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RESEARCH ARTICLE

ORGANIC FARMING THROUGH THE INCORPORATION OF ECO-FRIENDLY INPUTS UNDER GRADED LEVELS OF INORGANIC FERTILIZERS FOR SUSTAINABLE MULBERRY (*MORUS ALABA* L.) LEAF PRODUCTION AND PROTECTION

***[1]Sudhakar, P., [2]Hanumantharayappa, S.K., [3]Jalaja S Kumar and [4]Sivaprasad, V.**

[1,2,3] Regional Sericultural Research Station, Central Silk Board (CSB), Kodathi, Bangalore-560 035, Karnataka, India
[4] Central Sericultural Research and Training Institute, CSB, Srirampura, Mysore-570 008, Karnataka, India

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ABSTRACT

Mulberry being perennial in nature cultivated as seasonal crop for its foliage to feed silkworm demands huge amounts of organic (@20MT/ha/yr farmyard manure) and inorganic inputs (NPK @350:140:140kg/ha/yr). However, sustainable level of crop productivity management, keeping soil health safe and preventing ever growing chemical pollution of soils has become priority of any farming. Keeping the above objective in concern, a field experiment was carried out at Regional Seri cultural Research Station, Kodathi, Bangalore during 2009-2011 to evaluate the impact of organic manures (FYM, Vermicompost, biofertilizers (NFBs & PSBs) combined with vermicast wash and panchagavya spray on the plant growth, yield, cocoon production and crop protection. A total of 10 mulberry harvests and a single crop of bioassay with silkworm rearing were done. Pooled data of two years revealed that foliar application of 7% vermicast wash along with soil application of 50% N+P+20kg *Seriazo*+25kg *Seriphos* biofertilizers+10MT FYM+5MT vermicompost/ha/yr, respectively has recorded significantly increased levels of mulberry leaf (10,977.9kg/ha/crop) compared with no foliar spray of vermicast (9,869.7kg/ha/crop). However, the yield level was not significantly differed compared to the recommended dose of NPK @350:140:140kg and 20MT FYM/ha/yr (10,656kg/ha/crop). Further, increased level total chlorophylls and decreased level of mulberry pests was also noticed in the said treatment. No marked variation was noticed in case of bioassay of silkworm due to various combinations of treatments. Further, minimal levels of pest infestation were also noticed in the foliar sprayed plots with VC & PG. From the results it is evident that filtrates of vermicompost and Panchagavya offer a valuable resource which could be effectively exploited for quality and enhanced mulberry leaf production and protection.

INTRODUCTION

Mulberry is grown under varied agro-climatic conditions in India. Research and technological developments during the recent past have indicated that the yield of mulberry can be improved to about 60mt per hectare/year following improved package of practices under irrigated conditions (Dandin *et al.,* 2003). Nitrogen is one of the major field inputs in mulberry cultivation for sustainable foliage production. It is observed that 2kg of nitrogen is taken by the mulberry plants from the soil to produce 100kg leaf. With the above view >350kg inorganic nitrogen per hectare per year is recommended for optimum leaf production for tropical areas (Dandin *et al*., 2003). This is not only a financial burden on the farmers but may also impair the natural soil fertility and health.

****Corresponding author:*** **Sudhakar, P.,**
Regional Sericultural Research Station, Central Silk Board (CSB), Kodathi, Bangalore-560 035, Karnataka, India.

Nitrogen fixing bacteria as biofertilizers can partially replace inorganic nitrogen in field crops and vegetables (Somani *et al.,* 1990; Subba Rao, 1986). Much work has been done on symbiotic and free living soil bacteria with the object of exploiting them as biofertilizers. Efforts were also made to establish the beneficial effects of various biofertilizers at reduced levels of chemical fertilizers in perennial crops like mulberry in North as well as South India (Das *et al*., 1996, Sudhakar *et al.,* 2000). Benefits of foliar application of liquid biofertilizers at reduced doses of inorganic nitrogenous fertilizers and their influence in reducing the foliar diseases of mulberry was also attempted in various agricultural crops as well as in mulberry (Pati & Chandra, 1981, Sen, 1988; Sudhakar *et al*., 2000a,b). Application of chemical fertilizers in combination with FYM and vermicompost was proved to be effective in improving various agricultural crops as well as mulberry (Choudhuri *et al*., 2001; Ranwa and Singh, 1999; Setua *et al*., 2005; Sreenivas *et al*., 2000; Wani & Lee, 1992).

