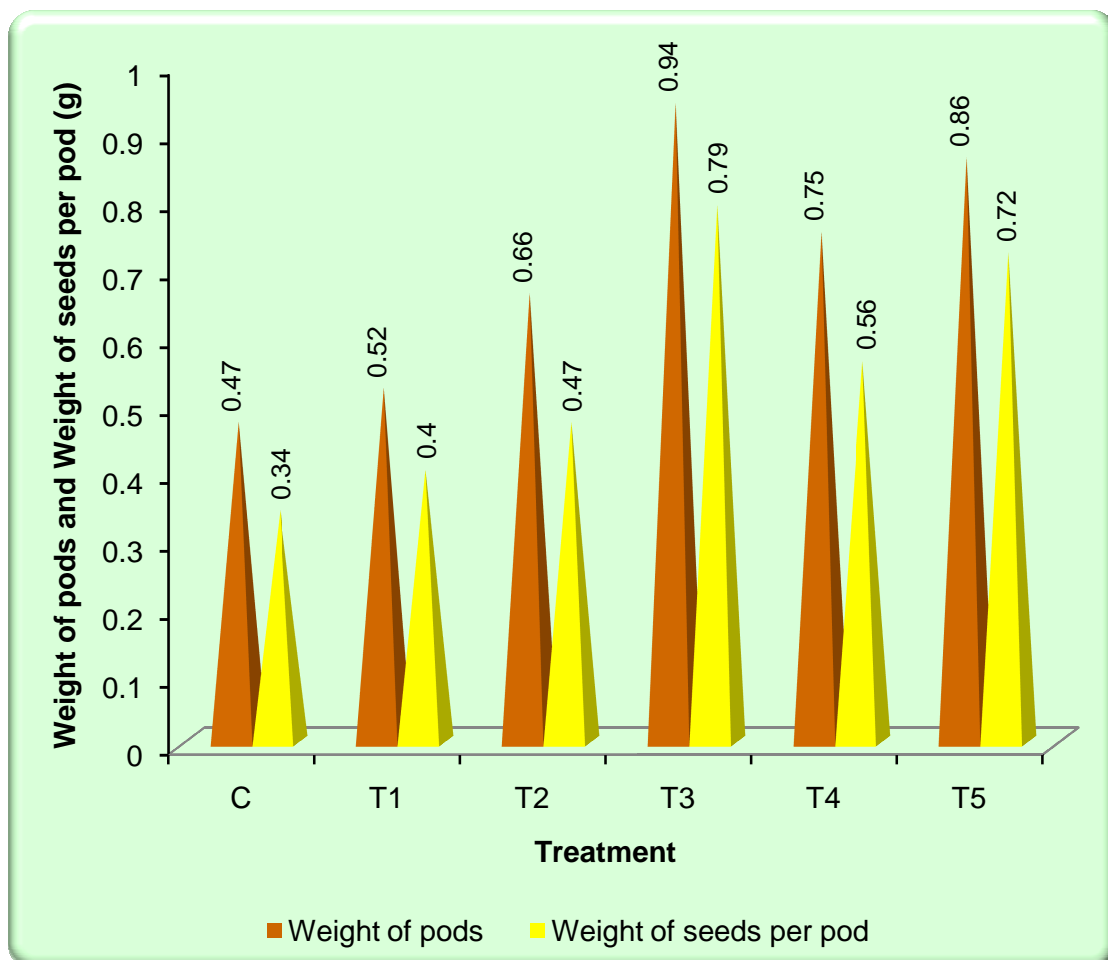


FIGURE – X
EFFECT OF VERMICOMPOSTED CORNCOB AND RHIZOBIUM ON
POD LENGTH IN GREEN GRAM



- C** - **Control**
T₁ - **10 g Vermicomposted corncob + *Rhizobium***
T₂ - **12.5 g Vermicomposted corncob + *Rhizobium***
T₃ - **15 g Vermicomposted corncob + *Rhizobium***
T₄ - **17.5 g Vermicomposted corncob + *Rhizobium***
T₅ - **20 g Vermicomposted corncob + *Rhizobium***

