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VERMICOMPOST AND BIOFERTILIZER EFFECT ON SOIL NUTRITIONAL STATUS OF TASAR SILKWORM GROWING REGIONS

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ABSTRACT
Soils of tasar growing regions are failed to sustain the nutrients due to continuous application of sole chemical fertilizers. Biofertilizer is of immense significance in order to alleviate deterioration of soil health and quality in tasar sericulture regions ensuing great quality of tasar silk cocoon and productivity. Thus, a field experiment was conducted at Central Tasar Research and Training Institute, Ranchi with an aim to improve nutritional status of host plant of tasar silkworm and soils by using different biofertilizer and vermicompost. The experiment was consisted of eight treatments with different combination of treatments includes control. The soil samples were collected and analysed from respective treatments for physical and chemical characters. The study revealed that soils of different treatments were varied from very strongly to moderately acidic range (4.59 to 5.07). Organic carbon content was higher with T_4 (0.89%) followed by T_1 (0.86%) and T_3 (0.84%). The EC were found in the range of 0.015 to 0.021 dS m^{-1}. Available nitrogen was observed quit low and ranged from 152.7 to 221.9 kg ha^{-1}. However, available phosphorus recorded medium to higher range (14.33 to 36.7 kg ha^{-1}). In this study, available potassium content was ranged from 196.6 kg ha^{-1} to 326.7 kg h_a^{-1} which resulted medium to high range. All the micronutrients (Cu, Zn, Mn and Fe) in the plots which treated with T_4 were found to be sufficient amount. This study is apparently indicated that sole application of organic manure cannot meet the nutrient requirement of tasar host plants. Hence, amalgamation of manure with biofertilizer could be promised to improve the nutrients content of plants and soil without endangering the environment.

KEYWORDS: Biofertilizer, Host plants, Nutrients, Tasar silkworm, Vermicompost.

INTRODUCTION

Tasar sericulture is a forest based activity. It is mainly consists of silkworm rearing and maintaining of tasar food plant. Tasar silkworm, *Antheraea mylitta* D. is a polyphagous insect feeds primarily on Asan (*Terminalia tomentosa*), Arjuna (*T. arjuna*) and Sal (*Shorea robusta*) and dozens of secondary host plant (Gupta and Sinha, 2013). Its mainly an outdoor practices carried by the forest dweller tribal communities and rural people of Jharkhand, Madhya Pradesh, Andhra Pradesh, Chhattisgarh, West Bengal, Bihar, Odisha and Maharashtra states of India. It is a source of livelihood for about 1.5 lakh tribal families of tasar growing state. The quality and Quantity of tasar silk depends upon the nutritive value of the leaves on which the silkworm feed (Pandiaraj *et al*., 2017). Good Quality cocoon crops can be obtained from good quality leaves (Sahay *et al.*, 2001). Continuous exploitation of host plant by using chemical fertilizer have deteriorated the nutritional quality of leafs; thus, affecting the quality and quantity of cocoons (Singhvi, 2013). So, it is important to improve the nutritional quality of soil by improving physical, chemical and biological health (Singhvi, 2013). Vermicompost and biofertilizer helps in increasing the nutrient content of the soil. Vermicompost is humus like material produced by the combined action of microorganism and earthworm by the conversion of organic waste into a valuable end-product (Garg *et al*., 2006; Suthar, 2007; Mainoo *et al*., 2009). Earthworm excrement called casting which helps to improve the biological, chemical and physical properties of soil. It contains rich source of NPK which is easily available to the plant. Vermicompost helps in enhancing the growth of plant, suppress plant disease, improve soil structure, microbial activity, water retention and aeration. It's reduces the use of chemical fertilizer. Continuous use of chemical fertilizer has made the soil deprived of organic matter and essential plant nutrients resulted less population of beneficial microorganism and affecting the soil fertility and making the plant prone to various diseases (Narendrakumawat *et al*., 2017). Biofertilizers are preparation containing living cells of microorganisms when inoculated into the soil provide essential nutrients to the plant by association with the plant roots and by solubilization of other nutrients like phosphorus. Use of biofertilizer is an economical, eco-friendly, more efficient and easily accessible to marginal and small farmer over chemical fertilizers. Thus, this study was aimed to evaluate the nutritional status of tasar silkworm host plant and soil with vermicompost and biofertilizers.