However, no efforts were made to use the liquid forms of vermicast washes and panchagavya as foliar applicants for improvement for foliage crops. Therefore, through this study it is evaluated the use of microbial inoculants (biofertlizers) along with reduced levels of chemical fertilizers and farmyard manure (FYM), vermin compost as soil applicants and vermicast washes and panchagavya organic liquids as foliar applicant for the improvement of mulberry leaf and cocoon production.

MATERIALS AND METHODS

Existing V1 mulberry garden of 5 years old planted in paired row/ IJ spacing [(60x90) x150cm] at Regional Sericultural Research Station, Kodathi, Bangalore was selected for the experimentation. It is established that mulberry cherish under desirable levels of pH (6.5-7.5), electrical conductivity (EC- <1.00dS/m^2), organic carbon (OC: 0.65-1.0%), available N (250-500kg/ha), P (15-25kg/ha) and K (120-240kg/ha), respectively in the soils. The experimental plot soil being sandy loamy in nature initial nutrient status was recorded with desired range of pH (6.94), ideal salinity (EC-0.154 dS/m^2), low level of organic carbon (OC-0.428%), low in available nitrogen (N-195.6kg, desired level of available phosphorous (P-24.10kg and medium level of available potassium (K-161.3kg per hectare respectively. Experimental layout was in randomized block design (RBD) with 7 treatments in 3 replications. Each replicated gross plot measuring with 1024 sq.ft. accommodating 128 plants where as net plot in 672sq.ft. with 84 observatory population. All the plots were maintained imparting standard recommended package of practices (Dandin *et al.,* 2003).

The treatments include T0- Control [NPK @350:140:140kg & 20MT/ha/yr], T1- Control(2) [$N_{175}P_{70}$+20kg SA+25kg SP+10/5MT FYM & VC], T2- [T1+5% VC spray], T3- [T1+7% VC spray], T4-[T1+5% PG spray], T5- [T1+7% PG spray] and T6- [T1+5% VC+PG spray], respectively. However, recommended dose of potassium (K @140kg/ha/yr) is applied as common dose in all the treatments. Vermicast (VC) wash was collected from the 90 days old well decomposed vermin compost pits of *Eudrillus eugenie* (by increasing >50% moisture leading to oozing of vermin washes and used by diluting 5 & 7%). Panchagavya (PG) was prepared by using cows milk+urine+curds of 1 lit each +1kg cow dung+250g of cow ghee+Jagree each well mixed in 10 lit of water and left for 9 days for fermentation. After 9th day the fermented broth of PG liquid is filtered and used for foliar application in required concentrations.

The VC wash and PG filtrates of required concentrations were sprayed on the foliage of mulberry leaves twice in each crop i.e. 30 days and 40 days after pruning during dusk hours @ 600 lit/ha quantity. The experimental plots were maintained in irrigated conditions by giving 1.5 acre inch of water/irrigation in 3-4 days. All the plant growth and leaf yield parameters were recorded 70 days after pruning of every crop i.e. for 5 crops in a year. For leaf area, 10 healthy leaves of 5th/6th position from the top (apical tip) of the branch were taken from 10 plants selected at random in each replicated plot and the area was calculated through the regression equation [Leaf area= -2.12+0.68 (LxB)] (Satpathy *et al*., 1992). Moisture and chlorophylls contents were estimated from 5th/6th leaf from the top (Rao *et al*., 1991). Pest infestation of mulberry foliage was scored 10 days after second spray of vermicast wash and panchagavya following the standard procedures (Rajdurai, 2005). Soil chemical analysis of the experimental plots before and after experimentation was analyzed for pH, electrical conductivity, organic carbon, available phosphorous (P) and potassium (K) by standard methods (Chopra and Kanwar, 1976; Jackson, 1973). Bioassay with silkworm rearing was undertaken by feeding the different treatmental leaves brushing with CSR2xCSR4 bivoltine breeds with 3 replications/ treatment during December, 2010. Cellular brushing was conducted up to Chawki by feeding uniform quality chawki leaf and late age rearing was conducted keeping 300 worms per replicate. All the improved technologies as recommended for the Bivoltine silk worm rearing was followed (Dandin *et al.,* 2003). All the plant growth, yield, quality, disease incidence and silkworm rearing data were analyzed using ANOVA with factorial analysis.

