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Swine Manure as Soil Supplement to Enhance the Growth and Yield of Black Gram *(Vigna Mungo.L.)*: A Field Study

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ABSTRACT

This study emphasis on the impact of Swine manure (SM), Vermi compost (VC) and combination of both the manures (SMVC) treatments on physico-chemical, chemical and physical properties of Sandy Clay Loam (SCL) soil and on the growth parameters of the Black Gram *(Vigna Mungo.L.)*. A field experiment was conducted with three different treatments viz., sole application of SM, VC and combined application of both manures SMVC at three different doses of 8, 12.5 and 17 t ha^{-1} respectively. Soil properties got better enhancement for the amendment of swine manure as a single treatment at 17 t ha^{-1} (T3) and also responded well when combined usage with vermicompost at 17 t ha^{-1} (T9) too. The highest yield of 512 kg ha^{-1} was obtained for the treatment T9 and it is also in par with T3 of 510 kg ha^{-1}, and the lowest yield 94 kg ha^{-1} was acquired with the control plot (T10). Chemical properties like Nitrogen (N) and Phosphorus (P) and Potassium (K) got enriched after amendment with organic supplements, hence the development in the growing parameters viz., height of the plant and number of leaves per plant got increased. Bulk density takes place a cardinal role in the enhancement of water holding capacity along with saturated moisture (SaM) and thereby increases the yield. Statistical analysis has been done using SPSS ($P<0.05$) and height of the plant in 45DAS was found to be significantly responded to the crop yield. Present finding revealed that swine manure could be reliably used to enhance the productivity of Black Gram *(Vigna Mungo.L.)* instead of preferring to the Chemical Fertilizers (CF) and deteriorating the environmental ecosystem also to reduce the first concern of FYM.

Keywords: Swine manure, Vermicompost, Sandy clay loam, Black gram, Chemical fertilizers.

INTRODUCTION

Agriculture creates an evolution in the advancement of human civilization. In the recent years, chemical fertilizers stand its feet in the field of agriculture and generates a vigorous effect on the health of the people along with an unendurable extent of pollution and declining the fertility of the soil. Studies have been done for a long time and proven that incessant usage of chemical fertilizers in agricultural land declines the crop yield. The reason behind to it is ineffective usage of nitrogen, diminishing of soil physical and chemical characteristics deficiency of relevant micronutrients

in such fertilizers[1]. These issues can be sorted out by choosing the organic manures as soil conditioners.

Vermicomposting is the method which makes use of earthworms to convert organic residues into secondary by-product called vermicompost, that can be used as an organic fertilizer for the growth of crops. A previous study reported that compost in a companion with Jatropha cake promoted the yield of maize[2]. It carries a mixture of micro- and macro-nutrients and the absorption of the nutrients has a beneficial influence on plant nutrition and its growth and also reported in their finding that the vermicompost amendment has been used as a basal fertilizer which has a positive impact on the soil health along with fungal environment[3]. It was stated Vermicompost possess plant growth hormones and enzymes. In an earlier finding Poultry Farm Solid Waste (PFSW) vermicompost enriched the soil fertility and nutritional status of Andrographis Paniculata and Euphorbia hirta[4]. It was stated that agro-food waste compost paves the attention in improving the mineralization of carbon[5]. Swine manure (SM) contains about 13 essential nutrients necessary for the plant growth.

Farm Yard Manure (FYM) has been considered as a soil nourisher for the past years, but adequate usage of FYM leads to lack of availability nowadays. So, SM can be used as a supplement for organic farming instead of preferring usual animal wastes. After proper management SM can be implemented as soil amendment for the growth and production of crops[6].

India is the largest pulse producing country which produces 27 % of pulses across the world and imports 14% of pulses in the world. Black Gram *(Vigna Mungo.L.)* is also known to be Black Lentil, it is considered to be one of the most widely consumed lentils in India. In the previous investigation, Black gram has been grown under the recommended dose of fertilizer along with 60 kg K_2O ha^{-1} with the yield of 1156 kg ha^{-1} of Black Gram[7]. Even though it produces much yield, genuinely saying it is not taken into account as a healthy product as it was toned with chemicals and it also reduces the vitamin C in vegetables[8]. Rather the investigations have been turned to the side of organic cultivation as like earlier days. Black gram has been grown under the foliar application of Panchagavya as organic source which promotes the physiological growth, nitrogen content and chlorophyll content[9]. Many researchers also tried with organic manures for producing good yield and quality of Black Gram[10]. Animal wastes can be utilised as organic manure to have a sustainable agriculture and it also shows a positive effect on SCL soil in the nitrogen mineralization aspect[11,12]. In the present investigation, swine manure and vermicompost has been used as organic fertilizers in sandy clay loam soil for the growth of Black Gram *(Vigna Mungo.L.)*.

