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Effect of vermicompost as fertilizer on growth, yield and biochemical characteristics of plant *Dolichos purpureus* L.

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Abstract

Vermicomposting is associated with environmentally and economically friendly processes to decompose organic waste. India's agro-industrial sector contributes large resources of plant materials within the variety of compost. The results of vermicompost on the expansion, yield and chemical characteristics of lablab-bean *Dolichos purpureus* L. were meted out in the pot experiment. Five treatments were applied to gauge the impact of vermicompost, compared to inorganic fertilizers–NPK, 100:0, 75:25, 50:50, 25:75 and 100 percent chemical plant food. A pot experiment was conducted with the target to analyze the results of vermicompost and NPK plant food on crop growth, pods yield and organic chemistry characteristics of lablab-bean with 5 treatments and 5 replications. The macro and micronutrients were analyzed within the before and when treatment of pot mixture. Vital improvement of all the parameters, like the length of shoot, length of root, number of leaves, leaf area and number of branches was discovered in plants at regular intervals. Vermicompost contains a mixture of macro and micro-nutrients and therefore the uptake of the nutrients includes a positive impact on plant nutrition, growth, chemical change and pigment content of the leaves. The results showed that Vermi-fertilizer completely affected all measured characteristics of lablab-bean. This plant food is as progressively thought-about in agriculture and husbandry as a promising various to inorganic fertilizers and/or vegetable matter in greenhouse potting media.

The modern agricultural farming practices, along with irrational use of chemical inputs over the past four decades have resulted in not only loss of natural habitat balance and soil health but have also caused many hazards like soil erosion, decreased groundwater level, soil salinization, pollution due to fertilizers and pesticides, genetic erosion, ill effects on the

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environment, reduced food quality and increased the cost of cultivation, rendering the farmer poorer year.[22] Due to the continuous use of chemical fertilizers, the decline in organic matter content of the agricultural soil leading to the depletion of beneficial microorganisms which in turn reduced the soil productivity. The agricultural land is diminishing exorbitantly and there is no scope for further expansion in the area. Hence to meet the increasing demand, crop production has to be increased per unit area of land. Man-made fertilizers contain nitrogen, phosphorus and potassium, which increase the output of agricultural products. The demand for chemical fertilizers is continually increasing, the gap between the demand and supply is widening and such a gap would be difficult to bridge in the wake of the energy crisis. Therefore, the strategy for improving agricultural production should consider supplementing nitrogen and phosphorus through microbial processes. This can be accomplished through the application of organic fertilizers. Organic agriculture could be a holistic production management system that promotes and enhances agro-ecosystem health, including biodiversity, biological cycles and soil biological activity. It emphasizes the use of management practices in preference to the use of off-farm inputs, taking into account that regional conditions require locally adapted systems. This is accomplished by using wherever possible, agronomic, biological and mechanical methods, as opposed to using synthetic materials, to fulfil any specific function within the system.[7] Organic manures generally improve the soil's biological, physical and chemical properties along with conserving the moisture-holding capacity of soil and thus resulting in enhanced crop productivity along with maintaining the quality of crop production. A mixture of worm castings, undigested organic wastes, microbes, vitamins, enzymes, hormones and antibiotics forms the vermicompost. It has less soluble salts, neutral pH, greater ion exchange capacity, humid acid content, nitrates, calcium and magnesium. It improves the water holding capacity of the soil. It contains plant hormones like auxins and gibberellins and enzymes which are believed to stimulate plant growth and discourage plant pathogens. Additionally, it enriches the soil with useful microorganisms which add different enzymes like phosphatases and cellulases to the soil. It enhances germination, plant growth and thus overall crop yield[10,27]. It is rich in NKP and retains the nutrients for a long time and whereas the conventional compost fails to deliver the required amount of macro and micronutrients including the vital NKP to plants in a shorter time.

Most of the organic manures are very low in nutrient contents, which are not sufficient to fulfilthe nutritional requirement of the crops, especially when inorganic fertilizers are not applied. Under such circumstances, fortification of organic manures and composts with permitted additives like rock phosphate, beneficial microbial cultures and neem cake is a feasible option for nutrient supplementation in organic food production. However, the increased growth, yield and quality of beans are due to the application of vermicompost which improved the physical conditions of the soil which support better aeration to plant root, drainage of water, facilitation of actions N+, P+ and K+ exchange, sustained availability of nutrients, and thereby the uptake by the plants resulting in better growth. The treatment 50%

vermicompost + 50% NPK supplies higher macro and micronutrients to the soil and plants in the available from which results in better growth, yield and quality of beans[12].

