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Effect of organic manure and chemical fertilizer on the seed germination and growth of Wheat (*Triticum aestivum* L.)

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ABSTRACT

After the Green Revolution chemical fertilizers have been extensively used in all the crops for large production, which decrease soil fertility, soil profile and quality of the crops. In order to investigate the comparative effect of organic manure and chemical fertilizer on wheat performance, an experiment was conducted on the Black Cotton Soil based on Randomized Block Design with three replications at the Madhav Science PG College Ujjain. A total of ten different treatments of both organic manure (Farmyard- manure, Vermicompost) and chemical fertilizer (NPK) were used in this experiment in order to identify the optimum doses that would be successfully used for the better production of this crop. Various parameters such as, seed germination, seedling survival, root length, shoot length, seedling height, fresh weight and dry weight were determined in the present investigation. The results revealed that germination percentage was more in the low dose fertilizer treatments than the control (T1) sets and was found maximum in T6 (20% Vermicompost) followed by T3 (20% Farmyard-manure) treatment, but it was found comparatively less at the higher doses. Also the survival percentage was found higher in all treatments except at the highest dose (300gm/m^2) of NPK where it was found minimum. The results also showed that root length, shoot length and seedling height was maximum at the optimum dose of Vermicompost (20%) treated plants and was found minimum at the highest dose (300gm/m^2) of NPK fertilizer treatment Fresh weight and dry weight was increased in the low dose of fertilizer treatments and was found maximum in 20% vermicompost treatment. The results of the study revealed that organic manure (Vermicompost) is highly nutritious, more efficient, more beneficial at optimum doses and less toxic at higher doses than the chemical fertilizers which are more toxic at higher doses and are harmful for the plants.

Key words: *Black cotton soil, Vermicompost, Farmyard manure, NPK.*

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Introduction

Soil is a dynamic living matrix that is an essential part of the terrestrial ecosystem. It is a critical resource not only for agricultural production and food security but also towards maintenance of most life processes. Fertilizers are organic or inorganic materials of natural or synthetic origin that are added to soil to supply one or more nutrients essential for the growth of plants. Fertilizers can change rates of plant growth, maturity time, size of plant parts and biochemical content of plants. They are used for higher yield and effective growth of plant and agricultural products (Ramteke *et. al*., 2012). The long-term use of inorganic fertilizers without organic supplements damages the physical, chemical and biological properties of soil. The excessive use of chemical fertilizers are dangerous for the environment because they are not eco-friendly and are the cause of pollution as well as harmful for the soil microorganisms (Kharub and Sharma, 2002). Organic manures are the source of nutrients and organic matter in the soil, also they increase microbial biodiversity and activity in the soil, influence structure, and many other changes related to physical, chemical and biological parameters of the soil (Albiach *et al.,* 2000).

Vermicompost is prepared by biological degradation of plant and animal residues by the joint action of earthworms and micro-organisms. The application of Vermicompost favourably affects soil pH, microbial population and soil enzyme activities (Maheshwarappa *et al.*, 1999). The presence of organic matter in the soil has been reported to provide the compounds which affect root growth and the distribution of nutrients absorbed by plants (Lobartini *et al*, 1997), also organic matter in the soil have been proved to enhance the yield and yield components of cereals (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).

Wheat (*Triticum* spp.) is the most important cereal crop of the family Poaceae. It is third highest in the production of all the cereals of the world and is grown on more land area than any other commercial food crop combined. Globally wheat is the leading source of vegetable protein in human food, having higher protein content than other cereal grains, also it contains large amount of carbohydrates, vitamins and minerals.

Wheat (*Triticum aestivum* L.) is one of the major cereal crops with a unique protein, which is consumed by humans and is grown around the world in diverse environments (Abedi *et al*., 2010). It contains starch (60-90%), protein (11-16.5%), fat (1.5-2%), inorganic ions (1.2-2%) and vitamins (B-complex and vitamin E) (Rueda *et al*., 2011).