MATERIALS AND METHODS

A field experiment was conducted in the Kharif season 2018 at Servaikaranmadam of Thoothukudi district belonging to southern zone of Tamil Nadu state of India. The area under field work done was at a latitude of 8.6970° N latitude and 78.0502° E longitude. The field area was completely ploughed twice using rotor ploughing machine. The design of the experiment was implemented as Randomized Block Design (RBD) which was replicated thrice. The dimension of each plot is about 8.0 m × 5.0 m (40 m^2), with a separation of 1m between the plots. Drip tubes were used in the field for water irrigation with a spacing of 0.3 m or 30 cm. Swine waste applied as manure is collected from the pig farms, where it is piled up and waste leaves are added to that waste. It is dig down for ten days once to have proper aeration and also to have good turn out as composted form. Since direct application of swine manure promotes some environmental hazards and it is also too hot which will damage the growth of plants. Swine manure (SM) solely as three treatments (T1, T2 and T3) with three different doses (8,12.5 and 17 t ha^{-1} respectively). Swine manure was analysed for nutrient composition. It contains 2.10% of Organic carbon, 1.62% of Total Nitrogen, 0.17% of Total Phosphorus and 1.23% of Total potassium. Likewise, Vermicompost (VC) as a single manure treatment (T4, T5 and T6) with the similar doses as SM. T7, T8 and T9 is the combination of swine manure and vermicompost SMVC at 8,12.5 and 17 t ha^{-1} respectively. Finally for comparing the effects of the manure treated samples, a control plot T (10) is also under taken.

The organic manures are initially spread in the surface, after the application it is incorporated well using auger and hand harrow so that manures get penetrates into the soil rather than the residing on the surface alone. This is done to reduce nutrient runoff and nitrogen leaching. This is done periodically at an interval of ten days for a month for thorough mixing of the manures into the soil. The seeds were sown after 30 days. Test crop used for this investigation is Black Gram *(Vigna Mungo.L.)*. The variety used for the cultivation is Vamban BG (4). The seeds got germinated within a week of sowing. The samples of the soil were randomly collected prior to the study from a depth of 0-30 cm using auger. The samples were dried is air space and sent for analysis to soil testing laboratory. The potential of Hydrogen and Electrical Conductivity (EC) of the soil were determined with (1:2.5–soil:water) potentionmetry method. Available Nitrogen (N) from soil was determined by alkaline permanganate method[13]. Available Phosphorus (P) and Potassium (K) was also evaluated by $NaHCO_3$ using the mentioned methods[14,15]. Physical properties like Bulk Density (BD), Particle Density (PD), Water Holding Capacity (WHC), Saturated Moisture (SaM) and Pore Space (PS) was determined using Keen Raczkowski method 16. The pH, EC, N, P, K, BD, PD, WHC, SaM and PS were predicted initially T10 (before planting) as represented in Fig. 1(a) and (b). The same analysis has also been taken after the harvest period as shown in the graphical representation. Percentage of increase or decrease of a property can be calculated by considering the maximum attained value and the minimum attained value from the respective plots and by using the following formula.

%Of Increase of a property=((Maximium – Minimum)/(Maximum)) *100

%Of Decrease of a property=((Minimium– Maximum)/(Maximum)) *100

Ten Black Gram plants were randomly chosen for sampling and it was tagged for each plot in order to trace the parameters of the development of growth. The growth terms include height of the plant, number of leaves per plant.

The collected data from the study were analysed using Statistical Package for the Social Sciences (SPSS) for analysis of variance (one-way ANOVA) ($P<0.05$). Moreover, coefficient correlation was calculated to determine the relationship between Black Gram crop yield and physical properties of soil.

RESULTS

Effect of swine manure and vermicompost on physico-chemical properties of soil

The potential Hydrogen (pH) of the manure treated soils reduced slightly, for the treatment T9 it was found to be the lowest with a value of 7.0 compared to the manure untreated soil T10. The nature of the control soil is seeming to be slight alkaline in nature. The lowest is on par with the treatments T6 and T8 respectively. Electrical Conductivity (EC) is the term that refers to the number of salts reside in the soil, which plays the role of soil health indicator. The lowest value of EC was noted for the treatment T9 with the value of 0.15 ds m^{-1}. With the increasing dose of vermicompost added soils (VC) and also with SMVC treated soils there seen a decrement response. The pH and EC variation for the organically applied manures represented in Figure 1 (a).

