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Review paper

Trends in Organic Moriculture: An Approach for Revitalizing Silk Production

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ABSTRACT

Sericulture involves a continuous series of biological processes in which the mulberry silkworm utilizes the leaf protein to form natural silk in the form of protective covering known as cocoon. Being a traditional agro-enterprise, sericulture is mainly functional in rural area of the country. Success and failure of this industry fully depends on the production of quality mulberry leaves. Though the synthetic fertilizers produce exponential increase in crop yield but possess serious threat on its quality and degrade the soil health and environment as well. Indiscriminate use of chemical fertilizers in mulberry cultivation directly affects the quality of leaf by interfering with the biochemical composition of the leaf and hence impairing the silkworm health as well. In order to meet the current demand of increased quality mulberry leaf for boosting silkworm rearing, emphasis has been laid to opt for the natural or organic based alternatives including Farm yard manure, compost, vermicompost, green manures and biofertilizers. In this direction, the concept of organic based mulberry cultivation can be viewed as an important aspect for reviving the silk industry on global context. More importantly awareness on the harmful effect of toxic chemicals and the need for an eco-friendly sericultural, industrial and agricultural management with natural resources have been deeply felt which can only provide a new shape of the life style of the human being, which is expected to be substantially better and potential to improve the sericulture industry in the way of improvement in leaf, cocoon as well as silk production and quality.

1. Introduction

Almost 80 percent of Indian population residing in villages and rural areas are engaged in agricultural activities for their livelihood generation and almost 70 per cent of them operate agriculture as their main occupation. Thus, agriculture in the country is considered as the backbone of Indian economy. Similar to other commercial agro-enterprises, sericulture is a cottage based industry which offers

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employment opportunities to the farmers to gain additional income by devoting very less inputs (Chanotra et al., 2019). Sericulture is a unique combination of cultivation of mulberry plant for rearing of Lepidopteran larvae of silkworm *Bombyx mori* L. which produces the silk cocoons in the form of protective covering and industrial aspects of cocoon reeling for unwinding the silk thread in order to produce the ultimate product viz. silk fabric (Ahmed and Rajan, 2011). Dewangan (2013) reported that there about 10 million persons engaged in silkworm rearing and about 0.5 million in industrial sector. On global map, Asia is the top producer of mulberry silk contributing about 95 per cent of total raw silk production. Although 58 countries in the world practice sericulture but bulk production is released from China and India alone, followed by Japan, Brazil and Korea etc. (Nagaraju, 2008).

In sericulture, production of high quality mulberry leaf is the primary requisite attributing towards production of quality silk. Silkworm utilizes the leaf protein and with the help of metabolic conversion factors, converts the leaf protein into animal protein that we get in the form of natural silk expelled out by the worm through its spinneret while cocoon formation. Thus, mulberry leaf forms the most important factor deciding the ultimate quality of the cocoon. In order to meet the requirements of the industry, farmer relies on chemical fertilizers to speed up the growth and yield of the foliage and this indiscriminate use of synthetic fertilizers and chemical pesticides or insecticides etc. produces hazardous effects on plant, soil and environment as well as the residues of such chemicals remains to be persistent for considerably longer period of time. Undoubtly, higher yields in terms of mulberry foliage production can be achieved at commencing stages but indiscriminate use may results in detoriation of environment, soil and ecosystem quality. Thus emphasis has been made to find out suitable alternatives. In this direction organic farming and use of natural biofertilizers proves to be the most efficient and promising option.

2. Integrated Organic Nutrient Management Practices

Similar to other agricultural crops, quality and yield parameters of mulberry is also reflected by the status of soil health in which the cultivation is being practiced as soil forms the only medium for growth and survivality of plant's root zone and for exchange of nutrients and other life supporting elements. Thus, the integrated nutrient management strategy combined with improved agronomic practices has greater influence on quality of product as it aids in improving overall physical, chemical and biological properties. Organic manures can improve the water holding capacity, infiltration of nutrients and regulates the soil pH to optimum levels thus favours the growth of beneficial microorganism in the soil. Some of the major organic inputs and biofertilizers reported to be an efficient, effective and eco-friendly alternatives by various researchers have been described below;

2.1 Farm Yard Manure (FYM)

Farm yard manure (FYM) is most commonly used organic manure and ecofriendly if preferred over chemical fertilizers. It can be easily prepared with little amount of inputs and space. It requires the use of left over agriculture material combined with cattle dung or poultry wastes composed in deep pits for few months. Completely decomposed FYM forms a rich source of nutrients and essential elements like nitrogen, phosphorous and potassium etc. in mulberry cultivation use of FYM is highly recommended to improve the soil health status in mulberry garden. Application dosage and schedule to be followed for addition of FYM varies considerably with varying soil types and the available carbon content in the given soil and the general schedule of FYM application is given in Table 1 (Sakthivel et al., 2014).