Vermicompost: For the vermicompost, the various NPK ration level was mixed individually under lab condition. The moisture content was optimally maintained for the facilitative growth of mixed inoculants. The enriched vermicompost was kept for 21days for maximal changes such as physical, chemical and biological activities. After the enrichment, the enriched vermicompost was used for the Pot experiment.

Pot experiment: The Pot experiment was conducted to study the nursery performance of NPK enriched vermicompost. The soil mixture was prepared by mixing black soil, red soil, and sand in the ratio of 1:1:1 for the pot experiment. The vermicomposts were applied 20g each at the topsoil of the pots at regular intervals for 15 days. The experimental details were, The treatments-T1-100% Vermicompost; T2-75%
Vermicompost + 25% fertilizer (N, P, K); T3-50% Vermicompost + 50% fertilizer (N, P, K); T4-25% Vermicompost+ 75% fertilizer (N, P, K); T5 -100% fertilizer chemical nutrient (N, P, K).

The growth parameters such as seed germination[13], germination index[7], and seedling vigour index[16] shoot length, root length, number of leaves, leaf area, number of pods, number of seeds/pod, fresh weight and dry weight were studied in the treated and untreated control plants. The number of seeds germinated in each treatment was counted on 7day after sowing. The final count of germination was recorded on the 7th day and the number of normal seedlings was expressed as percentage germination. Germination Index was calculated with the number of germinated seeds and days of the first count to the days of the last count. Seedling Vigour Index was calculated with the help of data recorded on germination percentage and seedling growth. For the analysis of plant biomass, the plants were uprooted without causing any damage to the seedlings and it was thoroughly washed with tap water to remove soil and debris particles. Then the shoot length was measured with the help of a meter scale. In uprooted plants, the root length was measured with the help of a meter scale and expressed in centimetres. The fresh weight of whole plant parts (shoot, leaves and root) was weighed using an electronic balance. The fresh undamaged whole plant system of seedlings was kept in the oven at 80°C for 4-6hours and the dried seedlings were weighed using an electronic balance. Biochemical characters such as Chlorophyll and carotenoids[28], Protein[20], total glucose[14] free amino acid[14] were estimated.

Statistical Analysis: The values are expressed as Mean ± Standard deviation. The data obtained were subjected to analysis of variance (ANOVA). * Significant at $p < 0.01$, ns - non-Significant.

The effect of chemical fertilizer and enriched vermicompost on the growth and biochemical characteristics of lablab-bean was analyzed in the pot experiment. The growth characters such as germination percentage, germination index, seedling vigour index, shoot length, root length, number of leaves, leaf area, number of pods, number of seeds/pod, fresh weight and dry weight were analyzed in the chemical fertilizer and enriched vermicompost (in different ratio level T1, T2, T3 and T4). The results revealed that there was a significant difference was observed in the rate of seed germination of lablab-bean and the rate was higher in the plant's treatment (100% Vermicompost, 75% Vermicompost + 25% fertilizer (N, P, K), 50% Vermicompost + 50% fertilizer (N, P, K), 25% Vermicompost + 75% fertilizer (N, P, K), 100% fertilizer chemical nutrient (N, P, K)with vermicompost enriched with over the 100% chemical fertilizer. Among them, 100 % vermicompost enrichment is superior to others. The germination index of seed is also varied according to the nature of enrichment of vermicompost. Different chemical fertilizers enrichment shows little difference in germination index. But the effect was significantly higher than chemical fertilizers. The values of the vigour index of the *Dolichos purpureus* L. also varied according to the nature of enrichment. The lowest of vigour index was shown by the 25% Vermicompost + 75% fertilizer (N, P, K) plant and the highest value of vigour index was for the application of soil to 100% Vermicompost, followed by 75% Vermicompost + 25% fertilizer (N, P, K) and 50% Vermicompost + 50% fertilizer (N, P, K) (Table-1, 2, and 3). Regarding the plant biomass production, T1, T2 and T3enriched vermicompost improved the shoot length compared to T4 and T5. Among them, 100% vermicompost respond well followed by enriched with chemical fertilizer. Further, 75% and 100% vermicompost than vermicompost alone significantly influence the number of leaves per plant. The highest number of leaves was found in plants enriched with 100% vermicompost closely followed bychemical fertilizer and 75 % of vermicompost. The fresh and dry weight of the T1 was found to be maximum, which was followed by T2, T5, T3 and T4 (Table-4 and 4a).

