Shahin Sultana Asian University for women

Comparative Assessment of Cow Manure Vermicompost and NPK Fertilizer on the Growth of Zinnia *(Zinnia Elegans)* Plant

ABSTRACT:

A pot experiment was carried out to explore the comparative effect of cow manure vermicompost and NPK fertilizer on the growth of Zinnia *(Zinnia Elegans).* An air dried sandy loam soil was mixed with three rates of vermicompost equivalent to 5, 10, 20 ton·ha–1 and four rates of NPK fertilizer equivalent to 50% (N-P-K = 69-16-35 kg·ha–1), 100% (N-P-K = 137-32-70 kg·ha–1 K), 200% (N-P-K = 274-64-140 kg·ha–1) and 400% (N-P-K=548-128-280 kg.ha-1). Two plants were grown in each pot. After blooming of flowers, the plants were harvested at 50 days of growth and leaves and stems were separated. The growth parameters (shoot height, leaf number, leaf length, leaf diameter, fresh and dry weight of flower, leaf, stem and root, root length, total number of flower, flower diameter) increased by the rates of cow manure vermicompost and NPK fertilizer treatments. Among the treatments, growth performance of Zinnia was better with the highest rate of 20 ton·ha–1 vermicompost treatments. The result shows that the growth performance of 5% vermicompost treatment is higher than the 400% NPK fertilizer treatment. Moreover, the result of the present study indicated that 5 ton·ha–1 vermicompost could be used instead of 400% NPK fertilizer to get better yield and to improve soil conditions.

Key words: NPK fertilizer, vermicompost, Zinnia

1. Introduction

Farmers use synthetic fertilizers to increase the yield of their crops and improve soil fertility. However, the use of synthetic fertilizers causes a great impact on the soil quality of the environment. After the application of NPK fertilizer in soil, they go various transformation processes. For example, dynamics of N in the soil-plant-atmosphere system includes various soil processes like mineralization, immobilization, urea hydrolysis, Nitrification, volatilization and denitrification (Impact of fertilizer on the environment). There are some environmental consequence are described in below due to the NPK fertilizer uses and vermicompost application.

1.1. Environmental Consequences of NPK Fertilizer Uses

1.1.1. Nitrate Pollution in Groundwater

Pollution of groundwater from N fertilizer as nitrate (NO_3^-) is caused by leaching. As groundwater is polluted by nitrate (NO_3), there is health risks identify due to this pollution. Two main health hazards, blue baby disease of young babies and cancer, occur due to nitrate ingestion in food and water. As young babies cannot detoxify the nitrate, it is converted into nitrite in the intestine and absorbed in the blood stream. Then, it is combined with blood hemoglobin and form methaemoglobin which reduces the capacity of blood to carrying oxygen. The skin becomes grey or blue in color, which is known as "methaemoglobinaemia" or "blue baby syndrome" (Impact of fertilizer on the environment).

1.1.2. Eutrophication

Eutrophication on surface water is another major problem associated with excess fertilizer use. After application of Phosphorus in soil, it is either removed by crop or converted into various insoluble forms (Fe and Al phosphate in acid soil and Ca-phosphate in alkaline soil). Potassium is the most abundant plant nutrient in soil and it is more mobile than phosphate. That is why; it is vulnerable to loss by leaching, runoff and erosion (Impact of fertilizer on the environment, Ashoka et al., 2012). When considerable amounts of nitrate, phosphate, potassium and other nutrients mainly go through run-off and erosion, they add and enrich the nutrients in water body. The increase nutrient leads to growth of algae which is responsible to die fish and other organisms in water body due to less oxygen demand. This is called eutrophication (Impact of fertilizer on the environment).

1.1.3. Ammonia Volatilization

Volatilization of NH_3 is not only a major loss of N but also a cause of environmental pollution. From atmosphere, NH_3 is washed out by clouds and redeposit on the terrestrial ecosystem. In northern Europe, it has been estimated that 94% of the NH_3 is released from agricultural sources and re-deposited into surrounding ecosystems. Moreover, in atmosphere, it is oxidized to N_2O which acts as a greenhouse gas and responsible for the destruction of ozone layer. It also forms salts with acidic gases and these salt particles can be transported long distances especially in the absence of clouds and redeposit (Impact of fertilizer on the environment).

1.1.4. Acid Rain

Nitrogenous fertilizers contribute ammonia emissions, which is one of the agents for causing acid rain. A high atmospheric concentration of ammonia results in acidification of land and water surfaces, which cause plant damage and reduce plant bio-diversity in natural systems (Impact of fertilizer on the environment).

1.1.5. Greenhouse Gases

Greenhouse gases (GHGs) are atmospheric compounds that store energy and influencing climate. For example, Nitrogen fertilizer inputs only 0.5 percent of NO emissions although Nitrogen oxides are not greenhouse gases. However, both nitric oxide (NO) and nitrogen dioxide (NO_2) react in sunlight with volatile organic compounds to form tropospheric ozone (O_3). Ozone is toxic to crops even at low concentrations and detrimental to the health of sensitive individuals. Moreover, nitrogen fertilizers are direct or indirect source of N_2O which accounts for only 0.8 per cent of the N_2O emission and it is a greenhouse gas (Impact of fertilizer on the environment).

1.1.6. Trace Element and Heavy Metals Contamination

There is an increasing concern about the occurrence of trace elements concentration in the environment, which is harmful for plant and animal health. Phosphatic fertilizers, in particular, contain various amounts of trace elements such as F, As, Cd, Co, Cr, Hg. Mo, Ni and Pb. It becomes a concerning issue because of i) soil accumulation and possibility of the long-term effects on crop yields and quality, ii) plant uptake and the content of the element in animal feed and human diet iii) potentially damage soil micro flora and iv) direct exposure to human through contact and ingestion (Impact of fertilizer on the environment).

As NPK fertilizer has negative impacts on soil, plant growth and surrounding environment, so, vermicompost was used for this study as organic fertilizer to compare various growth parameters of plant. Like NPK fertilizer, the environmental consequences of vermicompost are discussed below:

1.2. Vermicompost

Vermicomposting is a non-thermophilic and simple biotechnological process of composting, in which certain species of earthworms and microorganisms are used for biological degradation of organic waste (Khan and Ishaq, 2011, Arancon and Edwards, 2005). Vermicompost is aerobically decomposed products of organic wastes such as cattle dung and animal droppings, farm and forest wastes, vegetative waste, municipal solid wastes (MSW). However, for this study, cow manure was used as source of vermicompost because it is available in rural areas.

1.2.1. Types of earthworms

Earthworms are invertebrates. There are nearly 3600 types of earthworms in the world and they are mainly divided into two types:

(1) burrowing; and (2) non-burrowing.

The burrowing types *Pertima elongata* and *Pertima asiatica* live deep in the soil and come onto soil surface at night. The burrowing types are 20 to 30 cm long, pale and live for 15 years. Furthermore, they make holes in the soil up to a depth of 3.5 m and produce 5.6 kg casts by ingesting 90% soil and 10% organic waste (Nagavallemma et al., 2006).

On the other hand, the non-burrowing types *Eisenia fetida* and *Eudrilus eugenae* live in the upper layer of soil surface. The non-burrowing types are 10 to 15 cm long, red or purple but their life span is only 28 months. They eat 10% soil and 90% organic waste materials and convert the organic waste into vermicompost faster than the burrowing earthworms. They can tolerate temperatures ranging from 0 to 40°C but the regeneration capacity is more at 25 to 30°C and 40–45% moisture level in the pile (Nagavallemma et al., 2006).