A lot of work has been done related with this topic on different soils, but no research has been done on the Black Cotton Soil yet. So keeping these points in view, the objective of the present study was to investigate the effects of farmyard manure, vermicompost and chemical fertilizer (NPK) at different concentrations on the seed germination and growth of this important cereal crop.

Materials and Methods

Plant Material: In the present study healthy and certified seeds of Lok-1 variety of bread wheat cultivar were used. About 180 seeds were sown in field trials with three replicates for each treatment which was $1m^2$ in size and the experiment was conducted on Black Cotton Soil and in a Randomized Block Design at Govt Madhav Science PG College Ujjain (M. P.).

The vermicompost used in the study was cow-dung vermicompost. Treatments were given to the soil before sowing of seeds in different concentrations. Data on various parameters such

as germination percentage, survival percentage, root length, shoot length, fresh weight, dry weight 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,

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

The root and shoot length was measured after 15 days of sowing using standard centimetre scale. Fresh weight and dry weight was also measured after 15 days of sowing by using simple electronic balance. Dry weight was determined after drying the seedlings in a hot air oven at 80^0 C for 14 hours. (Kabir *et al*., 2008). Fresh weight and dry weight of the seedlings were calculated by using electrical balance. Seedling height was measured after 30 days with the help of centimetre scale. To determine these parameters, ten plants of each treatment were randomly selected.

Treatment	Germination (%)	Relative value	Survival (%)	Relative value
Control (T1)	87.24	100.00	94.02	100.00
10% FYM (T2)	91.63	105.03	96.16	102.27
20% FYM (T3)	94.95	108.83	96.94	103.10
30% FYM (T4)	86.32	98.94	89.83	95.54
10% VC (T5)	93.42	107.08	96.56	102.70
20% VC (T6)	97.13	112.48	97.82	104.04
30% VC (T7)	85.45	97.94	95.29	101.35
100gm NPK (T8)	88.13	101.02	93.74	99.70
200gm NPK (T9)	84.32	96.65	86.82	92.34
300gm NPK (T10)	80.46	92.22	77.85	82.80

Treatment Details

Control (no fertilizer)	= T1
FYM (Farmyard manure)	= T2 (10%), T3 (20%) T4 (30%)
VC (Vermicompost)	= T5 (10%), T6 (20%), T7 (30%)
NPK (Nitrogen, Phosphorus, Potassium)	= T8 (100gm), T9(200gm), T10(300gm)

Results and Discussion

Seed Germination (%): The percentage of seed germination in control was 86.66% (table 1) which was considerably increased with the addition of fertilizers. However, the higher doses of NPK have decreased the germination percentage as compared to the control sets. The germination percentage was observed maximum with the application of vermicompost. The highest germination (97.13%) was observed in the seeds treated with 20% vermicompost which decreased after the percentage of vermicompost was increased i.e., 30%. The application of farmyard manure also showed increase in the germination percentage with the highest being observed at 20% FYM (94.95%) followed by 10% FYM (91.63%) but, higher dose (30% FYM) decreased this percentage to 85.33%. The lower dose of NPK showed increase in germination percentage (87.32%) with respect to control plants but higher doses decreased this percentage to 80.46%. 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 germination percentage at lower doses of vermicompost.

Seedling Survival: The survival percentage was increased to 97.82% (table 1) by applying 20%VC to the soil followed by 96.94% in those plots which are treated with 20% FYM. However, the higher doses of all the treatments showed the gradual decrease in survival

percentage (Fig. 1). 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.

Table 1: Effect of FYM (Farmyard manure), VC (Vermicompost) and NPK fertilizer on seed germination and survival of wheat