Table-1. Available of Pysico-chemical properties of soil

S.no.	Analysis	Physical-chemical nutrients	Sample value
1.	Physical properties of the soil	Coarse sand	2.00%
		Fine sand	2.43%
		Silt	40.71%
		Clay	54.86%
		Texture class	Silty clay
2.	Macro nutrients of the soil	N	12.29
		P	48.15
		K	326.18
3.	Micro nutrients of the soil	Fe	3.45
		Mn	6.42
		Zn	1.62
		Cu	3.25
4.	Chemicals properties of the Soil	pH	7.02
		EC	1.26

Table-2. Available of Pysico-chemical properties of Vermicompost

S.no.	Analysis	Physical-chemical nutrients	Sample value
1.	Physical properties of the soil	Bulk density	746
	Organic matter	36.27	
	C/N ratio	1:13:27	
2.	Macro nutrients of the soil	N	15.31
		P	54.25
3.	Micro nutrients of the soil	K	502.14
		Fe	10.25
		Mn	18.27
4.	Chemicals properties of the Soil	Zn	5.86
		Cu	11.57
		pH	7.58
		EC	1.08

Table-3. Effect of NPK with Vermicompost on the growth characters of lablab-bean

S. No.	Treatment	Seed germi nation (%)	Germina tion index	Seedling vigour index
1	T1-100% Vermicompost	96%	1.45	24.21* ± 0.14
2	T2-75% Vermicompost + 25% fertilizer (N, P, K)	90%	1.37	23.15* ± 0.20
3	T3-50% Vermicompost + 50% fertilizer (N, P, K)	85%	1.27	21.31* ± 0.14
4	T4-25% Vermicompost + 75% fertilizer (N, P, K)	76%	1.02	$19.08^{ns} \pm 0.20$
5	T5-100% Chemical fertilizer added soil (N, P, K)	88%	0.99	21.27± 0.15

Table-4. Effect of Chemical fertilizer with vermicompost on the growth characters of lablab-bean

S. No.	Treatment	Shoot length(Cm)	Root length(Cm)	Number of leaves/ Plant	Leaf area (cm^2)
1	T1- 100% Vermicompost	35.56* ± .04	25.6* ± 1.17	35* ± 0.6	2.55* ± 0.81
2	T2-75% Vermicompost + 25% fertilizer (N, P, K)	34.25* ± .28	24.5* ± 1.15	28* ± 0.33	2.45* ± 0.0
3	T3-50% Vermicompost + 50% fertilizer (N, P, K)	$30.6^{ns} \pm 0.14$	24.5* ± 0.12	$25^{ns} \pm 0.33$	$2.40^{ns} \pm 0.47$
4	T4-25% Vermicompost + 75% fertilizer (N, P, K)	$31.6^{ns} \pm 0.20$	$22.9^{ns} \pm 0.44$	$28^{ns} \pm 0.17$	$2.41^{ns} \pm 0.27$
5	T5-100% Chemical fertilizer added Soil (N, P, K)	32.5 ± 0.2 8	24.1 ± 0.18	29 ± 0.27	2.45 ± 0.23

Table-4a. Effect of Chemical fertilizer with vermicompost on the growth characters of lablab-bean