FIGURE – XI
EFFECT OF VERMICOMPOSTED CORNCOB AND RHIZOBIUM ON
WEIGHT OF POD AND WEIGHT OF SEEDS PER POD IN GREEN GRAM



- C** - **Control**
T₁ - **10 g Vermicomposted corncob + *Rhizobium***
T₂ - **12.5 g Vermicomposted corncob + *Rhizobium***
T₃ - **15 g Vermicomposted corncob + *Rhizobium***
T₄ - **17.5 g Vermicomposted corncob + *Rhizobium***
T₅ - **20 g Vermicomposted corncob + *Rhizobium***

due to the combined application of NP_2O_5 , K_2O fertilizer (8 : 13 : 10 kg) + vermicompost (3.75 kg/ha) in French bean.

The findings were in close conformity with that of Natchimuthu and Daniel (2008) who observed an increase in the length of pod (9.44 cm) and weight of pod (5.73 g) of hyacinth bean with application of vermicompost (5 t/ha) using *Lampito mauritti* and *Rottboellia exaltata*.

The increase in pod length and weight may be due to application of vermicomposted corncob and the usage of seeds inoculated with biofertilizers (*Rhizobium*) which might have released more nutrients in the soil available to the crop.

Number and Weight of Seed per Pod (Figures – XII)

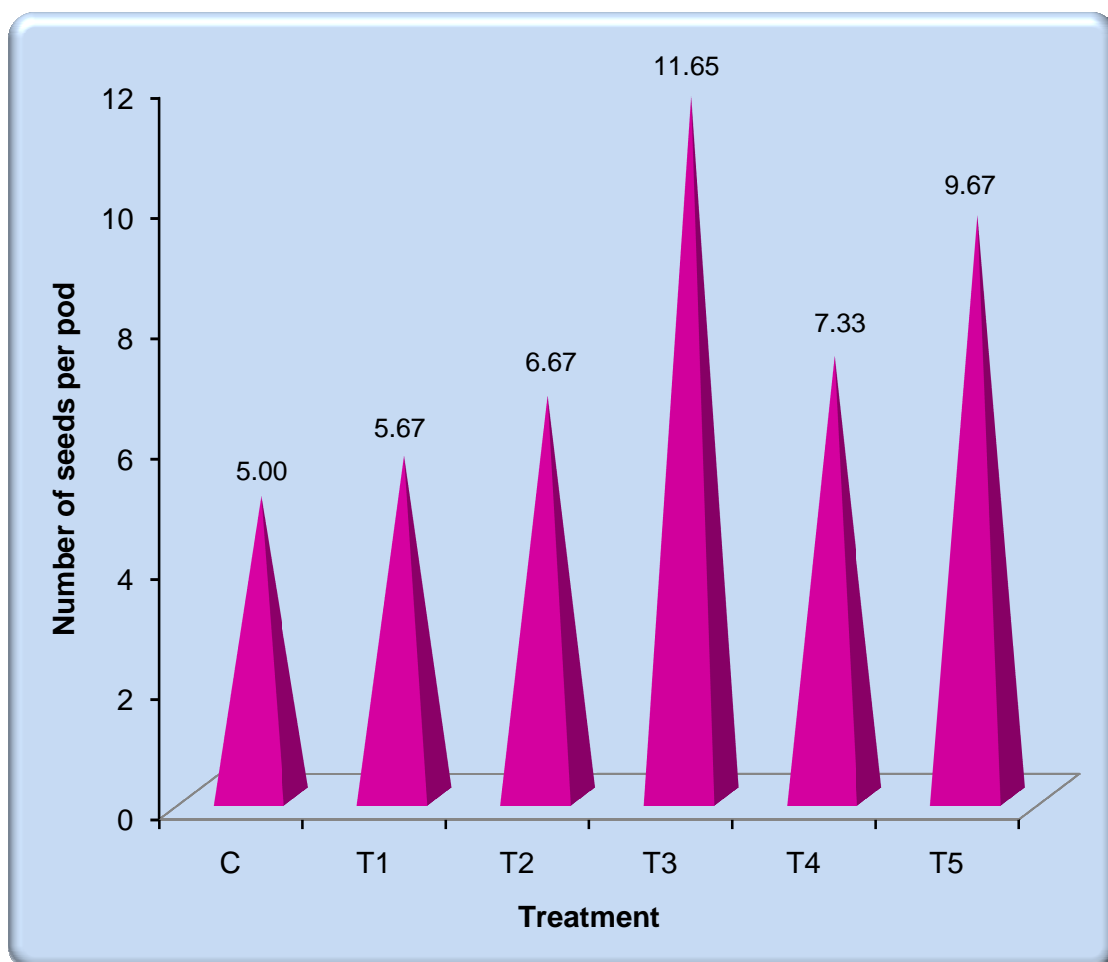
At the harvest stage (55 DAS) the number of the seeds per pod was significantly increased in the treatment T_3 (11.65) followed by T_5 (9.67) when compared with control (5.0). The weight of seeds per pod was observed higher in the treatment T_3 (0.79 g) followed by T_5 (0.72 g) when compared to control (0.34 g). This results agrees with Kavitha and Nagendran (2000) who revealed that there was significant effect on number of grains per plant in wheat (cv. Raj 3777 and cv. Raj 3765) due to application of vermicompost.