RESULTS AND DISCUSSION

During the period under the experimentation, 10 crops (in two years) plant growth, leaf yield, leaf biochemical analysis, soil analysis and pest incidence data recorded was compiled, pooled data was subjected to ANOVA and presented. The mulberry plant growth and leaf yield was responded significantly well to the 50% N & P supplemented with 7% VC wash (T3-10,977.9kg/ha/crop) and 7% VC+PG spray (T6-10,732.9) compared to the full dose application of NPK (T0-10,656.7kg/ha/crop) and 50% reduced levels of NP supplemented with *seriazo* & *seriphos* (T1-9,869.7kg/ha/crop). The leaf yield recorded significantly superior in T3 compared to all the combination of treatments indicating that 7% VC wash spray combined with reduced doses of NP supplemented with NFBs & PSBs biofertilizers indicated that 50% N & P could be saved through the use of 7% VC wash (Table 1 & Fig. 1). However, T1 and T4 treatments where 50% reduced levels of NP supplemented with biofertlizers and PG spray recorded lower yield compared to all the treatments. This indicates that in South India, 50% of the recommended inorganic nitrogen fertilizer can be possible (Das *et al.,* 1996) further reductions adversely affects the leaf yield, presumably because biofertilizers either alone or in combination have got limited ability to fix nitrogen (Postgate, 1990; Dey, 1988) and shows more ability in a nitrogen deficient environment (Rangaswami, 1988). Similar observations were made by Sudhakar *et al*., (2000, 2000a) and Das *et al.,* (1996) by using biofertilizers as soil as well as foliar applicants along with reduced levels of inorganic fertilizers.

Further, Manickam (1993) observed that often there was a slow but steady decline in crop production with continuous use of chemical fertilizers alone. The yield trend obtained in the present study reaffirms their observations. Foliar application of organic extracts under reduced levels of chemical fertilizers have shown significant improvement in case of plant height and leaf area where as no variation was observed in case of plant height, no. of branches, no of leaves per plant and L:S ratio respectively. Significant variation was observed in case of leaf moisture and total chlorophylls (Fig. 2). Foliar spray of 7% vermicast wash in T4 treatment has shown its superiority recording higher levels of leaf moisture (74.84%) and total chlorophylls (4.14mg/g) followed by T6, T5 & T2 whereas the same was less in T1, T4 and T0.

Table 1. Impact of eco-friendly inputs on plant growth and leaf quality of mulberry

Treatments	Plant height (cm)	No. of branch/ plant	No. of leaves/ plant	Leaf area/ cm^2	L:S ratio	Leaf moisture (%)
T0-$N_{350}P_{140}$+20MT FYM (Control-1)	158.3	8.3	271.8	191.8	62.20	74.27
T1-$N_{175}P_{70}$+20kg SA+25kg SP+10/5MT FYM & VC	157.8	8.2	271.2	184.2	61.45	73.63
T2- -do- + 5% Vermicast (VC) spray.	155.2	7.9	271.4	189.2	61.94	74.50
T3- -do- + 7% VC spray.	151.0	8.3	259.4	192.2	62.65	75.06
T4- -do- + 5% Panchagavya (PG) spray.	152.6	8.9	271.5	182.9	62.93	74.45
T5- -do- + 7% PG spray.	156.1	8.4	273.9	192.5	61.71	74.84
T6- -do- + 5% VC + PG spray.	156.2	8.4	274.6	190.1	61.18	73.81
CD at 5%	4.6	N.S.	N.S.	6.8	N.S.	0.92