The most appropriate species for producing vermicompost is *Eisenia Fetida* which is reddish brown and smaller than ordinary earthworms (Abduli et al., 2013, Yadev et al., 2013, Angima et al., 2011). The population of the earthworm increases by geometrical progression. Earthworms consume various organic wastes and reduce the volume by 40–60%. Each earthworm weights about 0.5 to 0.6 g and eats waste equivalent to its body weight and produces cast equivalent to about 50% of the waste it consumes in a day (Nagavallemma et al., 2006). So, there are about 1000 to 2000 worms per kilogram (Abduli et al., 2013). The moisture content of castings ranges between 32 and 66% and the pH is nearly neutral (Nagavallemma et al., 2006).

1.2.2. Converted of organic waste by Earthworm

Earthworms consume organic wastes and fragment them into finer particles by passing them through a grinding gizzard and derive their nourishment from microorganisms that grow upon them. As decomposition rate of organic matter accelerate by the time, the physical and chemical properties of the materials alter. Then, the materials lead to a humification effect in which the unstable organic matter is fully oxidized and stabilized. The end product is greatly humified through the fragmentation of parent organic materials by earthworms and colonization of microorganisms, which is commonly referred as vermicompost (Arancon and Edwards, 2005). Walpola and Wanniarachchi (2009) reported that 1000 tons of moist organic manure can be converted into 300 tons of compost by earthworms.

1.2.3. Environmental Consequences of Vermicompost Use

1.2.3.1. High levels of bio-available nutrients for plants

Vermicompost contains most nutrients in plant-available forms such as nitrates from (N), phosphates from (P), soluble potassium from (K) and magnesium (Mg) and exchangeable phosphorus (P) & calcium (Ca). It is also showed that exchangeable potassium (K) is over 95% higher in vermicompost (Earthworms Vermicompost: A Powerful Crop Nutrient over the Conventional Compost & Protective Soil Conditioner against the Destructive Chemical Fertilizers for Food Safety and Security, 2009). So, plants can easily take nutrients of readily form.

1.2.3.2. High level of beneficial soil microorganisms promoting plant growth

Vermicompost are rich in microbial populations and diversity particularly fungi, bacteria and actinomycetes. It is also reported that bacterial count is 32 million per gram in fresh vermicompost compared to 6-9 million per gram in the surrounding soil. It also has beneficial soil microbes like ‘nitrogen-fixing bacteria’ and ‘mycorrhizal fungi’, which plays important role in plant growth (Earthworms Vermicompost: A Powerful Crop Nutrient over the Conventional Compost & Protective Soil Conditioner against the Destructive Chemical Fertilizers for Food Safety and Security, 2009).

1.2.3.3. Rich in growth hormones: Biochemical stimulating total plant growth

Researches show that Vermicompost stimulates plant growth even when plants are already receiving optimal nutrition. It is also reported that vermicompost contains growth promoting hormone ‘auxins’, ‘cytokinins’ and flowering hormone ‘gibberellins’ secreted by earthworms, which stimulates plants growth in various parameters (Earthworms Vermicompost: A Powerful Crop Nutrient over the Conventional Compost & Protective Soil Conditioner against the Destructive Chemical Fertilizers for Food Safety and Security, 2009).

1.2.3.4. Rich in humic acids: Biochemical promoting root growth & nutrient uptake:

It is reported that humic acids isolated from vermicompost enhanced root elongation and formation of lateral roots in maize. Vermicompost enhance the nutrient uptake by increasing the permeability of root cell membrane, stimulating root growth and increasing proliferation of root hairs in plant (Mamta et al., 2012, Abduli et al., 2013, Earthworms Vermicompost: A Powerful Crop Nutrient over the Conventional Compost & Protective Soil Conditioner against the Destructive Chemical Fertilizers for Food Safety and Security, 2009)

1.2.3.5. Rich in enzyme activity:

Vermicompost contains some enzymes like amylase, lipase, cellulase and chitinase, which continue to break down organic matter in the soil and helps to release nutrients and make it available to plant roots. Moreover, annual application of suitable amount of vermicompost lead to significant increase in soil enzyme activities such as ‘urease’, ‘phosphomonoesterase’, ‘phosphodiesterase’ and ‘arylsulphatase’ (Najar and Khan, 2013, Earthworms Vermicompost: A Powerful Crop Nutrient over the Conventional Compost & Protective Soil Conditioner against the Destructive Chemical Fertilizers for Food Safety and Security, 2009)

1.2.3.6. Enhance plant growth and disease suppression

Vermicompost contains a high proportion of humic substances (humic acids, fulvic acids and humin) which provide numerous sites for chemical reaction. Microbial components known to enhance plant growth and disease suppression through the activities of bacteria (Bacillus), yeast (Sporobolomyces and Cryptococcus), fungi (Trichoderma) as well as chemical antagonists such as phenols and amino acids (Najar and Khan, 2013).

1.2.3.7. Protects plants against various pests and diseases

There has been evidence that vermicompost protects plants against various pests and diseases either by suppressing or repelling them or by inducing biological resistance in plants to fight them or by killing them through pesticidal action (Mamta et al., 2012, Earthworms Vermicompost: A Powerful Crop Nutrient over the Conventional Compost & Protective Soil Conditioner against the Destructive Chemical Fertilizers for Food Safety and Security, 2009). Vermicompost contains some antibiotics and actinomycetes which help in increasing the ‘power of biological resistance’ among the crop plants against pest and diseases. For this reason, pesticide spray was significantly reduced where vermicompost was used in agriculture (Ashoka et al., 2012, Najar and Khan, 2013, Earthworms Vermicompost: A Powerful Crop Nutrient over the Conventional Compost & Protective Soil Conditioner against the Destructive Chemical Fertilizers for Food Safety and Security, 2009)

1.2.3.8. Free of toxic chemicals:

Several studies have found that earthworms effectively bioaccumulate or biodegrade several organic and inorganic chemicals including ‘heavy metal’, ‘organochlorine pesticide’ and ‘polycyclic aromatic hydrocarbons’ (PAHs) residues in the medium in which it inhabits (Earthworms Vermicompost: A Powerful Crop Nutrient over the Conventional Compost & Protective Soil Conditioner against the Destructive Chemical Fertilizers for Food Safety and Security, 2009). As earthworm plays an important role for biodegrade heavy metals and other chemical substances, so there is no negative impacts on soil and thus plant growth will be fast by the vermicompost application.

1.2.3.9. Improve soil texture:

Several Studies showed that soil amended with vermicompost had significantly greater ‘soil bulk density’ and hence improves soil aeration and texture, which helps to reduce soil compaction and absorb water and minerals by plants (Walpola and Wanniarachchi, 2009, Earthworms Vermicompost: A Powerful Crop Nutrient over the Conventional Compost & Protective Soil Conditioner against the Destructive Chemical Fertilizers for Food Safety and Security, 2009). Vermicompost is pit like material which has very high porosity, aeration, drainage and water holding capacity. They also have a vast surface area, providing strong absorbability and retention of nutrients (Mamta et al., 2012, Arancon and Edwards, 2005, Najar and Khan, 2013). Furthermore, it is nutritionally rich organic fertilizer, which releases nutrients moderately slowly in the soil. Then, it enables the plants to absorb these nutrients over time and improves plants’ quality along with physical and biological properties of soil and thus ultimately plays vital role for crops yield (Khan and Ishaq, 2011, Walpola and Wanniarachchi, 2009, Earthworms Vermicompost: A Powerful Crop Nutrient over the Conventional Compost & Protective Soil Conditioner against the Destructive Chemical Fertilizers for Food Safety and Security, 2009).

