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Impact of Chemical Fertilizer and Organic Manure on the Germination and Growth of Soybean (Glycine max L.)

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Abstract
After green revolution chemical fertilizers has been used at a great extent in all the crops which decrease the fertility and profile of the soil. Due to various side effects of chemical fertilizers, use of organic fertilizers is an alternative method for the improvement of crop production and maintenance of soil fertility. The aim of the present study was to determine the effects of chemical fertilizer and organic manure on the growth of soybean crop. A total of ten different treatments of both organic manure and chemical fertilizer were used. The various parameters - seed germination, seedling survival, root length and shoot length and seedling height was measured in the present investigation. The results revealed that germination percentage showed increment in nearly all the treatments as compared to the control sets except at highest dose of NPK fertilizer which showed little decrease in germination percentage and was found maximum (97.33%) at optimum dose of vermicompost. The results also showed that survival rate was higher in all treatments than control except at the highest dose of NPK fertilizer in which the survival rate was found minimum (74.38%).Also the root length and seedling height was maximum at the optimum dose of Vermicompost (20%) treated plants and was found minimum in the highest dose (300gm) of NPK fertilizer. The results revealed that the chemical fertilizers at higher doses have deleterious effects on plant growth and development. Organic manures at very high doses checks plant growth but vermicompost had no side effects even at higher doses.
Keywords: Vermicompost, NPK, FYM, Soybean, Germination

Introduction

Fertilizer is any substance used to add nutrients to the soil for promoting soil fertility and increasing plant growth. Fertilizers can change rate of plant growth, maturity time, size of plant parts, and biochemical content of plants and seed capabilities. Environmental degradation is a major threat confronting the world, and the rampant use of chemical fertilizers contribute largely to the deterioration of the environment The long-term use of inorganic fertilizers without organic supplements damages the physical, chemical and biological properties of soil and causes environmental pollution. Organic manures act not only as a source of nutrients and organic matter, but also increase microbial biodiversity and activity in soil, influence structure, nutrients get turnover and many other changes related to physical, chemical and biological parameters of the soil (Albiach *et al.,* 2000). The soil having higher organic matter concentrations have been proved to enhance the growth and yield of different crops (Sarwar, 2005) as well as soil aeration, soil density and maximizing water holding capacity of soil for seed germination and plant root development (Zia *et al.,* 1998). Vermicompost is a type of organic fertilizer produced by biodegradation of organic material through interactions between earthworms and micro-organisms, contains nearly all types of nutrients necessary for the plant growth and also is rich in microbial growth and activities (Orozco *et al.,* 1996).

Soybean (*Glycine max*), commonly known as “Golden Bean” or “Miracle Crop” of the 20th century, is one of the most important legume crops in the world.It contains the highest(40% to 45%) amount of proteins among the legumes, 18 to 20% of edible oils, 24 to 26% of carbohydrates and good amount of vitamins (Koul and Das, 1986).The crop is grown on an estimated 6% of the world’s arable land, and since the 1970s, the area in soybean production has the highest increase compared with other major crops (Hartman et al., 2011).As a strategic product, soybean not only meets the variant food consumptions in the food chain but also it has many industrial uses. Soybean meal is also used as livestock’s food.

Imkongtoshi and Gohain (2009) evaluated the effects of combined use of farmyard manure and fertilizer on soybean. Pirdashi *et al.,* (2010) studied the effect of municipal solid waste, vermicompost and sewage sludge bio-solid on so soybean. Chaturvedi *et al.,* (2010) investigated the productivity and quality of soybean by integrating farmyard manure and micronutrients. Nutrient imbalance is one of the important factors affecting the productivity of soybean.

Therefore, keeping the above points in view, the present study investigated the effects of farmyard manure, vermicompost and chemical fertilizer on the germination and growth of this important legume crop.