Table 1. Carbon content in the given soil

Soil organic carbon (%)	Dosage (MT/ac/year)	No. of splits
<0.35	12	3
0.35 - 0.65	10	2
0.65 – 1.00	8	2

2.2 Compost

Compost is another useful end product resulting from of biodegradation of various organic materials such as left over leaves, twigs, dairy waste, poultry remains, weeds and other wastes of agro based activities and this decomposition is carried out by a variety of microorganisms including bacteria, fungi

and protozoa etc. The principles behind composting involve the bringing equilibrium in carbon: nitrogen ratio in the end product by complete destruction of macromolecules into soluble micro-molecules with the operation of optimum temperature under aerobic conditions. Quality of compost varies with the type of material under destruction and the degree of decomposition. Superphosphate or rock phosphate @ 10-15 kg/MT can be added to pose a synergic impact to increase the efficacy of compost (Sakthivel et al., 2014).

2.3 Vermicompost

Vermicompost is the biological process of conversion of organic wastes into valuable manure with the help of vermicasts i.e. the earthworms. In the process of conversion earthworms acts as bioreactors and breakdown the solid organic material into useful one. It forms a rich source of nutrients, enzymes, antibiotics, plant growth hormones and supports a large beneficial micro-organisms producing beneficial effects to the soil. Mulberry plants grown in such type of soil can yield quality foliage which in turn helps for obtaining quality silk. Addition of vermicompost @ 10 MT/ha/year can reduce dependency on chemical based fertilizers by approximately 50 per cent annually for one hectare of land (Sakthivel et al., 2014).

2.4 Poultry Manure

Poultry wastes like excreta, leftover feed or grains and dropped wings etc. can be successfully used for generation of a variety of organic manures and poultry one is such a kind with good proportion of proteins, phosphate and minerals etc. and can be served as an excellent biofertilizer after complete decomposition. Sakthivel et al., (2014) reported presence of higher content of various major essential elements in the poultry wastes like feather etc. in the proportion of nitrogen (4.55-5.46 %), phosphorus (2.46-2.82 %), potassium (2.02-2.32 %) and availability of minor elements such as Cu, Zn, Fe and Mn etc. have also been reported.

2.5 Green Manures

Incorporation off live green plants particularly the leguminous crops into the soil by repeated ploughing is termed as green manuring and it being completely organic in nature it has negligible ill effects on environment and improves the soil health and crop yield by adding enriched nutrients into the soil, thus improving its fertility and productivity. Crops to be used as green manures can be grown as intercrops in mulberry gardens and can be timely utilized by pressing down into the soil. Important green manure crops are Sun hemp, Dhaincha, Cowpea, Cluster bean, Horse gram etc. these can be mulched into soil surface , mixed well and irrigated for proper assimilation of nutrients in the deeper layers of the soil. Application of dhaincha (*Sesbania aculeata*) and sunn hemp (Crotalaria juncea) @ 15 kg/ acre is reported to impart beneficial impacts in reclamation of alkaline soils (Sakthivel et al., 2014).

2.6 Bio-fertilizers

Biofertilizers includes use of living material like bacteria and fungi which works with the action of microflora and fauna thus improving soil conditions and once added into the soil can serve many years. *Azotobacter chroococcum and Azospirillum* spp. forms the most effective options for replacing application of synthetic products. In addition to this, certain bacterium like *Bacillus megaterium* known for its unique property of solubilizing phosphorous can also be used to combat the emerging needs of biofertilizer application (Table 2).

Biofertilizers as alternative options have various advantages over chemical fertilizers as are cheaper and cost effective and renewable in nature, eco friendly, produce plant growth promoting substances and reduce the depletion of nutrients in soil. Moreover plays role in promoting mulberry growth and development of foliage. Commonly used biofertilizers consists of Vesicular- Arbuscular Mycorrhizae (VAM) having several beneficial effects of soil and providing pest and insect resistance to some extent as well. Application of VAM @ 1000 kg / ha is recommended for increasing the efficacy of soil nutrients and effective soil health management (Choudhury, 1995).

2.7 Neem Oil Cake (NOC)

Neem oil cake forms the easiest, efficient and cheaper choice of replacing chemical fertilizers with good productivity results and is particularly recommended for reclamation of alkaloid. In alkaloid soils nitrification process is functional at slow rate and it

be enhanced by addition of neem oil cake. It can be prepared by grinding the neem seeds with proper proportion of oils for activating the action of product. 60 kg of neem cake oil per acre per crop combined with nitrogenous fertilizers has been reported to impart significant increase in mulberry leaf production. Neem cake oil @ 800 kg/ac in 4 split doses is also reported to be effective against *Meloidogyne incognita* causing root knot disease in mulberry (Sakthivel et al., 2014).