K=@140kg/ha/yr in all treatments, FYM= Farmyard manure; VC= Vermicompost; SA= *Seriazo*; SP= *Seriphos*

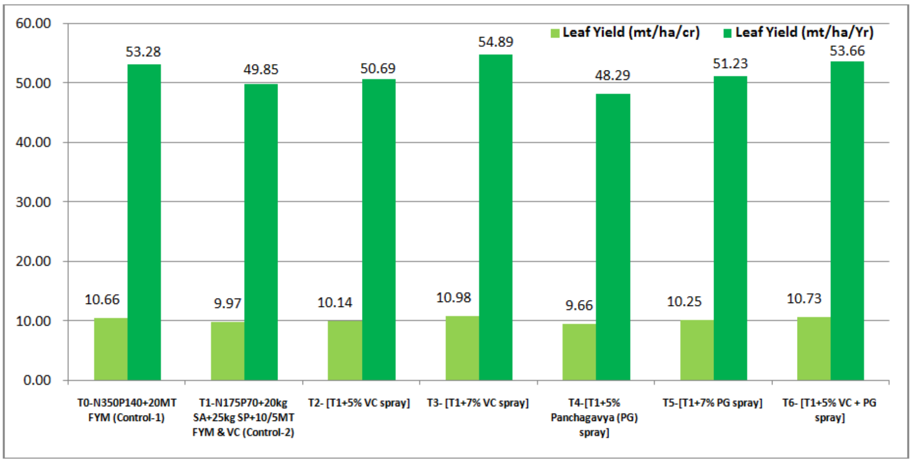

Fig. 1. Leaf yield of mulberry as influenced by the eco-friendly inputs in organic farming

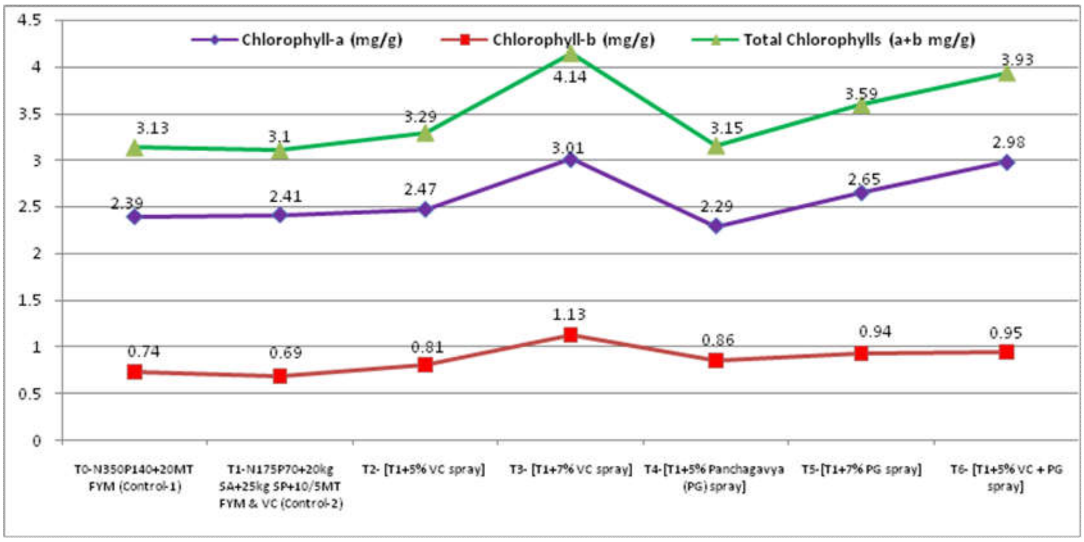

Fig. 2. Biochemical status of mulberry leaves as influenced by the eco-friendly inputs

However no significant variations was observed among the treatments compared to the controls in case of plant growth parameters such as no. of branches, no. of leaves/plant and L:S ratio (Table 1 & Fig. 2). Similar benefits were recorded by various workers by advocating microbial inoculants to soil as well as to foliar application along with FYM and vermicompost as a nutrient rich manure supplements in various crops as well as in mulberry (Choudhuri *et al*., 2001; Das *et al.,* 1996; Ranwa and Singh, 1999; Sreenivas *et al*., 2000; Sudhakar *et al*., 2000, 2000a). Further, foliar application of these diazotrophic beneficial microflora are more effective rather than field inoculation because, the energy for efficient fixation of atmospheric nitrogen is provided by the photosynthates present in the leaf leachates, hydrolysis of leaf polymers, lipids and metabolization of leaf waxes, which are not available in the soil (James, 2000; Samanta *et al*., 1986).