Materials and Methods

Plant Material: The healthy and certified seeds of JS 9560 cultivar were used in the present study. About 150 seeds were sown in field trials with three replicates for each treatment in a Randomized Block Design at Govt Madhav Science PG College Ujjain (M. P.). The field was prepared by digging out about 10- 12 inches of soil

deep in the ground and then plots were made of size $1m^2$ each. The vermicompost used in the present study was cow-dung vermicompost. Treatments were given to the soil before sowing of seeds in different concentrations as, Farmyard manure (10%, 20%, 30%), Vermicompost (10%, 20%, 30%) and NPK fertilizer (100gm, 200gm, 300gm). Data on various parameters such as germination percentage, survival percentage, root length, shoot length and seedling height were recorded and compared with the control populations.

Germination percentage was determined by counting the seedlings emerged in each plot per total number of seeds sown, multiplied by hundred. Similarly survival percentage was calculated by applying the following formula

$$Survival(\%) = \frac{No.\,of\,plants\,survived\,after\,30\,days}{Total\,no.\,of\,plants\,germinated} \times 100$$

The root and shoot length was measured after 10 days of sowing using centimetre scale.

Also seedling height was measured after 25 days of sowing with the help of scale.

Experimental Details

Design = Randomized block design.
Replications = 3(three)
Treatments = 10 (ten)
Total number of plots = 30 (thirty)
Plot size = 1 m^2

Treatment Details

FYM (Farmyard manure) = 10%, 20%, 30%
VC (Vermicompost) = 10%, 20%, 30%
NPK (Nitrogen, Phosphorus, Potassium) =100gm, 200gm, 300gm

Results and Discussion

Seed Germination (%): The percentage of seed germination in control was 86.66% which considerably increased with the addition of fertilizers. However, the higher doses of NPK decreased the germination percentage as compared to the control sets. The germination percentage was observed maximum with the application of vermicompost. The highest germination (97.33%) was observed in the seeds treated with 20 % vermicompost. The application of farmyard manure also showed increase in the germination percentage with the highest being observed at 20% FYM followed by 10% FYM but, higher dose (30%) of FYM decreased this percentage (85.33%). The lower dose of NPK showed the increase in germination percentage (87.33%) with respect to control plants but higher doses decreased this percentage to 80.66%.The present results are in accordance with the studies of Joshi and Vig (2010) and Buckerfield *et al.,*(1999) who observed decrease in the germination percentage at higher doses and increased percentage at lower doses of vermicompost.

Seedling Survival: The survival percentage was increased by applying the 20% vermicompost to the soil followed by 20% FYM. However, the higher doses of all the treatments showed the gradual decrease in survival percentage. Buckerfield *et al.,* (1999) reported that excess of nitrogen leads to inhibition of germination which may be the possible cause of decreasing survival percentage in the present study.

Root Length: The root length was increased during the experiment period in all treatments. The 20%VC treatment registered the maximum root length (8.58 cm) than the other treatments followed by 200gm NPK (Table-2). The results of the present study suggests that as vermicompost is highly nutritious than the other fertilizers and the nutrients might stimulate the functional activities of cells in the roots of plants (Ahsanur Rahman *et al.,* 2012).

Table 1: Effect of FYM, VC and NPK on Seed Germination and Seedling Survival of Soybean.

Treatment	Germination (%)	Relative value	Survival (%)
Control	86.66	100.00	93.07
10% FYM	91.33	105.39	97.08
20% FYM	95.33	110.00	97.90
30% FYM	85.33	98.46	85.93
10% VC	92.66	106.92	95.86
20% VC	97.33	112.31	98.63
30% VC	94.00	108.47	94.19
100 gm NPK	87.33	100.77	93.89
200 gm NPK	84.00	96.93	84.92
300 gm NPK	80.66	93.07	74.38

Shoot Length: The shoot length was increased in all the treated plants and among all treatments, it was found

maximum (11.9 cm) in 20% VC, and minimum in 300gm NPK treatment. Vermicompost has high microbial activity due to the majority of microorganisms like bacteria, fungi, yeast, actinomycetes and algae which are responsible for the production of plant growth regulators such as auxins, gibberellins, cytokinins, ethylene and abscisic acid (Frankenberger and Arshad 1995).