Similar results were positively correlated with the findings of Chavan (2015) in cluster bean with the application of vermicompost which enhanced the number of seeds per pod (7.5) and weight of seeds (1.62 g).

Similar results were correlated with findings of Azarpour *et al.* (2012) in soybean that the application of vermicompost (10 t/ha) enhanced the number of seeds per plant (60.29), seed yield (2868 kg/ha) and 100 seed weight (16.25 g).

Vermicomposted corncob enhanced the humus content and improved soil condition which resulted in healthier and more nutrient status of plants hence a maximum number of seeds were obtained in above treatments.

FIGURE – XII
EFFECT OF VERMICOMPOSTED CORNCOB AND RHIZOBIUM
NUMBER OF SEEDS PER POD IN GREEN GRAM



- C** - **Control**
T₁ - **10 g Vermicomposted corncob + *Rhizobium***
T₂ - **12.5 g Vermicomposted corncob + *Rhizobium***
T₃ - **15 g Vermicomposted corncob + *Rhizobium***
T₄ - **17.5 g Vermicomposted corncob + *Rhizobium***
T₅ - **20 g Vermicomposted corncob + *Rhizobium***

CHAPTER – V

SUMMARY AND CONCLUSION

The effects of vermicomposted corncob on seedling growth, vegetative characters, biochemical parameters, leghaemoglobin content analysis and yield of green gram were analysed and the results were summarized.

On 7 DAS of seedling growth a significant increase was noted in the treatments. The parameters like epicotyl length, hypocotyl length, root length, number of lateral roots, protein and carbohydrate content were increased in vermicomposted corncob treatment at 500 ppm concentration.

The application of vermicomposted corncob (15 g) + *Rhizobium* treatment significantly increased the vegetative parameters like shoot length, root length, number of leaves, number of nodules, plant fresh weight and dry weight on 25, 45 and 55 days after sowing.

Biochemical parameters like protein, carbohydrate, chlorophyll 'a', chlorophyll 'b' and 'total' chlorophyll were increased in green gram T₃ vermicomposted corncob (15 g) + *Rhizobium* treatment. Leghaemoglobin content was significantly increased in T₃ vermicompost corncob 15 g + *Rhizobium* treatment.

The yield parameters like length of the pod, weight of the pod, number of seeds per pod, weight of seeds per pod were increased significantly in green gram by T₃ vermicomposted corncob 15 g and *Rhizobium* treatment.

CONCLUSION

Disposal of waste material into the environment causes environmental pollution, health hazards to the people and affects the crop productivity. Organic waste is also responsible for pollution of soil and water bodies but if they are recycled properly they serve as a good source of plant nutrients.

They enrich the soil fertility and increase the crop productivity. Organic manures improve the physical, chemical and biological properties of the soil.

From the present investigation it has become evident that the combination of biofertilizers with organic manures positively influence the biometrical, biochemical, leghaemoglobin content and yield characters of green gram. Hence it was concluded that the vermicomposted corncob can be used as an organic manure for crop productivity.

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