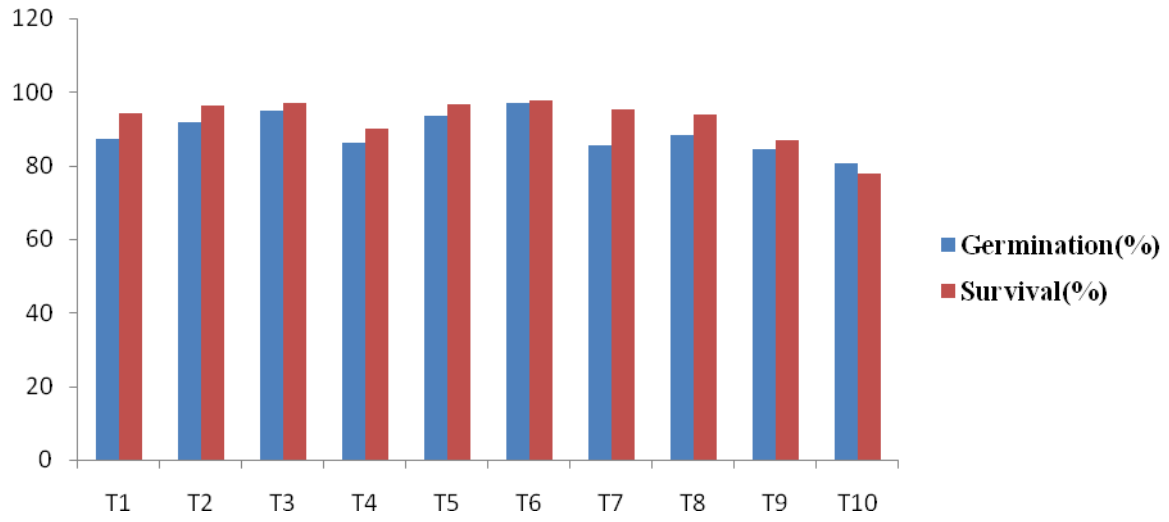

Figure 1: Effect of FYM, VC and NPK fertilizer on seed germination and survival of wheat.

Root Length: The root length was increased during the experiment period in all treatments than the control. The 20%VC treatment registered the maximum root length (9.6 cm) than the other treatments (Fig. 2) and was found minimum (5.89 cm) in 300gm NPK treatment (Table-2). The results of the present study suggest that as vermicompost is nutrient rich than the other fertilizers and the nutrients might stimulate the functional activities of cells in the roots of plants (Ahsanur Rahman *e. al.*, 2012). Presence of organic matter in the soil enhances soil

aeration, soil density and maximizing water holding capacity of soil for seed germination and plant root development (Zia *et al.,* 1998).

Shoot Length: The shoot length was increased in the fertilizer treated plants and among all treatments, it was found maximum (15.24 cm) in 20% VC, and minimum (10.84 cm) in 300gm NPK treatment (Fig. 2). Sarwar G. (2005) reported that there is the significant increase in growth and yield of wheat on the application of organic manures. Joshi *et al*., studied the impact of vermicompost at different doses on wheat and evaluated that there is no significant difference on applying the higher doses of vermicompost. Rupendra *et al*., (2006) explored the impact of vermicompost and NPK fertilizer on the growth and yield of wheat. Sandhya *et al*., (2014) reported that application of various fertilizers increased the growth and chlorophyll content of wheat (*Triticum aestivum* L.). 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 abcisic acid (Frankenberger and Arshad 1995).

Seedling Height: The seedling height showed marked increase in all the treatments and was observed maximum (24.45 cm) in 20% VC followed by (24.21 cm) in 200gm NPK (table 2). However, the increased concentration of NPK showed the decrease in the average plant height as compared to the control sets (Fig. 2). The present results are in accordance with Mekki and Ahmad (2005) who 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. Similarly Alam *et al*., (2007) investigated that application of vermicompost increased plant height of potato.