S. No.	Treatment	Number of pods	Number seeds/pod	Fresh weight(g)	Dry Wt(g)
1	T1- 100% Vermicompost	25* ± 0.12	6* ± 0.05	4.29* ±0.03	1.99* ± 0.12
2	T2-75% Vermicompost + 25% fertilizer (N, P, K)	20* ± 1.14	6* ± 0.02	4.15* ±0.05	1.85 ± 0.15
3	T3-50% Vermicompost + 50% fertilizer (N, P, K)	19* ± 0.18	5^{ns} ± 0.00	3.9^{ns}±0.12	1.83* ± 2.13
4	T4-25% Vermicompost + 75% fertilizer (N, P, K)	18^{ns} ± 1.11	5^{ns} ± 0.05	3.88^{ns}±0.12	1.79^{ns} ± 0.18
5	T5-100% Chemical fertilizer (N, P, K)	21 ± 0.04	5 ± 0.01	4.12±0.26	1.80 ±0.21

Table-5. Effect of chemical fertilizer with vermicompost on the biochemical characters of lablab-bean

S. No.	Treatment	Totalchlorop-hyll (mg/g)	Carotenoid (mg/g)	Protein (mg/g)	Aminoacids (mg/g)
1	T1- 100% Vermicompost	4.23* ± 0.18	2.44* ± 0.15	15.56* ± 0.27	12.96* ± 0.20
2	T2-75% Vermicompost + 25% fertilizer (N, P, K)	4.11* ± 0.16	2.35* ± 0.17	14.81* ± 0.04	11.12* ± 0.22
3	T3-50% Vermicompost + 50% fertilizer (N, P, K)	4.13* ± 1.13	2.13*± 0.13	13.93* ± 0.44	10.45* ± 0.25
4	T4-25% Vermicompost + 75% fertilizer (N, P, K)	4.06^{ns} ± 1.13	2.26^{ns} ± 0.12	15.28^{ns} ± 0.21	11.61^{ns} ± 1.12
5	T5-100% Chemical fertilizer (N, P, K)	4.11 ± 1.12	2.33 ± 0.21	15.32 ± 0.18	12.53 ± 1.22

The application of enriched vermicompost significantly increased the growth of *Dolichos purpureus* regarding seed germination, seedling vigour index, shoot length, root length, plant fresh weight and plant dry weight. The effect was varied with different ratio levels of vermicompost and fertilizer used for the enrichment. The combined use of fertilizers and vermicompost significantly increased the vine length in cucumber. The better efficiency in combination with organic manures and bio-fertilizers might be because organic manures provide the micronutrients such as zinc, iron, copper, manganese, *etc.*, at an optimum level. Zinc plays a role in the biochemical synthesis of the most important plant hormone, Indole Acetic Acid (IAA) through the pathway of conversion of tryptophan to IAA. Iron also plays a significant role in the chlorophyll synthesis pathway. The application of organic manure helps in the plant metabolic activity through the supply of such important micronutrients in the early crop growth phase, which in turn encouraged early vigorous growth[2,27]. The pot culture studies have shown that, due to uptake of readily available micro and macronutrients in the vermicompost and its associated microbes, all the root and shoot parameters are higher in the pots which are supplied with biofertilizer enriched vermicompost. The combined application of vermicompost and chemical fertilizer is superior in enhancing the growth and development of the green leafy vegetable, *Amaranthus*. The application of bio-fertilizers along with chemical fertilizers and vermicompost proved that the increased growth and nutrient content of the *Amaranthus* plants. Hence it is recommended that the use of bio-fertilizer and vermicompost along with the chemical fertilizer would be beneficial to the environment as it would reduce the use of inorganic fertilizers and promote sustainable agriculture.[1]. Whereas, another experiment that the highest pod number were found with vermicompost (20%) treatment.[12] The lowest number of pods was obtained with chemical (100%) in the two tested seasons. The development improved and yield increased by application vermicompost with beans cultivated in amended soil.[8] Also, the number and weight of fruits per plant of tomato (*Lycopersicum esculentum*) plant grown in soil treated with vermicompost increased compared to other treatments.[6] The organic amendments of soil increased the nutrient supply and plant productivity at different magnitudes depending on the quality of residue used and its mode of application. Different forms of organic amendment to soil could be useful for the different crops; however, the use of vermicompost could be a better option in general.[23] Furthermore, the application of vermicomposts in the field enhances the quality of soils by increasing microbial activity and microbial biomass which is key components in nutrient cycling, production of plant growth regulators and protecting plants soil-borne disease and arthropod pest attacks[3]. Vermicompost is produced by using organic material through interactions between earthworms and microorganisms it is known as vermicomposting. The continued use of chemical fertilizers causes health and environmental hazards such as ground and surface water pollution by nitrate leaching.[6]. Quality of soils enhanced by the application of vermicomposts in the field also increases the microbial activity and microbial biomass which are key components in nutrient cycling, production of plant growth regulators and protecting plants soil-borne disease and arthropod pest attacks.[3] However, this organic fertilizer is therefore increasingly considered in agriculture and horticulture as a promising alternative to inorganic fertilizers.[3] Likewise, the increased growth, yield and quality of beans are due to the application of vermicompost which improved the physical conditions of the soil which support better aeration to plant root, drainage of water, facilitation of actions N+, P+ and K+ exchange, sustained availability of nutrients, and thereby the uptake by the plants resulting in better growth of beans. In the pot plants, the biochemical characters such as total chlorophyll, carotenoid, glucose, protein and free amino acids, were estimated to found out the beneficial effect of enriched organic manure regarding biochemical response in the