Main objectives of the study:

1. To reduce the negative impacts of inorganic fertilizer (NPK) on soil health, plants and environment by using vermicompost.
2. To use organic fertilizer instead of inorganic fertilizer as the cost of inorganic fertilizer is increasing.
3. Reduces the pool of waste from our environment by using them as source of vermicompost and keep our environment clean.

2. Materials and Methods

2.1. Plant Growth Experiment

A pot experiment was carried out in the roof of a building of Asian University for women in Chittagong, Bangladesh using a sandy loam surface soil (0-15 cm). Soil sample was air dried and passed through 4-mm sieve for using it in the pots. For laboratory analysis, a sub sample was air dried and passed through a 2-mm sieve and stored. Soil pH was of 5.07 (1:2.5 soil to water ratio), organic carbon was (Walkley and Black, 1934) 0.93% and CEC (extraction with 1 M NH4OAc} (Soil Survey Laboratory Staff, 1992) was of 4.01 cmol·kg–1. The soil contained 73% sand, 13% silt and 14% clay measured by hydrometer method (Bouyoucos, 1962). Vermicompost was collected from the composting plant of Meherpur, sieved and analyzed for chemical properties. The pH of vermicompost was 7.13. Three rates of vermicompost equivalent to 0 (control), 5, 10, 20 t·ha–1 and four NPK fertilizer rates equivalent to 50% (N-P-K = 69-16-35 kg·ha–1), 100% (N-P-K = 137-32-70 kg·ha–1), 200% (N-P-K = 274 -64-140 kg·ha–1) and 400% (N-P-K=548-128-280 kg.ha-1) were applied separately in each pot containing three (3) kg soil. Before having soil in each pot, a small piece of foam was used on the hole of pot to protect loss of any dose or nutrient. The pots were arranged in a completely randomized design (CRD) with three replications. Two plants were grown in each pot and water was applied up to the field capacity. After 15 days, urea fertilizer was applied in each pot. The rates of Urea equivalent to (50% N-P-K=0.670 g/9 kg, 100% N-P-K=1.340 g/9kg, 200% N-P-K=2.68 g/9kg, 400% N-P-K=5.36 g/9kg). After blooming of flowers, the plants were harvested at 50 days of growth and leaves, stems and flowers were separated. The growth parameters (shoot height, number of leaf, leaf length, leaf diameter, root length, total number of flower, flower diameter) were recorded. Moreover, in terms of weight, fresh weight of flower, leaf, stems and root were recorded and the samples are kept in oven at 60˚C for 72 hours. After 3 days, the dry weight of each parameter was recorded.

2.2. Vermicompost preparation in Meherpur in Bangladesh from cow dung

At first, cow dung is collected from cow shelters considering the capabilities of bin. The dung is kept as a pile for about 5-7 days covered with polythene. Then, after 5-6 days, it should be exchanged the layer of cow dung, which allow them to mix well and upper layer goes to the bottom and bottom layer will go to upper. Again, the piles of cow dung are kept 4-5 days covering with polythene. Then, the pile is kept in bin such a way that the space should be empty for 2 inch. Water is sprinkled to let the compostable matter cool down. Earthworm is put on the top of the manure. The amount of compost is depending on the number of earthworm. It is estimated that it needs 5000 earthworm for composting 200 kg cow dung and with optimal environment it is possible to make 100 kg within 25-30 days (How to make vermicompost).

2.3. Statistical analysis

Microsoft Excel and ANOVA were used for statistical analysis.

3. Results

3.1. The impact of various treatments at different growth parameters of plant:

Analysis of variance (table-1) showed that the impact of various treatments on shoot height, number of leaves, fresh and dry weight of leaves, length and diameter of leaves, fresh and dry weight of leaves, roots length, roots fresh and dry weight, total number of flower, flowers fresh and dry weight.

Table 1: Analysis of variance from ANOVA in various parameters

Parameters	F	P
Shoot height	29.99	0.000
Leaves number	60.09	0.000
Leaves fresh weight	88.82	0.000
Leaves dry weight	81.68	0.000
Leaves length	45.15	0.000
Leaves diameter	39.61	0.000
Stems fresh weight	139.55	0.000
Stems dry weight	33.87	0.000
Total number of flower	101.23	0.000
Flowers fresh weight	56.16	0.000
Flowers dry weight	35.41	0.000
Roots length	57.62	0.000
Roots fresh weight	116.43	0.000
Roots dry weight	116.43	0.000

From the table, it is observed that the value of $P=0.000$ in each parameter. $P\leq0.05$ means that there is significance difference in various treatments for each parameter. In this experiment, there is significant difference observed in each parameter of the plant at 50 days in both NPK fertilizer treatments and vermicompost treatments.

3.2. Shoot height: Table 1 shows the effect of treatments on the shoot of the plants at 50 days. Maximum height of the shoot is related to 20% vermicompost and minimum height of the shoot is obtained in 50% NPK fertilizer treatment. There is significant difference in vermicompost and NPK fertilizer treatment and control as the value of $P \leq 0.05$ (table-1). If it is compared to the vermicompost and NPK fertilizer treatment, from figure 1, it is obvious that shoot height is more in 5% vermicompost than 400% NPK fertilizer treatment at 50 days.

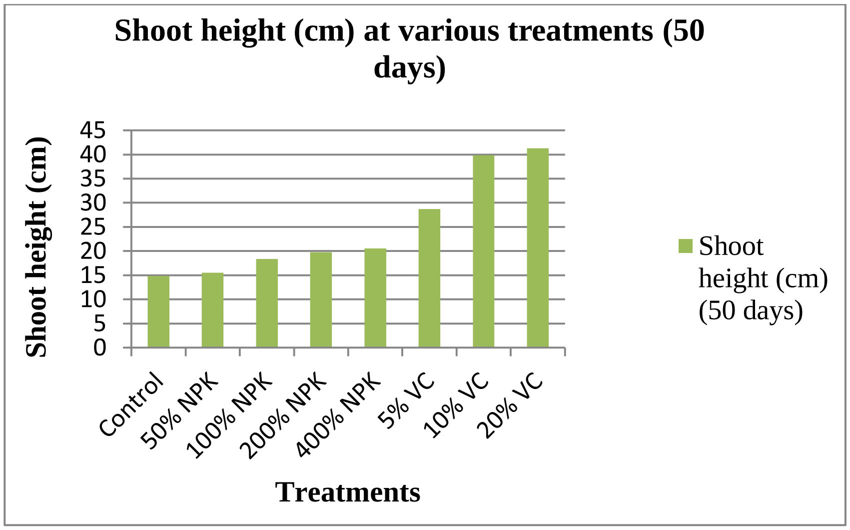

Fig 1: Shoot height (cm) of the plant at 50 days in various treatments

3.3. Number of leaves: The result in figure 2 shows that maximum number of leaves is obtained from 20% vermicompost treatment and minimum number is from 50% NPK fertilizer. There is not much difference in control and NPK fertilizer treatment however, there is significant difference observed in vermicompost and NPK fertilizer treatment at 50 days (fig-2).