Use of rich organic washes like compost, vermicompost and also panchagavya a Vedic composition was also proved to be beneficial as foliar applicants in several agricultural crops (Yadav *et al,* 2006 & 2006a). Chemical analysis of soil reaction of pH & EC and nutrient parameters of OC%, available N, P & K have shown marked variation and improvement in all the treatments compared to the initial nutrient status of the experimental plots (Table 2). In case of pest incidence during the experimentation, though there was seasonal incidence of Tukra and Thrips but the occurrence of both the pests was common in all the replicated plots at economically threshold level & no significant variation was observed among the treatments (Fig. 3). These microbial manures having the characteristic features of secreting PGRS, antibiotic and toxic metabolites when applied in the soil and phylloplane of the plants could not only enhance the crop

Table 3. Influence of eco-friendly inputs on reaction and nutrient status in mulberry soils

Treatments	Soil analysis parameters					
	pH	EC (dS/m^2)	OC %	Available P (kg/ha)	Available N (kg/ha)	Available K (kg/ha)
Initial status	*6.94*	*0.15*	*0.42*	*24.10*	*188.2*	*161.30*
T0- $N_{350}P_{140}$+20MT FYM (Control-1)	7.05	0.22	0.48	35.15	288.5	225.02
T1- $N_{175}P_{70}$+20kg SA+25kg SP+10/5MT FYM & VC	7.21	0.15	0.43	36.05	225.8	165.55
T2- -do- + 5% Vermicast (VC) spray.	7.08	0.14	0.42	33.10	237.3	185.01
T3- -do- + 7% VC spray.	7.12	0.22	0.46	40.10	218.6	192.25
T4- -do- + 5% Panchagavya (PG) spray.	7.04	0.18	0.49	39.26	263.4	205.03
T5- -do- + 7% PG spray.	7.10	0.20	0.45	37.45	250.9	195.20
T6- -do- + 5% VC + PG spray.	7.20	0.19	0.47	39.10	276.0	200.45