Dolichos purpureus plants. The total chlorophyll content was found to be maximum in the T1 (100% vermicompost) when compared to the other treated plants. The T2, T3 treatments were increased the leaf carotenoid in plants than treated pants (T4 and T5). But, there were no significant differences found among the treatments (Table 5). The glucose content of *D. purpureus* was highly enhanced by the application of enriched vermicompost alone than other enrichments and non-enriched vermicompost. The protein content of all the treatments was found to be significantly higher when compared to the Chemical fertilizer (T5). The amino acid content level was higher in the plants treated with 100% vermicompost which was followed by enrichment with 75% vermicompost. The soil amendment with different types of microbe's enriched vermicompost significantly responds to the biochemical attributes such as total chlorophyll, carotenoid, protein, glucose content, the amino acid content of *Dolichos purpureus* L.. The maximum chlorophyll a, chlorophyll b and total chlorophyll, carbohydrate and protein content found in plants treated with biofertilizers enriched vermicompost in *Vigna unguiculata* L. The increased amount of chlorophyll contents seems to correlate with the increased photosynthetic properties.[11,17,18] The application of vermicompost highly enhanced the carbohydrate content in tomato plants.[5] The combined application of biofertilizers, inorganic fertilizers and vermicompost increases the biochemical constituents in chili fruits. The biofertilizers added to soil provide macronutrients and micronutrients, which are assimilated by plants and utilized for various metabolic activities to synthesize chlorophyll, required for their normal growth and development. Various micronutrients are needed for catalytic activities of enzymes essential for respiration, photosynthesis, flowering, fruit setting and seed filing as well as fight against abiotic and biotic stresses.[4,24]. The grain protein content was increased with nitrogen for organic and inorganic sources.[21] The application of organic manures not only influenced the growth and yield of wheat but also helped in enhancing the parameters of seed quality. The increase in quality parameters might be due to the higher protein content and better-sized seeds with these treatments. Significantly higher protein content in seed was observed in treatment receiving vermicompost with poultry manure in groundnut.[15]. The highest protein content in lablab-bean fruit was recorded with the application of N through FYM, vermicompost, poultry manure and urea over control.[26] Inoculation with nitrogen-fixing bacteria always increased leaf NRA suggesting a greater supply of NO_3 to the plants over un-inoculated control. The increased NO_3 uptake may relate to increased root development in response to the production of hormones.[9,25] The wheat plants inoculated with *Azospirillum* showed greater activity of the nitrate reductase enzyme.[28].

The present investigation revealed that the plant growth and yield is increased in the plants treated with 100% vermicompost than 100% chemical fertilizer alone. Further, the response also reflected in the vermicopost dynamics as well as nutrient status of amended soil. The positive effect is differed with reference to vermicompost enrichment. Among them, the enrichment with 100% vermicompost is superior to 75% vermicompost

+ 25% chemical fertilizer, 50% vermicompost + 50% chemical fertilizer, 25% vermicompost + 75% chemical fertilizer and 100% chemical fertilizer. Hence, 100 % vermicompost is best suit for *Dolichos purpureus* L. plant. From this study, it can be concluded that enriched vermicompost would be conducive for greater plant growth and also would improve the soil health and soil fertility status. It can be recommended that by using enriched vermicompost, the yield of *Dolichos purpureus* L. can be improved.

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