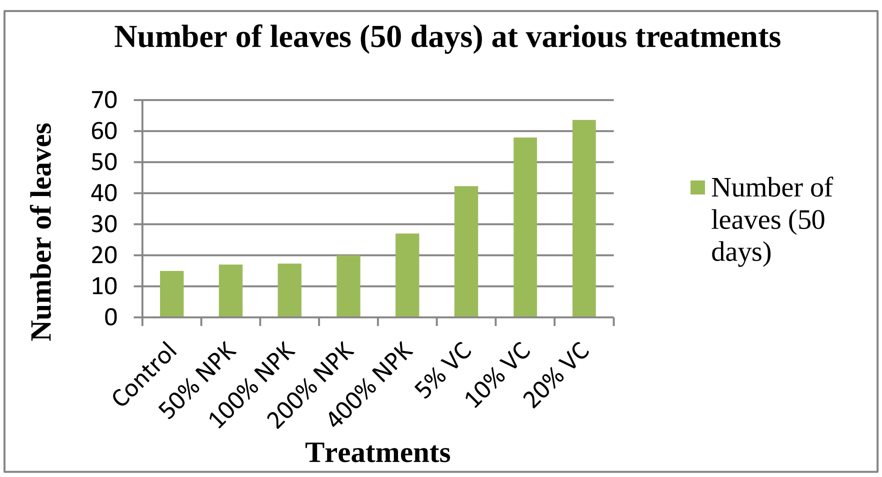

Fig 2: Number of leaves at 50 days at various treatments

3.4. Leaves length and diameter: The length of the leaves increases with the treatments of NPK fertilizer and vermicompost. Highest leaf length is observed in 20% vermicompost and lowest leaf length is observed in 50% NPK fertilizer treatment. As P=0.000 which is ≤0.05, so there is significant difference observed in various treatments of NPK fertilizer and vermicompost and control. From 400% NPK fertilizer treatment to 20% vermicompost treatment, the length of the leaves rapidly increasing where the rate of leaf length is comparatively slow from 50% to 200% NPK fertilizer treatments (fig-3).

In terms of the leaves diameter, maximum diameter is observed at 20% vermicompost treatment and minimum diameter is observed at 50% NPK fertilizer treatment. There is no significance difference in control and NPK fertilizer treatment, however, there is huge difference observed in various treatments of NPK fertilizer and control (fig-4).

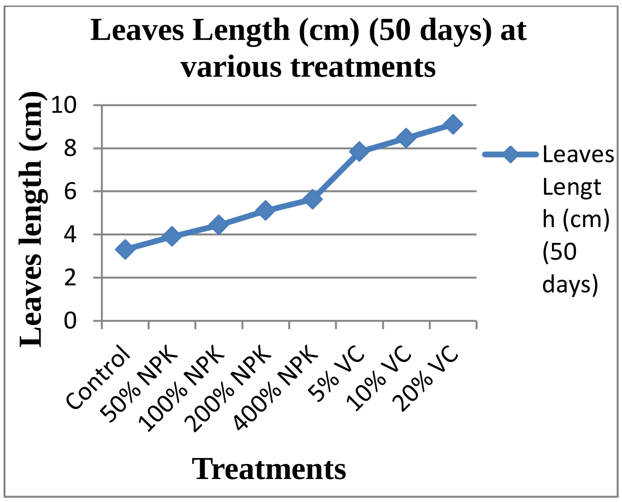

Fig 3: Leaves length (cm) in various treatments

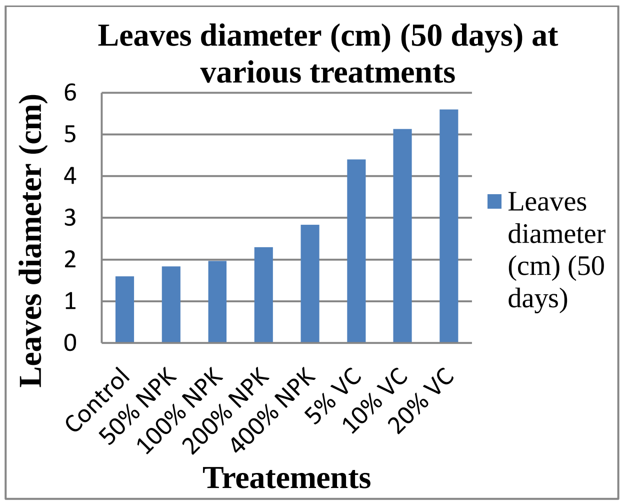

Fig 4: Leaves diameter (cm) in various treatments

3.5. Leaves fresh and dry weight: The result shows that maximum leaves' weight is obtained from 20% vermicompost in both fresh weight and dry weight. There is not much difference between the treatments of NPK fertilizer and control; however there is huge difference in various treatments of vermicompost and NPK fertilizer and control. Specially, for the fresh weight, huge differences are observed (fig-5). From the statistical analysis, the difference is feasible in various treatments as P≤ 0.05. There are many new leaves observed after 35 days in the treatments of vermicompost. The leaves are also bigger in size than the leaves in NPK fertilizer treatment.

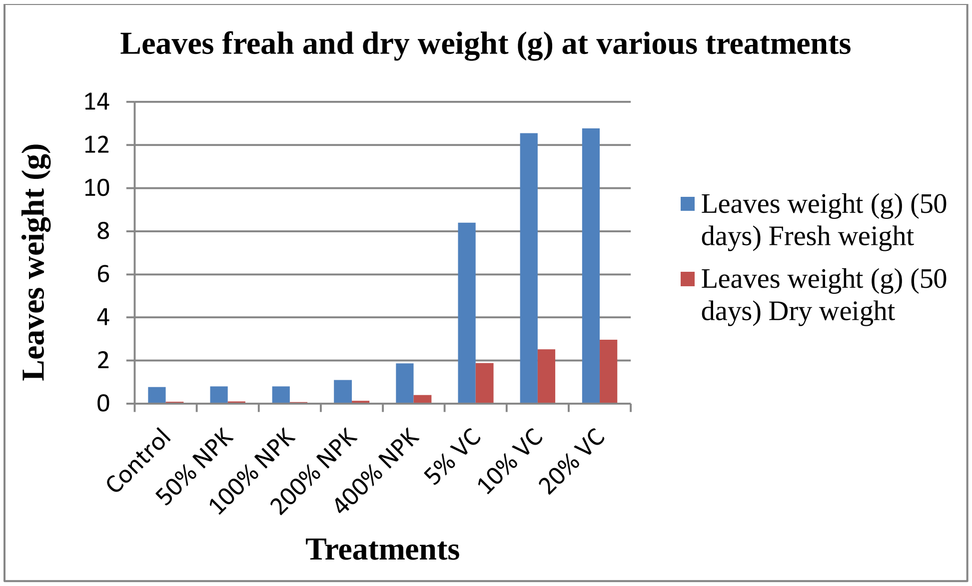

Fig 5: Leaves fresh and dry weight (g) at 50 days in various treatments

3.6. Stems fresh and dry weight: Maximum stems' weight observed in 10% vermicompost treatments and minimum weight observed in 50% NPK fertilizer treatment. Unlike other parameter, stems fresh weight give different result in the treatments of vermicompost. Fresh weight of stems should be higher in 20% vermicompost treatment, however, the maximum fresh weight is observed in 10% vermicompost treatment (fig-6). Moreover, $P \leq 0.05$ indicates the significant difference between NPK fertilizer treatments and vermicompost treatments in the weight of stems.