Table 2: Effect of FYM, VC and NPK on Root Length, Shoot Length and Seedling Height

Treatment	Root length (cm)Mean	±SD	Shoot length (cm)Mean	±SD	Seedling height (cm)Mean	± SD
Control	5.14	± 0.72	8.63	± 0.88	14.65	± 0.59
10% FYM	7.01	± 0.47	10.12	± 0.57	16.47	± 0.30
20% FYM	7.92	± 0.55	11.12	± 0.60	17.21	± 0.75
30% FYM	6.98	± 0.38	10.43	± 0.47	14.86	± 0.78
10% VC	7.43	± 0.64	11.06	± 0.84	16.84	± 0.56
20% VC	8.58	± 0.47	11.89	± 0.66	18.13	± 0.71
30% VC	7.31	± 0.44	11.27	± 0.64	16.49	± 0.70
100 gm NPK	7.25	± 0.43	10.55	± 0.52	16.38	± 0.44
200 gm NPK	8.31	± 0.67	12.18	± 0.86	17.58	± 0.71
300 gm NPK	6.00	± 0.45	9.40	± 0.69	12.11	± 1.28

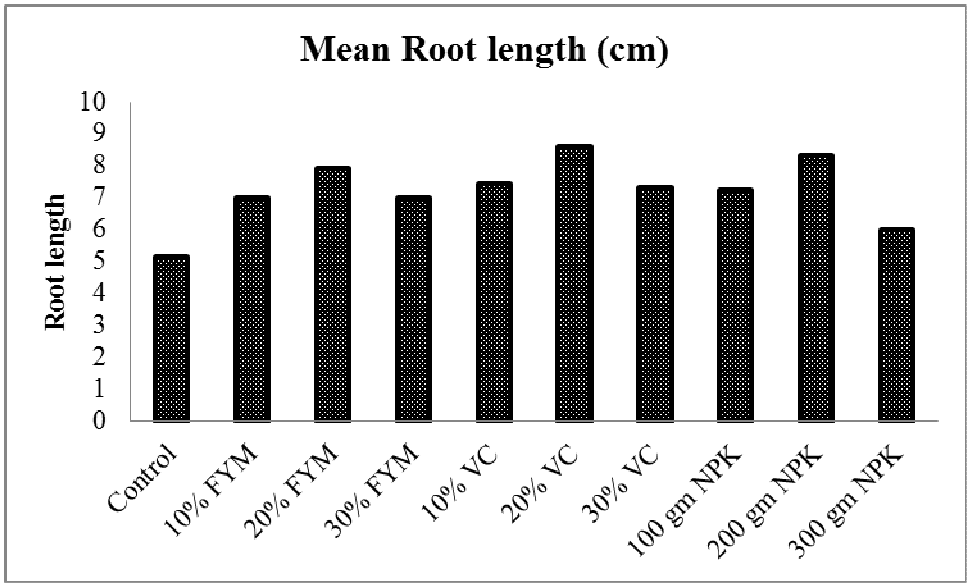

Figure 1. Effect of farmyard manure (FYM), vermicompost (VC) and NPK fertilizer on root length.