MATERIALS AND METHODS

Description of the Study Area

The study area is situated in the Central Tasar Research and Training Institute, Piska-Nagri, Ranchi, Jharkhand state. It is lying between 22°30' and 24°30' N Latitude and between 83°22' and 85°06' E Longitude at an altitude of

651 meters above MSL. The region enjoys a humid to sub-tropical climate and receives a mean annual rainfall of 1323 mm in 100 rainy days. Of this, nearly about 85% is received during southwest monsoon (2^{nd} week of June to 1^{st} week of October), 7.78% during North East monsoon (2^{nd} week of October to 3^{rd} week of December), 2.87% during winter (January to February) and 7.48% during summer (March to May). The maximum temperature ranges from 29.3°C to 36.2°C and the minimum temperature ranges from 4.5°C to 19.8°C.

Experimental Design

In this experiment, a field study using a randomized complete block design with eight treatments was conducted with three replication. The treatments were consisted of absolute control (T_0), Vermicompost (CTR&TI) + PSB (T_1), Vermicompost (BAU) + PSB (T_2), Vermicompost (RKM) + Azotobacter (T_3), Vermicompost (CTR&TI) + Azotobacter (T_4), Vermicompost (BAU) + PSB + Azotobacter (T_5), Vermicompost (RKM) + PSB + Azotobacter (T_6) and Vermicompost (BAU+CTR&TI) + PSB (T_7). The host plant of tasar silkworm *i.e*. arjun plant planted by 4×4 feet has selected as tested crop in this study. The experiment field was designed to have such four plants falls in each treatment.

The soil was collected from each treatment plots and analysed for soil physical and chemical properties. Soil Reaction (pH) and Electrical Conductivity was determined by using 1:2.5 soils: water suspension with the calibrated pH and conductivity meter by following the method given by Jackson (1973). Organic Carbon was determined by modified Walkley and Black (1934) method. Available nitrogen was determined by alkaline permanganate method as described by Subbiah and Asija (1956). Available Phosphorous was determined by spectro-photometer by Bray and Kurtz (1945) method. Available Potassium was determined by Flame Photometer with 1N neutral ammonium acetate as an extractant by following Hanway and Heidel (1952) method. Available Sulphur was determined by following Turbidimetric Chesin and Yien (1950) method. Aavailable boron was estimated using hot water soluble B method, available micronutrients estimated by DTPA extractable method (Lindsay and Norvell, 1978) using AAS (Agilent 280FS). The data were analysed using descriptive statistics and SPSS 20.0.

RESULTS AND DISCUSSION

Soil Physical Properties

The result of soil physical property characters of experiment is given in Table 1. Soil pH is one of the important factors and it determines the availability of essential nutrients to the plants and thus the fertility of the soil. The solubility of nutrients is also determined by pH. Leaching of nutrients increases with increasing acidity resulted in decreasing their availability to plant (Brigg's, 1977). It also affects the soils microbes; thus greatly influence the decomposition of organic matter and nutrient availability (Menget and Kirby, 1982). The quantity of some nutrients becomes toxic to plants under acidic or alkaline conditions (Daji, 1996). Therefore, the soil pH should be maintained between 6.5 and 7.5; so that the nutrient will be available to plants. In the present study, pH was found to be ranged from 4.59 to 5.50 irreversible to treatments reflecting strongly acidic nature of soils. This acid pH might be due to several organic acids released while decomposing vermicompost with help of microbes in biofertilizer. This organic acid imparts H^+ ions to the solution which decrease the pH value. This result also corroborated by Chimdi *et al*, 2012.