Table 2: Effect of FYM, VC and NPK on root length, shoot length and seedling height

Treatment	Fresh Weight Mean (gm)	±SD	Dry Weight Mean (gm)	±SD

Treatment	Root Length Mean (cm)	±SD	Shoot Length Mean(cm)	±SD	Seedling Height Mean (cm)	±SD
Control (T1)	6.14	±0.66	11.46	±0.67	17.82	±0.71
10% FYM (T2)	8.02	±0.56	13.48	±0.42	22.03	±0.49
20% FYM (T3)	8.81	±0.52	14.13	±0.30	23.63	±0.37
30% FYM (T4)	8.14	±0.43	13.94	±0.39	22.78	±0.40
10% VC (T5)	8.62	±0.32	14.52	±0.32	23.73	±0.37
20% VC (T6)	9.60	±0.20	15.24	±0.27	24.45	±0.31
30% VC (T7)	9.32	±0.29	14.71	±0.30	23.92	±0.35
100gm NPK (T8)	7.55	±0.62	12.89	±0.52	21.24	±0.57
200gm NPK (T9)	8.40	±0.96	13.88	±0.50	24.21	±0.53
300gm NPK (T10)	5.89	±0.38	10.84	±0.73	16.32	±0.77

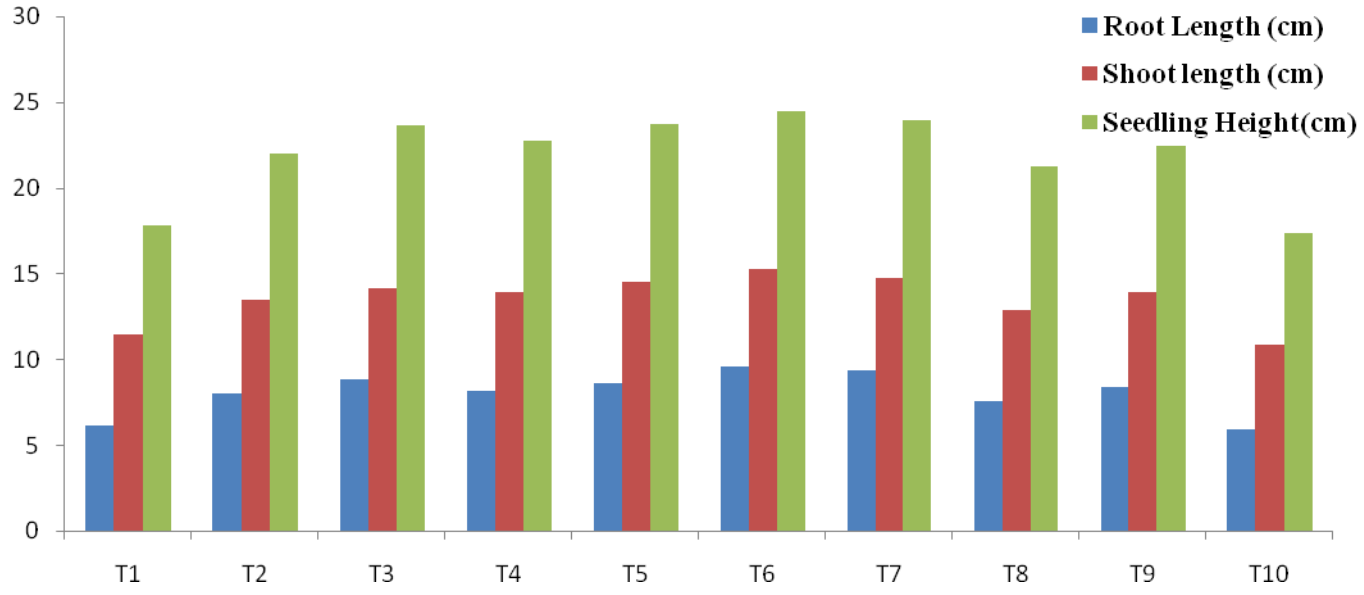

Figure 2: Effect of FYM, VC and NPK on root length, shoot length and seedling height.