Effect of swine manure and vermicompost on chemical properties of soil

As represented in Fig. 1(a) and (b) the untreated soil T10 has the low Nitrogen (N) content of 86.49 kg ha^{-1}. On analysing the samples after the harvest, the N value gets improved for the treatment T6. It is nearly twice the nitrogen content of control soil (T10) as it gets varied to 158.15 kg ha^{-1}. Phosphorus (P) is an essential nutrient needed for crops to capture the energy of the sun and converting it into a usable nutrient for growth and development of the plants. The available Phosphorus (P) was recorded as highest for the treatment T6 at 17 t ha^{-1} with the value of 37.07 kg ha^{-1}. It was observed that manureless plot T10 has the medium level of P as 8.77 kg ha^{-1}. The test soil taken for the field study has the available potassium of 373.13 kg ha^{-1}. After harvesting the available potassium was found to be the highest in T1 with a value of 1201.80 kg ha^{-1}.

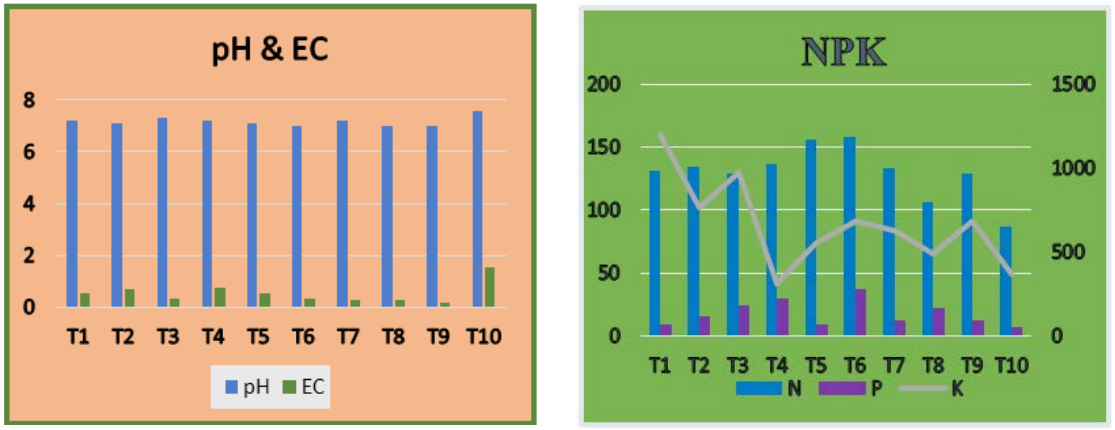

Fig. 1. Effect of SM, VC and SMVC variation in (a) Physico-chemical properties of soil (b) Chemical properties of soil

Effect of swine manure and vermicompost on the Physical properties of the soil and growth parameters

The applied organic manures thereby lowered the densities (BD, PD) of the soil, according to the concentration applied (Fig. 2a). On comparing to the sole implementation of manures with different doses, swine manure at 12.5 t ha^{-1} responded well in the lowering of the bulk density of 0.7882 g/cm^3. Likewise, SM at 8 t ha^{-1} has the lowest particle density of 1.0072 g/cm^3. In account to SMVC, the lowest bulk density is attained for the treatment T9. This value is 49.56% lower than the untreated soil T10 with a BD of 1.0459 g/cm^3. Particle density for the treatment T7 attains the minimum value among the three treatments of SMVC and for T1 it is attained to be the most minimal one. It is of 25.88% times lower than the control plot. This is 23.42% times got reduced in comparison to the control plot T10. The data presented in Fig. 4b revealed that the swine manure and vermicompost significantly increased the Water Holding Capacity. SMVC (T8 and T9) was superior with higher WHC compared to sole application of Vermicompost (V) but the value obtained for SMVC (T9) was similar to S at 12.5 t ha^{-1} (T2) and also much greater than control plot T10.This is moreover 22% times greater than the control plot. The results showed that Saturated Moisture (SaM) was significantly influenced by implementation of organic manures, it is represented in Fig. 2b. Sole application of V at 12.5 t ha^{-1} promptly increased the saturated moisture content in soil. This is 23.47% times higher than the control plot T10. This significant higher content was on par with sole application of Swine manure at 12.5 t ha^{-1} and also for SMVC at 12.5 t ha^{-1}. For the present work Pore Space (PS) was highest for the single manure concentration of SM at 17 t ha^{-1}. This is 30.94% times greater than the control plot T10. PS also got increased for the increasing doses of Swine Manure (SM) which was ranged for 24.48% to 29.01%. The gradual increment is also seen in sole application of vermicompost (T4, T5 and T6). Thus, applied manure improves the WHC significantly.