The electrical conductivity (EC) of soil indicates the presence of soluble salt in the soil. It plays a major role in soil salinity (Ravi Kumar *et al*., 2013). EC of soil will increase with increasing ion concentration. The electrical conductivity was ranged from 0.0159 dSm^{-1} in the treatment T5 to 0.0297 dSm^{-1} in T0. The EC of the soil could decrease with addition of organic manure (Khanday and Ali, 2012).

Soil organic carbon (SOC) is a valuable property soil. A soil with poor organic carbon is more prone to soil erosion (Tale and Ingole, 2015). Presence of organic matter in the soil is useful for tasar culture practices. In our study, the SOC content ranged from 0.53 to 0.89%. The higher SOC content was recorded in T4 and lower in control treatment (T0). Vermicompost along with Azotobacter helped to improve organic carbon in the soil. Organic carbon present in the soil decreases the pH of the soil. Addition of bio-fertilizer and vermicompost improves organic matter in soil (Harleenkaur *et al*., 2016). In this experiment, vermicompost applied with biofertilizers had significantly increased SOC in all the plots as compared to control treatment.

TABLE 1: Vermicompost and biofertilizer treatments as influenced on pH, EC (dS m^{-1}) and SOC (%)

Treatment	pH	EC	SOC
T0	5.50	0.0297	0.53
T1	4.64	0.0176	0.86
T2	4.59	0.0181	0.77
T3	4.89	0.0215	0.83
T4	5.07	0.0198	0.89
T5	4.76	0.0159	0.74
T6	4.87	0.0187	0.72
T7	5.01	0.0203	0.76
SEm±	0.09	0.0010	0.03
CD (P=0.05)	0.19	0.0021	0.06

Soil Chemical Properties

Macronutrients

The macronutrient status of experiment is given in Table 2. Nitrogen is one of the important macronutrients which determine the plant growth. The available nitrogen content of the soil was found between 152.7 to 221.9 kg ha⁻¹. A significantly higher content of available N was found with the treatment of T7 (229.9 kg ha^{-1}) (London, 1991). Vermicompost coupled with biofertilizer helps to buildup more N level in the soil. While decomposition of organic matter, exude several organic acids such as fulvic acid, humic acid *etc*. These acids induce the production of nitrogenase enzyme and start mineralization process to become available N. This would be the reason for higher available N in the treated plots.

Phosphorus is called the "Master Key to agriculture". In general, available P in tasar growing soils is very low to low content. Majority of the soil where tasar sericulture adopted in the regions are prevalently observed acid pH. This acid range of pH affects the P availability because iron present in the soil reacted with P resulted in iron complex P formed in the soil. This iron phosphate is an unavailable form to the plants. While adding phosphorus solubilizing bacteria (PSB) in the soil make available P to a plant after solubilize all the native form of P. It proved in our experiment also. Application of PSB along with vermicompost showed higher available P as compared to control treatment. A significant higher available P had recorded with treatment T4 (36.7 kg ha^{-1}); it was on par with treatment T3; whereas, low P availability was recorded in control treatment (T0). Its low solubility makes it the major limiting nutrient needed for plant growth, root development and blooming (Nagaraja *et al*., 2014).

Similarly, the available potassium was found to be medium range in most of the treatments. After the application of fertilizer and vermicompost it was found that the potassium was shifted from medium range to high range; so observed higher available K I the treatment T3. Vermicompost increase the potassium by 0.7% (RaviKumar *et al*., 2013).

Most of the sulphur in the soil is available through decomposition of organic matter. Organic matter along with bacteria plays a major role in buildup of sulphur content in soil. In this study also exhibited significantly more available S with treatment T1 where vermicompost (CTR&TI) along with PSB application followed by T4 and T7 treatments however, these later two are significantly not differed with each other. Control treatment in this study recorded considerably a lower available S content.