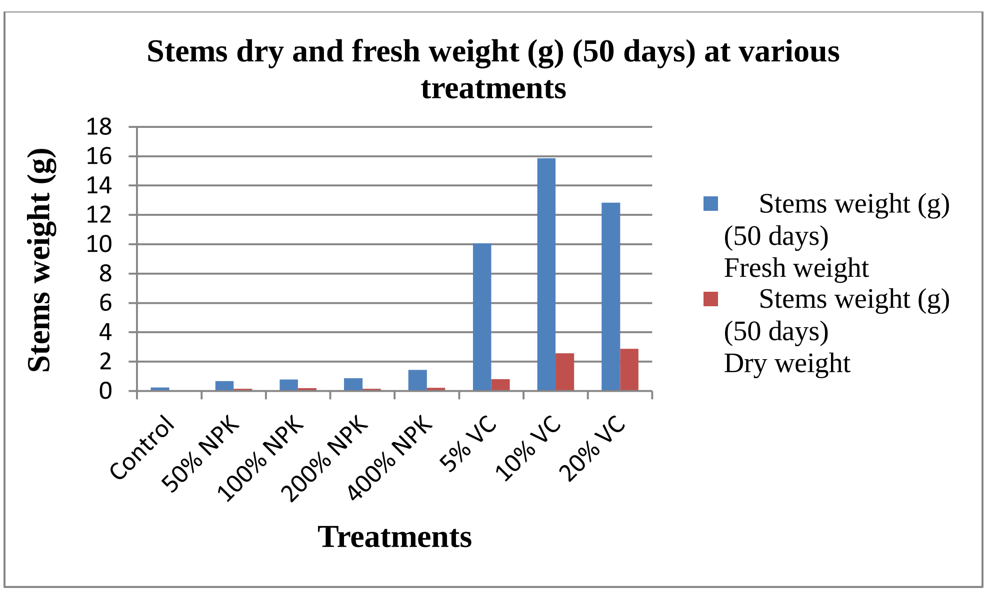

Fig 6: Stems fresh and dry weight (g) in various treatments at 50 days

3.7. Total number of flower: Increasing trend of flowers' number is observed from 200 % NPK fertilizer treatments to 20% vermicompost treatments. Maximum number of flower is obtained in 20% vermicompost and minimum number of flower is obtained from 50% NPK fertilizer treatment.

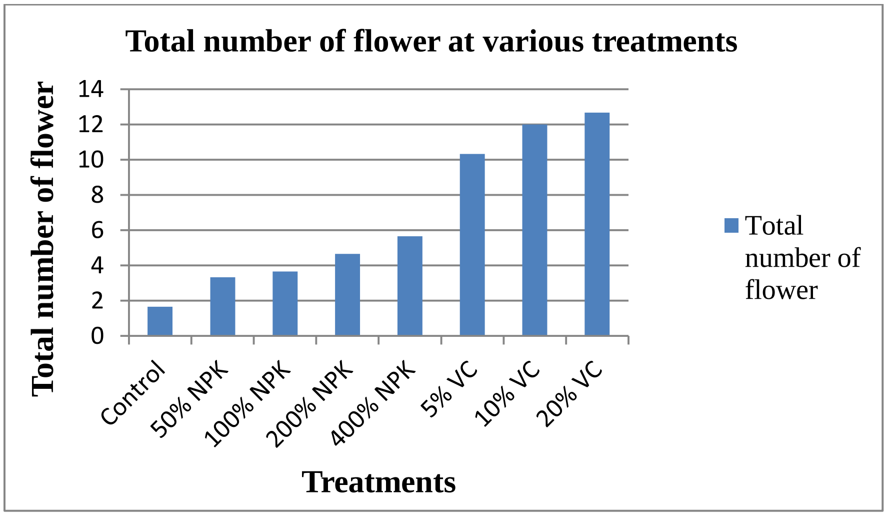

Fig 7: Total number of flower in various treatments at 50 days

3.8. Fresh and dry weight of flower: Like other growth parameters, maximum flower weight is observed in 20% vermicompost and minimum weight is observed in 50% NPK fertilizer treatment. There is not much difference in weight at various NPK fertilizer treatments. They are mostly equal in weights (fig-8).

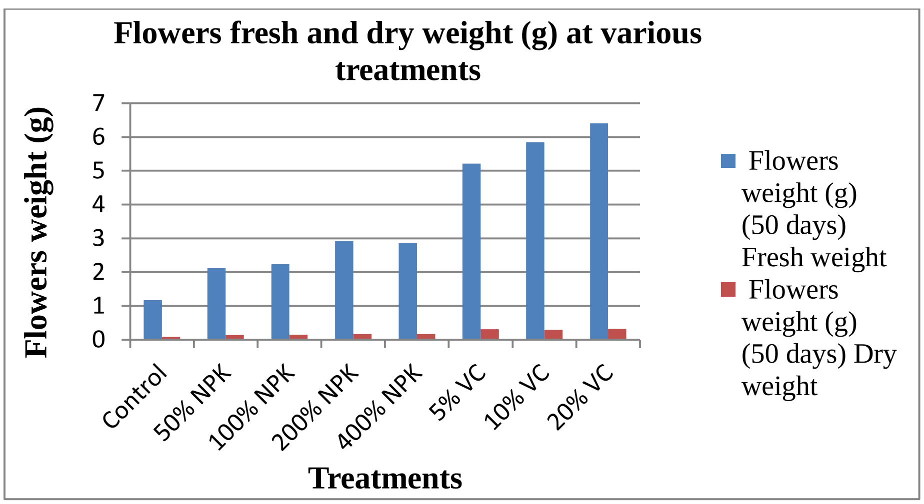

Fig 8: Flowers fresh and dry weight (g) in various treatments at 50 days

3.9. Flowers diameter: The maximum diameter of flower is obtained from 20% vermicompost and minimum diameter of flower is obtained in 50% NPK fertilizer treatment (fig-9 & 10).