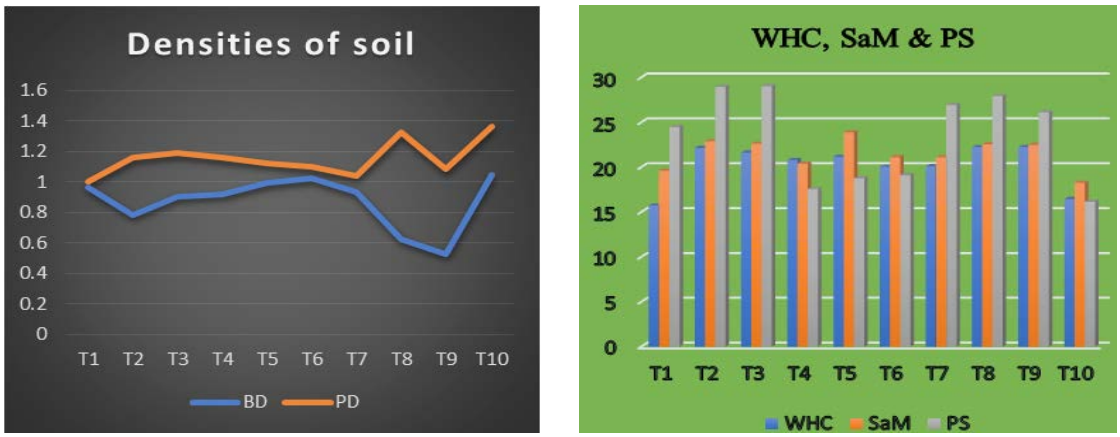

Fig. 2. Effect of SM, VC and SMVC variation in Physical properties of (a) Densities of soil (b) Water Holding Capacity, Saturated Moisture & Pore Space of soil

Table 1 represents the effect of swine manure and vermicompost on the growth parameters of the plant. The implemented manures induced the height of the plant and also with the number of leaves per plant at different days after sowing (DAS) and also at nigh harvest. Around harvest time, the highest plant was obtained for the treatment T6 at 17 t ha^{-1}. The height has got increased from the range of 13.50 cm of Control plot T10 to 25.03 cm. The reason behind the increase in the height of the plant is available Nitrogen (N), which is found to be greater for the treatment T6 as the Nitrogen is responsible for the plant growth. Phosphorus (P) shows its importance in the growth of leaf. As the P content was found to be higher for the T6 treatment it reflects its nourishment in the growth of leaves hence T6 has a greater number of leaves compared to the control plot. It was also on par with the treatment T9 of SMVC at 17 t ha^{-1}. Considering the yield as dependent the significancy was found for the 45DAS height of the plant with a probability of P=0.02.

DISCUSSION

Effect of swine manure and vermicompost on physico-chemical properties of soil

Implementation of vermicompost at increasing doses shows the impact on lowering the soil pH extent as reported in the previous works[17,18]. The decrease in the value of EC might be due to the rise of permeability which give on to the salt percolation. Earlier finding reported in their work that on implementing vermicompost supplemented with NPK fertilizer has lowered the EC value to a greater extent[19]. While it has been achieved in the present finding on the treatment T4, T5 and T6 even with the vermicompost alone.

Effect of swine manure and vermicompost on chemical properties of soil

The availability of N can be satisfactorily predicted up to within a year after implementation of manures or fertilizers[20]. Pig manure and NPK as a sole treatment and combined usage of both used as an enrichment to increase the macronutrient status of the soil along with the yield of tomato[21]. Likewise, the NPK and pig dung was used as manure and it significantly increases the agronomic parameters like plant height, number of leaves, number of fruits and weight of fruits[22]. Earlier finding suggested that the pH plays a vital role in the increment of nitrogen content in the soil by initiating the nitrification process thereby producing ammonium ion [NH_4^+] in the soil and generates mobile nitrates[23]. Phosphorus nutrient source can be improvised with the consumption of opting organic fertilizers like vermicompost and swine manure as insisted in this present study, instead of using inorganic fertilizers which builds up impact against soil microbial activity[24]. Implementation of organic fertilizer or phosphorus fertilizer had positive significance on the potassium availability for the maize growth[25]. In the present study the EC value of Swine manure shows its impact on the available potassium (K). Potassium (K) nutrient is responsible for the activation of enzymes and synthesis of protein. The uptake of potassium thereby also promotes the ability to use N and which rises the protein content of the crop.