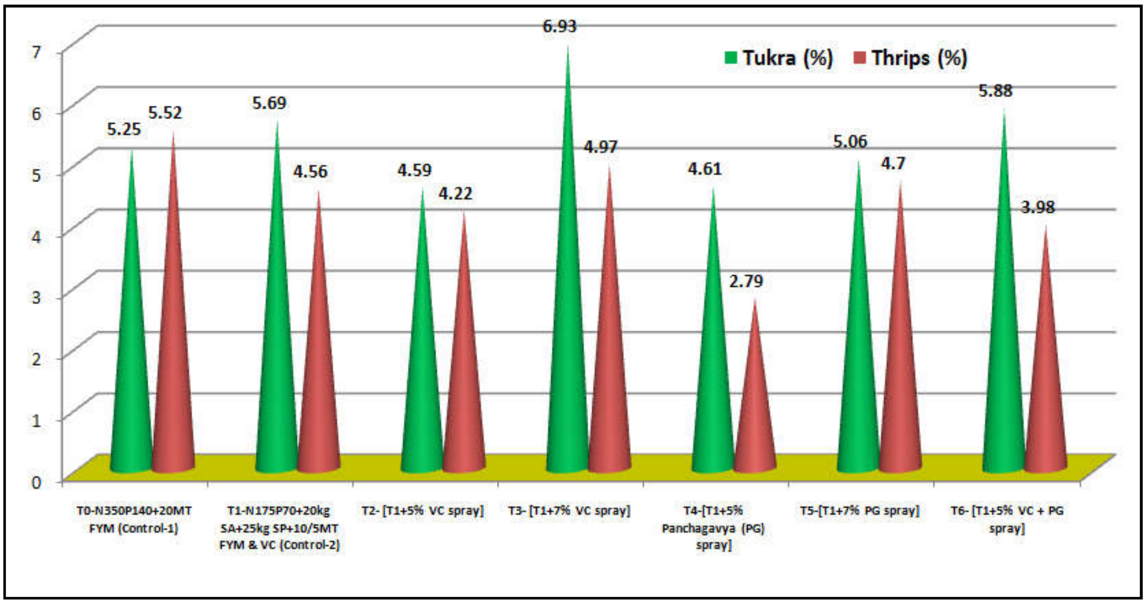

Fig. 3. Impact of eco-friendly inputs on the seasonal incidence of mulberry pests

Table 4. Influence of eco-friendly inputs on the commercial parameters of silkworm rearing

Treatments	Silkworm rearing quality parameters				
	ERR/ 10000 larvae		Single cocoon	Single Shell	SR
	No	Weight (g)	weight (SCW) (g)	weight (SSW) (g)	(%)
T0-$N_{350}P_{140}$+20MT FYM (Absolute control)	8899.67	16.57	1.927	0.400	20.70
T1-$N_{175}P_{70}$+20kg SA+25kg SP+10/5MT FYM & VC	8855.33	15.93	1.823	0.370	20.23
T2- -do- + 5% Vermicast wash spray	8999.67	15.93	1.816	0.364	20.03
T3- -do- + 7% Vermicast wash spray	9744.00	17.33	1.836	0.381	20.67
T4- -do- + 5% Panchagavya spray	9144.00	16.33	1.791	0.369	20.53
T5- -do- + 7% Panchagavya spray	9510.67	17.07	1.826	0.371	20.30
T6- -do- + 5% Vermicast wash+Panchagavya spray	9655.33	16.57	1.754	0.369	21.03
CD at 5 %	*N.S.*	*N.S.*	*N.S.*	*N.S.*	*N.S.*

production but also significantly control the insect and pests of many agricultural crops (James and Olivers, 1998; Mohan *et al*., 1987; Sharma *et al*., 1986; Singh, 1984). Foliar feeding of rich organic beneficial microbial broths with myriads of beneficial microflora was well documented (Pati and Chandra, 1981; Sen, 1988; Sudhakar *et al*., 2000a). Beneficial microbes sprayed on the foliage of plants could perform well even under adverse conditions like high temperature, humidity and low rain fall because these bacterial cells will get embedded in such a way that a micro niche environment created. Sharma *et al*. (1994) and Sudhakar *et al*. (1997) have documented the significantly reduced levels of mulberry foliage diseases due to use of microbial inoculants. The bioassay results with CSR2xCSR4 silkworm rearing feeding with 5th crop treatment wise mulberry leaves revealed that no marked variation was observed due to foliar application of vermi cast wash, panchagavya and both together under reduced levels of nitrogen and phosphorous (N & P) rather improved the silkworm quality parameters such as ERR no & ERR weight and SR% compared to controls (T0 & T1).

However, T6, T3 & T5 have shown an edge over controls in case of ERR no. ERR weight and SR% (Table 5). The bioassay results showing no significant values even up to 50% reduction in nitrogen and phosphorous supplemented with biofertilizers and foliar feeding of organic liquids agrees with the results obtained by Das *et al*., (1990) and Sudhakar *et al*., 2000, 2000a). It could be inferred that Mulberry, being a deep rooted perennial crop, having several thousand square meters of leaf area if these beneficial rich organic washes of various kind flooded with scores of beneficial microflora placed in an appropriate way in right time, right season and suitable site by way of foliar application mulberry farming can harness maximum beneficial effects like enhanced plant growth, leaf quality, leaf yield, increase of phyllopshereic beneficial microflora, enhancing diseases resistance *vis-a-vis* saving an inordinate expenditure on inorganic fertilizer inputs and crop protection measures thereby up-lifting the socio-economic conditions of the sericultural farmers and contributing the organic farming.

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