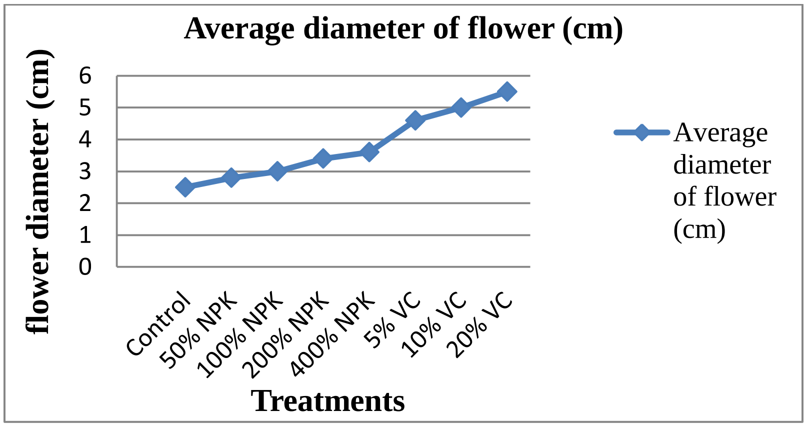

Fig 9: Flowers diameter (cm) in various treatments at 50 days

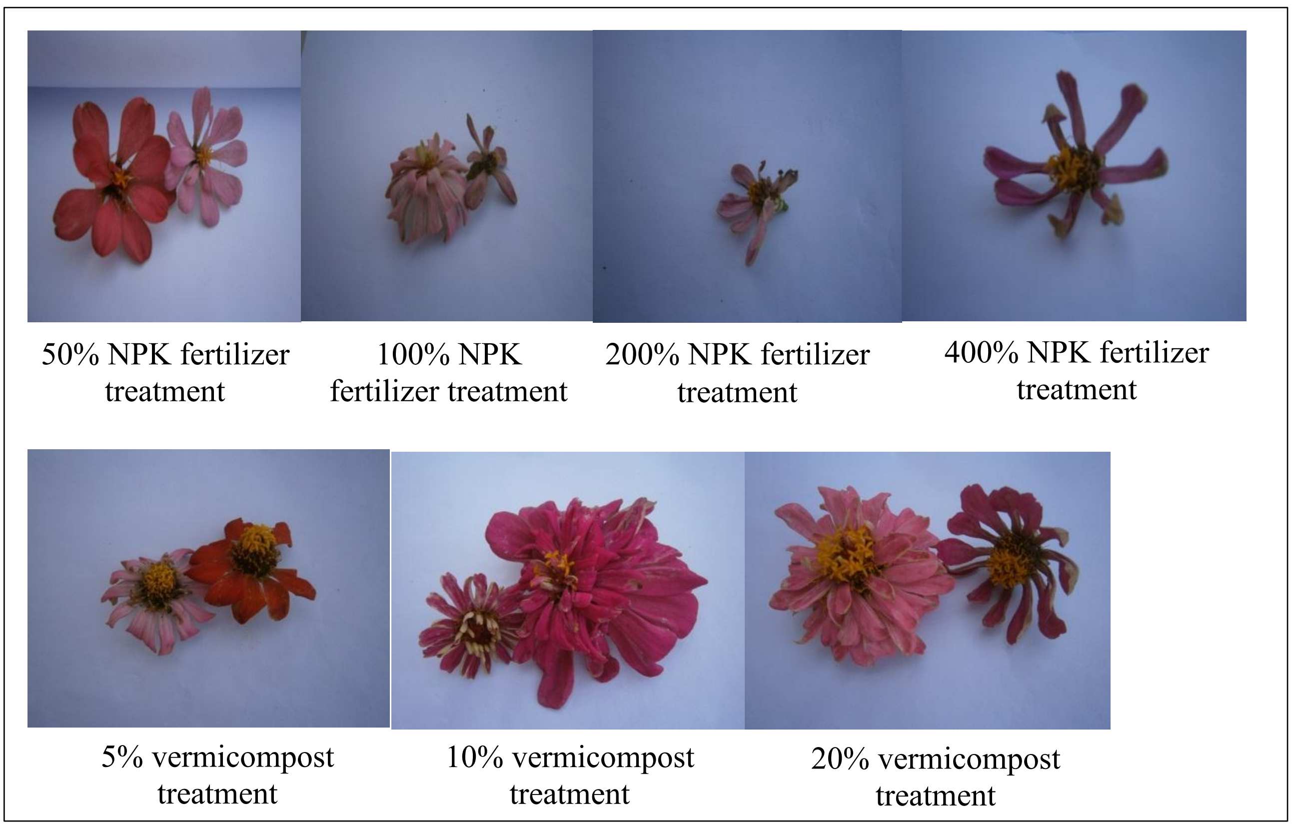

Fig 10: Flowers from various treatments at 50 days

3.10. Root Length: Along with other parameters, maximum length of the roots is obtained from 20% vermicompost and minimum length of the roots is obtained from 50% NPK fertilizer. There is no significant difference observed among the treatments of vermicompost or among the various treatment of NPK fertilizer and control. As P≤0.05, there is difference observed in between the treatments of vermicompost and NPK fertilizer.

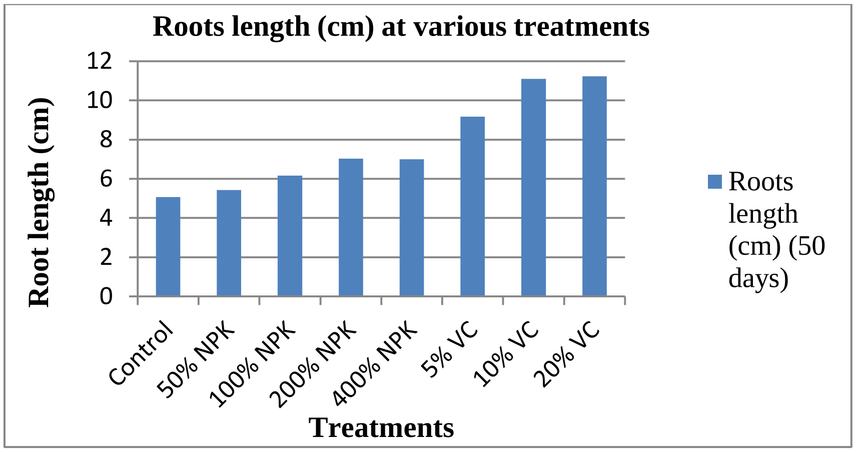

Fig 11: Roots length (cm) in various treatments at 50 days

3.11. Root fresh and dry weight: There is huge difference observed in the treatments of NPK fertilizer and vermicompost (fig-12) and from statistical analysis, if P≤0.05 (table-1), there must be difference in results. Maximum fresh and dry weight of roots is observed in 20% vermicompost and minimum is 50% NPK fertilizer. There is very little difference observed in between NPK fertilizer treatments and control (fig-12).