Table 3. Effect of VC, FYM and NPK on fresh weight and dry weight of wheat

Control (T1)	2.67	±0.39	0.35	±0.24
10% FYM (T2)	4.95	±0.16	0.68	±0.15
20% FYM (T3)	5.56	±0.21	0.73	±0.12
30% FYM (T4)	4.94	±0.25	0.70	±0.14
10% VC (T5)	5.06	±0.15	0.72	±0.11
20% VC (T6)	6.22	±0.11	0.82	±0.09
30% VC (T7)	5.51	±0.16	0.76	±0.17
100gm NPK (T8)	4.46	±0.28	0.60	±0.24
200gm NPK (T9)	5.71	±0.39	0.76	±0.32
300gm NPK (T10)	2.05	±0.47	0.32	±0.38

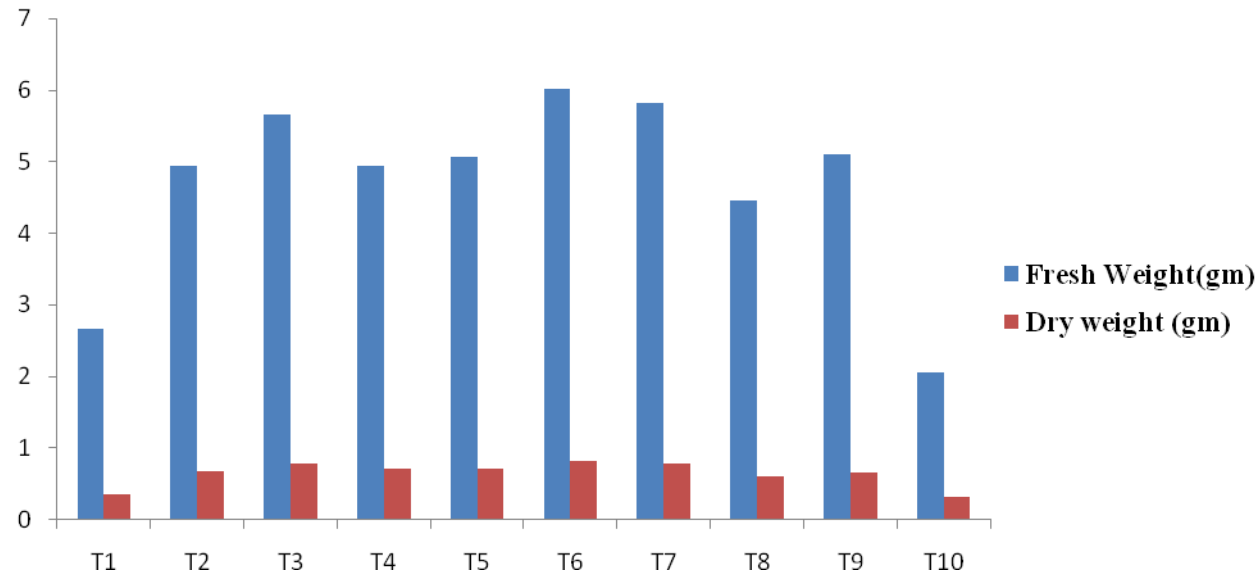

Figure 3: Effect of VC, FYM and NPK on fresh weight and dry weight of wheat

Fresh Weight and Dry Weight: Fresh weight and dry weight were more in the fertilizer treated plants than the control ones (Table 3). Fresh weight was maximum (6.22gm) in 20% VC (T6) treatment followed by (5.71 gm) in 200gm NPK (T9) treatment. Similarly dry weight was also maximum in T6 i.e., 0.82 gm followed by 0.76 gm in T9 treatment (Fig. 3).

The results of the present investigation are supported by Khaghani *et al*., (2012) who reported that application of fertilizers significantly affect the total fresh weight of chicory (Cichorium intybus L.). Presence of earthworm castes in the vermicompost has been shown to increase plant dry weight (Edwards C.A., 1995). On the addition of vermicompost in different concentrations, plant dry weight of strawberry increased significantly (Arancon *et al*., 2004).

Conclusion

The present study revealed that organic manures are more efficient and least toxic than chemical fertilizers for the seed germination and growth of wheat crop. Vermicompost is the most beneficial and nutrient rich organic manure than farmyard manure. It effectively enhances and provides the favourable conditions for seed germination and growth of wheat by improving the physical, chemical and biological properties of the soil. In the present findings vermicompost is more effective at 20% dose followed by 20% farmyard manure and 200gm NPK. However the application of chemical fertilizer (NPK) 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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