TABLE 2: Vermicompost and biofertilizer treatments as influenced on available N, P, K (kg ha^{-1}) and S (mg kg^{-1} of soil)

Treatment	N	P	K	S
T0	152.7	4.93	170.0	5.07
T1	192.2	17.33	270.0	16.28
T2	164.5	14.33	196.6	11.90
T3	203.9	34.96	326.7	12.05
T4	190.3	36.70	266.7	14.63
T5	196.4	27.06	256.6	13.75
T6	198.1	26.96	266.6	13.26
T7	221.9	20.56	240.0	14.57
SEm±	5.1	2.11	10.1	0.79
CD (P=0.05)	10.7	4.38	20.6	1.64

Micronutrients

The application of different doses of vermicompost and biofertilizer significantly increased the all DTPA extractable micronutrients such as Fe, Mn, Cu and Zn content in the soil (Table 3). Use of vermicompost along with biofertilizer increased the available micronutrients. In the present study, the available Fe content had significantly increased with T1 (68.95 mg/kg) treatment followed by T4 (67.97 mg/kg) as compared to control (42.83mg/kg). The results are in accordance with Singh (1964), Sabni *et al*. (1980), Saha *et al*. (1982) and Patil (1993). Khilari and Narkhede (1997) noticed increased in the DTPA extractable Fe with use of vermicompost and biofertilizer in the field. Higher concentration of available Mn was found with vermicompost and biofertilizers in the experimental plot as compared to control. A higher Mn content (74.86 mg/kg) was recorded in the T7 treatment followed by T4 (70.93 mg/kg) over the control T0 (41.21 mg/kg); however, this treatments of T7 and T4 were significantly stood similar and not differed with each other. Medhi *et al*. (1996) reported that addition of organic manure enhanced Mn concentration in soil which probably due to enhanced soil reaction. Similarly, higher available Cu was found in T4 treatment with 1.48 mg/kg that is significantly higher followed by T7 with 1.28 mg/kg over the control treatment (0.82 mg/kg). Increase in the Cu might be due to release of organic acid from organic manure which results in solubilization of metal micronutrients in accordance with the results of Singh *et al*. (1992), patil (1993) and Damshetti (1997).

The range available Zn was noticed from 0.64 to 0.75 mg/kg over the control. The Zn values were generally higher than those critical limits. A higher content of Zn was observed with T6 treatment (0.75 mg/kg of soil) followed by treatments T7 (0.74 mg/kg of soil) and T2 (0.71 mg/kg of soil) and all these are statistically similar with each other. Control treatment recorded lower content of available Zn in this experiment with 0.58 mg/kg of soil.

Likewise, coupled application vermicompost and biofertilizers enhanced the available B content in the treated soil. In this study, the B content was ranged from 0.53 to 0.94 mg/kg of soil. Treatments T4 and T3 were recorded significantly higher content of DTPA extractable B than control treatment.

TABLE 3: Vermicompost and biofertilizer treatments as influenced on available micronutrients (mg kg^{-1} of soil)

Treatment	Fe	Mn	Cu	Zn	B
T0	42.83	41.21	0.82	0.58	0.53
T1	68.95	67.81	1.08	0.64	0.69
T2	59.70	59.12	0.95	0.71	0.49
T3	54.10	62.71	1.07	0.64	0.84
T4	67.97	70.93	1.48	0.67	0.94
T5	42.74	52.90	0.93	0.67	0.60
T6	56.75	68.03	0.94	0.75	0.61
T7	53.63	74.86	1.28	0.74	0.75
SEm±	0.02	2.30	0.04	2.51	0.05
CD (P=0.05)	0.04	4.75	0.09	0.05	0.11

CONCLUSION

From the above results, it could be concluded that nutrient status of soil explicitly increased by use of vermicompost and biofertilizer. These are promising approaches to boost up the nutrient status of soil and leaves of tasar host plants; it would enhance leaf yield of tasar host plants as well as cocoon yield and quality characters of tasar silkworm. Further, use of organic manure will not only decrease the load of chemical fertilizer but also improve the soil health which is deteriorating due to continuous use of chemical fertilizer.

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