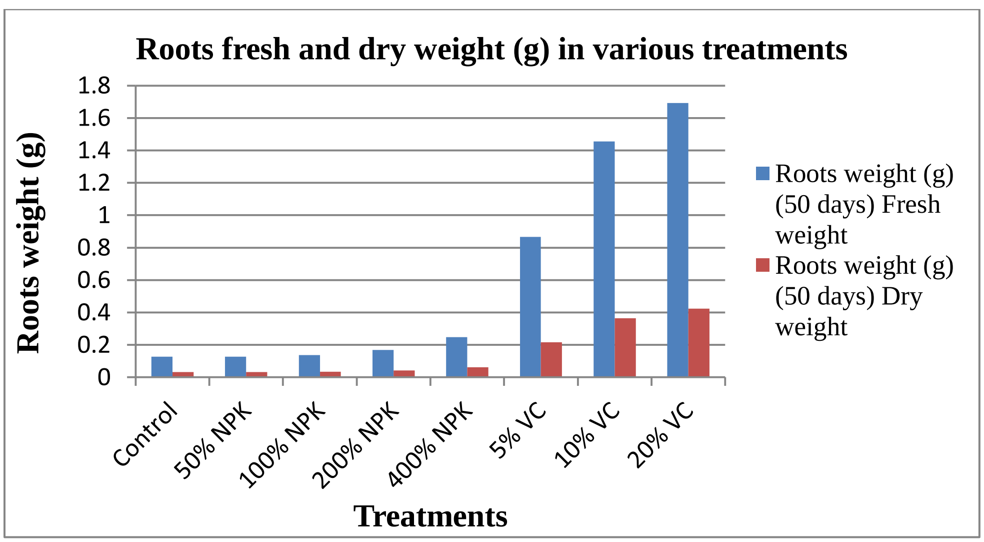

Fig 12: Roots fresh and dry weight (g) in various treatments at 50 days

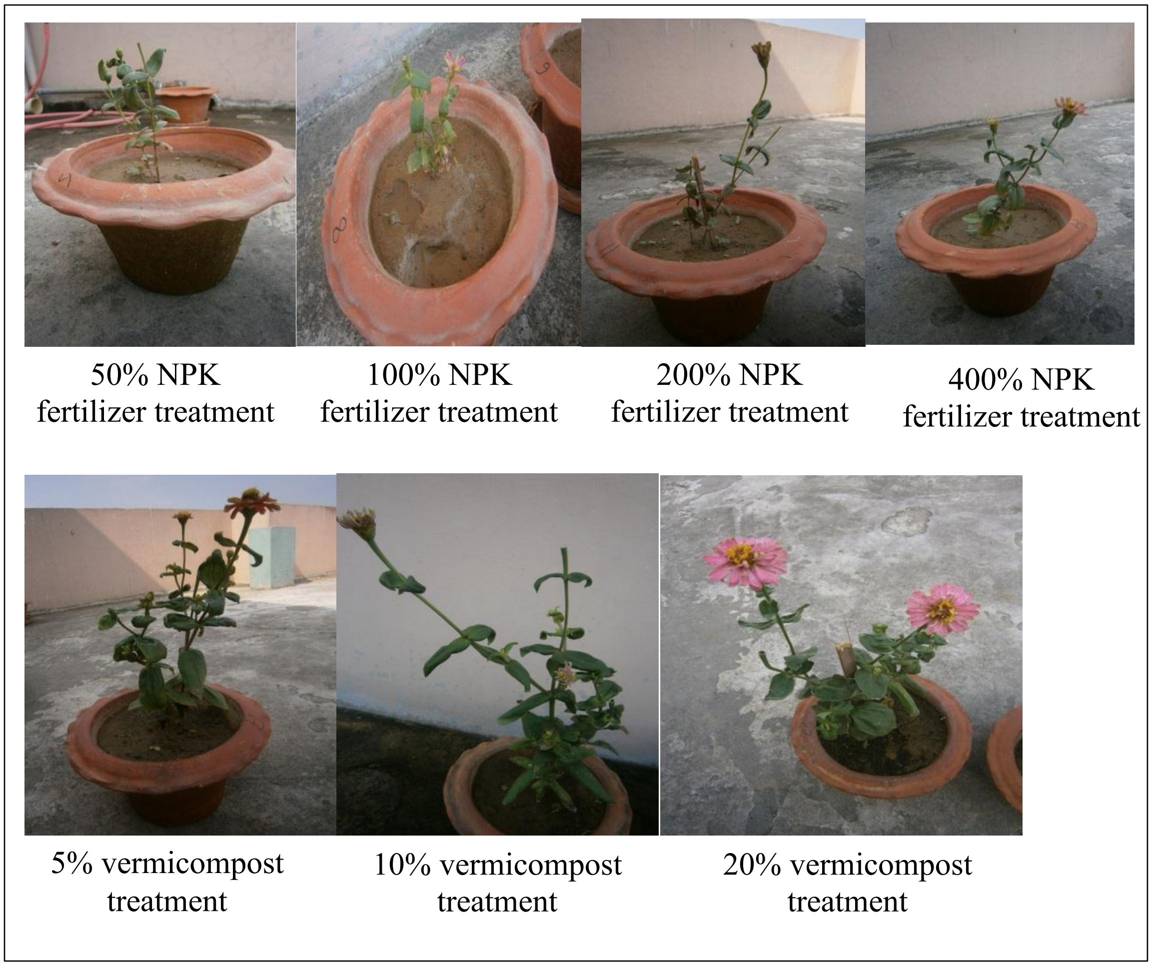

Fig 13: Zinnia plants in various treatments at 50 days

4. Discussion:

4.1. Shoot height: Height of the shoot is increasing fast in various treatments of vermicompost. As vermicompost contains high proportion of humic substances (humic acids, fulvic acids and humin), it plays important role for providing many sites for chemical reaction and thus more growth in plants. Microbial activities are more in vermicompost, which are important for enhancing plant growth. Moreover, vermicompost reduces the compaction of the soil, which helps the plants to uptake nutrients and minerals easily. As a result, plants growth is faster in 5% vermicompost treatments than 400% NPK fertilizer treatments at 50 days (fig-1).

4.2. Number of leaves, leaves diameter and leaves length: After 35 days of the experiment many new leaves have observed in vermicompost treatments. From the beginning of the experiment, it is observed bigger leaves with wide diameter and high length in vermicompost treatments comparing control and NPK fertilizer treatments. Moreover, comparing to NPK fertilizer treatment and control, the difference is very less in terms the length, diameter and number of leaves (fig 4, 5 & 6). As vermicompost contains some growth promoting hormone secreted by earthworm, so all growth parameter including leaves number, diameter, length is also higher in vermicompost rather than NPK fertilizer treatments.

4.3. Fresh and dry weight of leaves: Significant difference is observed specially in fresh weight of leaves between the vermicompost treatments and NPK fertilizer treatments (fig-5). As leaves diameter and number of leaves are higher in vermicompost, so the moisture content is also higher in vermicompost treatments. On the other hand, there is less number of small leaves, so moisture content is also less, which gives the less fresh weight in various treatments of NPK fertilizer.

4.4. Stems fresh and dry weight: There is significant difference observed in dry and fresh weight of stems, especially in fresh weight, in vermicompost and NPK fertilizer treatments. Like other growth parameter, stems' fresh weight should be higher in 20% vermicompost as the rate of treatment is higher. However, stems' fresh weight is higher in 10% vermicompost (fig-6). There are many stems grown in both 10% and 20% vermicompost treatments, but the bigger width of the stems is observed in 10% vermicompost treatments comparatively 20% vermicompost, which holds more moisture. As a result, the fresh weight of stem is higher in 10% vermicompost treatments. When the moisture away after three days, as usual, the dry weight of stems is higher in 20% vermicompost treatment rather than 10% vermicompost treatment. It is indicated that the moisture content has significance role for different scenario in terms of fresh and dry weight of stem. On the other hand, there is much difference observed in NPK fertilizer treatments and vermicompost treatments in terms of the growth and weight of stems as vermicompost contains several enzyme and hormone which play vital role for in growth in different parameters of plants.

4.5. Flowers diameter and flowers weight: There are many big flowers bloomed after 35 days of the experiment in vermicompost treatments. It is also observed that the flowers of the vermicompost treatments have many thick petals, which gives more weight of the flower. On the other hand, the flowers with less and light petals are observed in NPK fertilizer treatments, so the weight of the flowers is comparatively less than vermicompost treatments (fig 9& 10).

4.6. Root length and weight of the roots: Roots length is increasing with the treatments increasing in NPK and vermicompost. It is known that humic acids isolated from vermicompost enhance root elongation and formation of lateral roots, which gives significant difference in various treatments of NPK fertilizer and vermicompost. It is observed that 5% vermicompost treatments give higher length and weight of the root than 400% NPK fertilizer (fig-12).

There is many lateral root and thick main root formation in vermicompost treatments than NPK fertilizer treatments, which gives more weight of root in vermicompost treatments.