Table 1: Effect of the soil amendment on the growth parameters of the plant

	Height of the plant (cm)				Number of leaves per plant				Yield
Treatment	15DAS	30DAS	45DAS	60DAS	15DAS	30DAS	45DAS	60DAS	(kg ha^{-1})
T1	9.4	13.4	19.7	24	5.1	14	21.9	32.1	110
T2	11	15.7	26.4	29.9	5.1	15.6	25.2	39.8	330
T3	9.6	17.9	28.1	35.1	5.9	20.6	28.2	51.3	510
T4	10.95	16	27	33	6.1	18	23.7	44.1	470
T5	9.3	15.7	28.7	35.2	5	22.2	33.3	52.2	280
T6	11.2	22.1	28.9	37.9	5.5	22.1	43.9	59.4	360
T7	8.7	16.4	24.6	30.1	5.7	18.9	48	60	345
T8	10.6	18.7	29.1	36.8	9.9	19.3	30.8	63.2	440
T9	12.4	18.7	29.4	36.7	5.6	16.6	34.8	61.7	512
T10	7.7	11.7	16.5	18.1	8.8	14.7	25.2	28.7	94
Mean	10.085	16.63	25.84	31.68	6.27	18.2	31.5	49.2	345.1
SD	1.3897	2.9254	4.3980	6.3683	1.6820	2.9424	8.7172	12.5315	150.0611
CV (%)	13.7794	17.5910	17.0202	20.1019	26.8256	16.1671	27.6735	25.4447	43.48336
Significance	NS	NS	**	NS	NS	NS	NS	NS	**

NS-Not Significant **-Significant

Effect of swine manure and vermicompost on the Physical properties of the soil and growth parameters

Vermicompost shows positive influence on the properties like bulk density, water holding capacity and porosity. Thus, organic matter existing in organic manures tends to hold plenty of water, thus it directly impresses the water availability to crop. Water is an essential medium to sustain the life of the plant. Water Holding Capacity (WHC) is the capability to store that medium in the soil. It can be justified according to the size of the pores. Through the larger pores water can readily moves downward without any retainment. Implementing organic manures in the soil, consequently, produces aggregates and reduces the size of the pores. The small pores permit the soil and it supports to hold the water to a greater extent. Capillary forces play a vital role in retaining the water in between the pore space. The impact of Farm Yard Manure, tank silt and composted coir pith improved the saturated moisture (SaM) 26. SM is compared to have better nutrient composition that FYM, this makes the properties to get enriched and makes the yield better[27].

CONCLUSION

The results corroborated on the present study have revealed that the Swine Manure (SM) as a sole and also on addition with Vermicompost (SMVC) promptly produces a positive impact on the physico-chemical property of Electrical Conductivity (EC) for the treatment with SMVC at 17 t ha-1 and physical properties like Bulk Density (BD), Particle Density (PD) got reduced mainly for SMVC at 17 t ha^{-1} and individual application of SM at 8 t ha^{-1} thereby increases the Water Holding Capacity (WHC), Pore Space (PS) and Saturated Moisture (SaM) to a greater extent due to the direct interaction with the bulk density of the soil. This also mainly happens for the manures of SM at 12.5 t ha^{-1} and also with SMVC at 17 t ha^{-1}.The chemical property like available Nitrogen (N) responsible for the generation of chlorophyll and making the plants to grow taller is attained for the Vermicompost treatment (T6) at 17 t ha^{-1}, available Phosphorus (P) seems to be the greatest in the treatment Vermicompost (T6) at 17 t ha^{-1} which shows this reflectance in the number of leaves per plant and available Potassium (K) is highest for the swine manure treated soil T1. The farmers can beneficially choose swine manure for promoting the growth of Black Gram *(Vigna Mungo.L.)* without subsequently preferring FYM or availing inorganic fertilizer to the agricultural land and thus reducing the harmful impact against soil ecosystem in order to improve the crop growth.

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Conflict of Interest

There is no conflict of interest.

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