Table 2. Maintenance of mulberry with addition of biofertilizers

i	FYM/compost	20 MT	In two equal split doses (10 MT FYM+ MT vermicompost)
ii	Azotobacter	20 kg	In five equal split doses
iii	N-triacontanol***	250 ml	In two equal split doses/crop
iv	VAM inoculum** (for existing garden)	1000 kg	One dose in the life span of mulberry (inoculation through maize as host plant)
v	Ammonium* sulphate or Urea or CAN	750 kg 325 kg 600 kg	In five equal split doses
vi	Single super Phosphate	375 kgs	In two equal split doses(I and III crop)
vii	Muriate of potash	200 kg	In two equal split doses. (I and III crop)

* 50% of chemical fertilizer can be cut down due to application of Azotobacter and VAM
** VAM inoculation is not required for the garden, planted with Mycorrhizae inoculated saplings
*** 1st spray: In between 10-15 days after pruning/leaf plucking 2nd spray: 10 days after Ist spray

2.8 Pressmud

Press mud is the byproduct of sugar industry and is formed after squeezing the sugarcanes. It forms the most commonly used reclamatory material for alkaline soils. It can be easily used as biofertilizer after decomposition of solid waste into micro-particles which can be easily mixed with soil by repeated ploughings. For enhancing the decomposition, addition of rock phosphate, sulphur, zinc sulphate etc, is preferred under the dark conditions. Completely decomposed pressmud reported to possess all the major nutrients like nitrogen, phosphorous and potassium (NPK) as approximately 2 per cent, 3 per cent and 1 percent respectively (Sakthivel et al., 2014).

2.9 Foliar Fertigation

2.9.1 Vermi-wash

Vermi-wash can be obtained by bio degradation of compost forming material such as excretory wastes and mucus secretion of other micro-organisms residing underground the soil, together aids in improving the soil health status for supporting the plant life. It can also be used as direct foliar spray for checking insect pest attack. Vermi-wash is also reported to possess trace amounts of various plant growth hormones like auxins and cytokinins. 1 liter of vermi-wash can be sprayed by as foliar application of dissolving the product with 4 to 5 liters of water. Generally spray application is recommended to be conducted during cooler hours of evening or early morning. Combination of vermi-wash along with cow urine can be used as a biopesticide or liquid manure for checking pest attack and improving soil health (Sakthivel et al., 2014).

2.9.2 Panchagavya

Panchagavya is well recognized liquid of organic origin and supposed to play important role in promoting growth and immunity in plant system. It is used to regulate the soil pH status in problematic soils. Presence of microbial agents like *Lactobacillus* interacts with certain metabolites which aids in activation of pathogens. Thus contributing significantly for improving yield and soil attributes. Being biological in origin, simple in application, efficient in practice and environmentally safe, vermi-wash forms a suitable alternative over synthetic formulations.

2.10 Recycling and Utility of Seri-wastes

Byproducts generated at every single stage of silkworm rearing combined with left over agricultural wastes forms superior type of biofertilizer comprising of almost all the necessary elements. At every step in sericulture industry number of byproducts are known to be generated. These can be processed and converted into useful ones with the addition of a little input. Wastes generated during silkworm rearing including left over leaves, twigs, silkworm excreta and dead worms etc. can be decomposed to form quality manure rich in nutrient values with all the essential macro-

nutrients such as NPK along with traces of micro-nutrients such as iron, zinc and copper etc.

3. Conclusion

Continue exposure of mulberry fields to chemical fertilizers resulted in the depletion of nutrient and health status of soil and possess serious threat to the ecological balance by disturbing the micro and macro environment. Thus need of ecofriendly biofertilizers is now deeply felt which contributes in improvement in soil health status, maintenance of nutrient balance, support to micro flora and fauna for overall improvement in yield productivity. It also helps to maintain the quality of environment by minimizing the dependency on synthetic fertilizers and pesticides etc. and thus results in enhanced soil biological properties. As mulberry is primarily cultivated for its foliage to conduct silkworm rearing from time to time and repeated harvests requires addition of inputs in the form of fertilizers and organic manures. Therefore, application of organic manures can be viewed to produce profitable results and are reported to be better performers as an alternative to chemicals in mulberry cultivation. Hence, balanced application of required elements in the form of manure, fertilizers and bio-fertilizer is very essential for the sustainable yield.

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