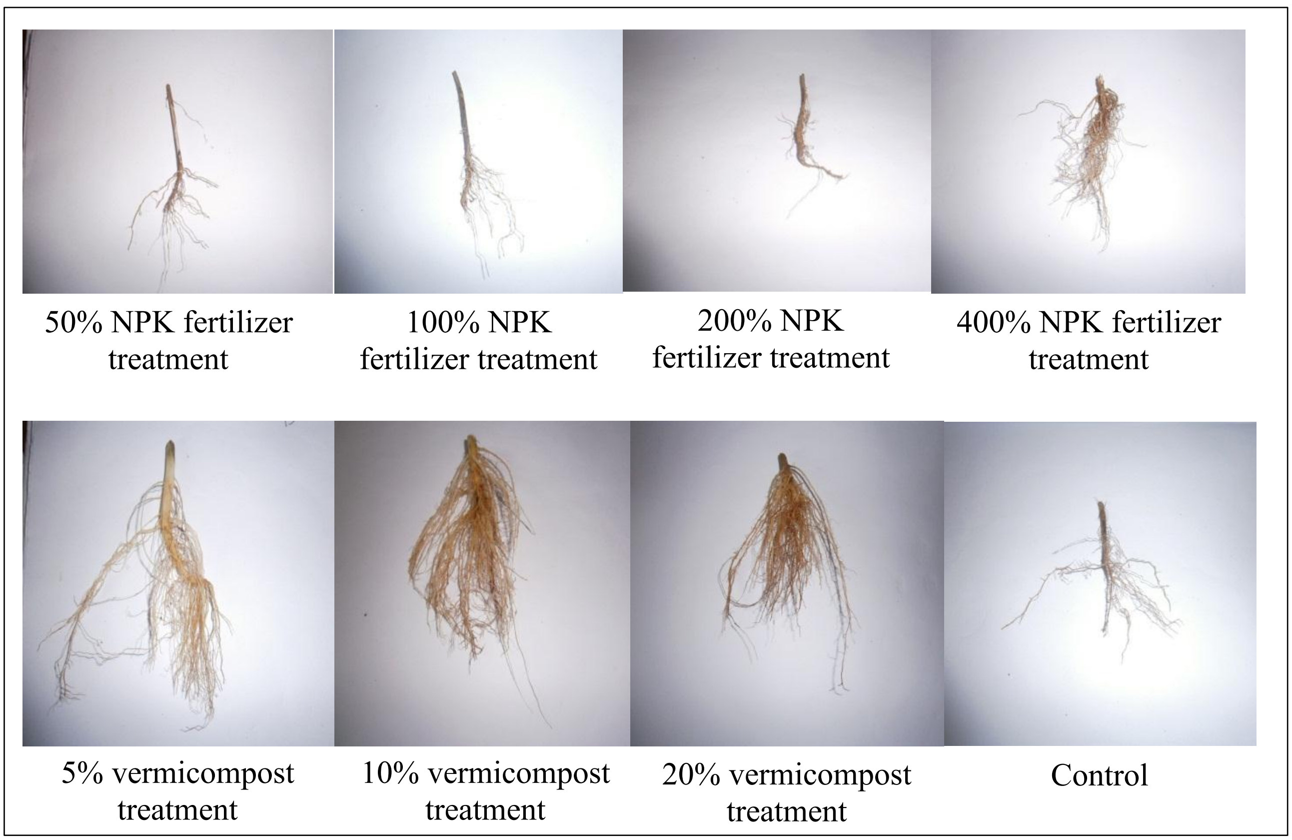

Fig 14: Roots in various treatments at 50 days

5. Conclusion:

From the experiment and above discussion, it is considered that the use of vermicompost is better than the inorganic fertilizer like NPK. To avoid the negative impacts on soil, plant growth and surrounding environment, vermicompost uses should be increased as they are cheap; production sources are available, organic, reduce the pool of waste from our environment and keep our environment clean and healthy. Moreover, in terms of plant growth and soil health, vermicompost plays important role for improving soil texture, aeration, soil compaction and thus plants uptake more water and nutrients from their surroundings. As vermicompost contains numerous hormones, enzymes, many humic substances and microbial activities are also higher, so the growth of each parameters of the plants are high and fast. This study suggest to use 5% vermicompost, which is minimum, rather than 400% NPK fertilizer to get better yield and improves soil conditions.

References:

Abduli, M.A., Amiri, L., Madadian, E., Gitipour, S. and Sedighian, S. (2013). Efficiency of Vermicompost on Quantitative and Qualitative Growth of Tomato Plants. Int. J. Environ. Res. 7(2): 467-472.

A. Walkley and I. A. Black. (1934). An Examination of Degtja-reff Method for Determining Soil Organic Matter and a Proposed Modification of the Chromic Acid Titration Method. Soil Science. 37(1): 29-38.

Arancon, Norman Q., Edwards, Clive A. (2005). Effects of vermicomposts on plant growth. Soil Ecology Laboratory, The Ohio State University, Columbus, OH 43210 USA.

Angima, Sam, Noack, Michael, and Noack, Sally. (2011). Composting with Worms. 1-13.

Earthworms Vermicompost: A Powerful Crop Nutrient over the Conventional Compost & Protective Soil Conditioner against the Destructive Chemical Fertilizers for Food Safety and Security. (2009). Am-Euras. J. Agric. & Environ. Sci. 5: 01-19.

G. J. Bouyoucos. (1962). Hydrometer Method Improved for Making Particle Size Analysis of Soils. Agronomy Journal. 54(5): 464-465.

How to make vermicompost. http://vermicompostbd.com/images_others/how_to_make_compost.jpg

Impact of fertilizer on the environment. Lecture-18.

http://tnau.ac.in/eagri/eagri50/SSAC222/lec18.pdf

Joshi, Rakesh, Vig, Adarsh Pal. (2010). Effect of Vermicompost on Growth, Yield and Quality of Tomato (Lycopersicum esculentum L). African Journal of Basic & Applied Sciences. 2 (3-4): 117-123.

Khan, Amir, Ishaq, Fouzia. (2011). Chemical nutrient analysis of different composts (Vermicompost and Pitcompost) and their effect on the growth of a vegetative crop Pisum sativum. Asian Journal of Plant Science and Research, 1 (1):116-130.

Lakshmi, Rama Ch.S., Rao, P.C., Sreelatha, T., Madahvi, M., Padmaja, G., Rao, P. V., Sireesha, A. (2013). Manurial value of different vermicomposts and conventional composts. Global Advanced Research Journal of Agricultural Science. 2(2): 059-064.

Lazcano, C., Dominguez, J. (2010). Effects of vermicompost as a potting amendment of two commercially-grown ornamental plant species. Spanish Journal of Agricultural Research. 8(4): 1260-1270.

Mamta, Wani, Khursheed Ahmad, Rao, R. J. (2012). Effect of vermicompost on growth of brinjal plant (Solanum melongena) under field conditions. Journal on New Biological Reports 1(1): 25-28.

Mohammadi Torkashvand, A., Shadanpour, F., Hashemi Majd, K. (2011). The effect of cow manure vermicompost as the planting medium on the growth of Marigold. Annals of Biological Research. Scholars Research Library. 2 (6): 109-115

Najar, Ishtiyaq Ahmed, Khan, Anisa B. (2013). Effect of Vermicompost on Growth and Productivity of Tomato (Lycopersicon esculentum) Under Field Conditions. Acta Biologica Malaysiana. 2(1): 12-21.

Nagavallemma, KP, Wani SP, Stephane, Lacroix, Padmaja, VV, Vineela, C, Babu, Rao M, and Sahrawat, KL. (2006). Vermicomposting: Recycling wastes into valuable organic fertilizer. Global Theme on Agrecosystems Report no. 8. International Crops Research Institute for the Semi-Arid Tropics. 2(1): 1-17

Soil Survey Laboratory Staff. (1992). Soil Survey Laboratory Methods Manual. Soil Survey Investigation Report, 42, USDA-SCS, Washington DC.

Walpola, B. C., Wanniarachchi, S. D. (2009). Microbial Respiration and Nitrogen Mineralization in Soil Amended with Different Properties of Vermicompost and Coir Dust. Bangladesh J. Agril. Res. 34(4): 537-543.

Yadav, Anoop, Gupta, Renuka and Grag, Vinod Kumar. (2013). Organic manure production from cow dung and biogas plant slurry by vermicomposting underfield conditions. International Journal of Recycling of Organic Waste in Agriculture. 1-7.

Appendix 1: Some chemical properties of vermicompost used in the experiment

Property	**Vermicompost**
EC(dS/m)	23.4
pH	7.17
CEC (meq/100g)	43.4
Organic carbon (%)	65.4
Total nitrogen (%)	0.308
Available phosphorus (mg/kg)	3.90
Available potassium (mg/kg)	750.0
Available Magnesium (mg/kg)	130.2
Available Calcium (mg/kg)	85.0

Source: (Mohammadi Torkashvand et al, 2011)