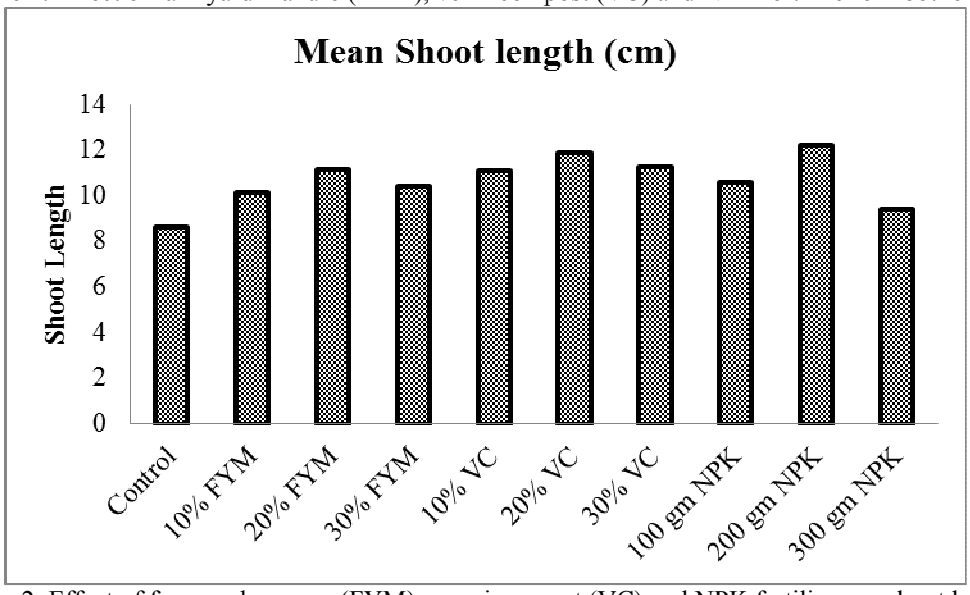

Figure 2. Effect of farmyard manure (FYM), vermicompost (VC) and NPK fertilizer on shoot length.

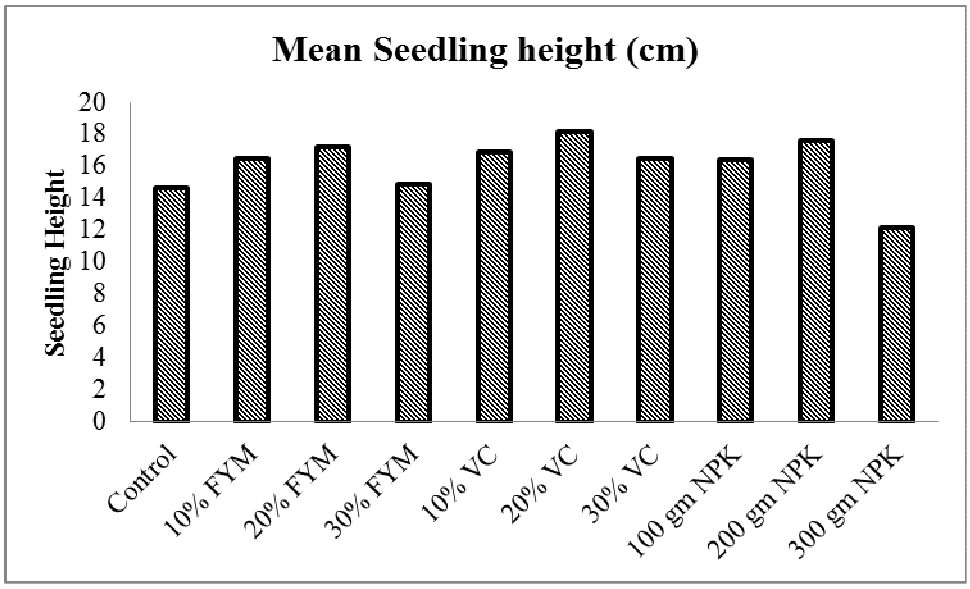

Figure 3. Effect of farmyard manure (FYM), vermicompost (VC) and NPK fertilizer on seedling height.

Seedling Height: The seedling height showed the marked increase in all the treatments and was observed maximum (18.13 cm) in 20% VC followed by (17.58 cm) in 200gm NPK. However, the increased concentration of NPK showed the decrease in the average plant height as compared to the control sets. Mekki and Ahmed (2005) suggested that application of cow dung vermicompost readily released the chemical nutrients in available forms. Joshi and Vig (2010) observed increase in average plant height after treating the plants with different concentrations of vermicompost which are in conformity with the present findings.

Conclusion

The present study revealed that organic manure is more beneficial and least toxic than chemical fertilizer for the seed germination and growth of soybean crop. Vermicompost is most beneficial which effectively enhance germination and growth of soybean by improving the physical, chemical and biological properties of the soil. However, the use of chemical fertilizer in the present investigation showed the negative effects at higher doses in nearly all the parameters by deteriorating the soil quality.

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