American Journal of

Plant Nutrition and Fertilization Technology

ISSN 1793-9445

Academic Journals Inc.

www.academicjournals.com

OPEN ACCESS American Journal of Plant Nutrition and Fertilization Technology

ISSN 1793-9445
DOI: 10.3923/ajpnft.2017.1.10

Research Article

Seriwaste Compost Enhances Mulberry Leaf Yield and Quality in Bangladesh

[1]Faruque Ahmed, [1]Rafia Sultana, [1]Oli Ahmed and [2]Md. Toufiq Iqbal

[1]Department of Mulberry, Bangladesh Sericulture Research and Training Institute, 6207 Rajshahi, Bangladesh
[2]Department of Agronomy and Agricultural Extension, University of Rajshahi, 6205 Rajshahi, Bangladesh

Abstract

Objective: Seriwaste compost may improve mulberry leaf yield, quality and cocoon production in Bangladesh. A three years field experiment was conducted to examine the effect of seriwaste compost on soil properties, growth, yield and leaf quality of mulberry plant as well as rearing performance of silkworm. **Methodology:** This study consisted of 6 treatments: Control, basal dose of NPK, cow dung compost, seriwaste compost, recommended basal dose of NPK+cow dung compost and recommended basal dose of NPK+seriwaste compost. **Results:** Results showed that combined seriwaste and BSRTI recommend fertilizer application received highest growth performance, leaf yield and quality of mulberry plant. The highest total leaf yield 52.23 Mt ha^{-1} $year^{-1}$ with maximum moisture, moisture retention capacity, crude protein, reducing sugar, total mineral, total sugar and soluble carbohydrate percentage were obtained in recommended basal dose of NPK+seriwaste compost treated mulberry plot. Results also demonstrated that rearing performance of silkworm was maximum in the combined seriwaste and amended plot recommended by BSRTI. The soil physical and chemical properties were also changed due to seriwaste amendment. **Conclusion:** This study concluded that utilization of seriwaste compost has a potential effect on improved soil fertility, leaf productivity and quality of mulberry plant as well as silkworm rearing performance.

Key words: Mounting, dinitrosalicylic acid, microorganisms, decomposition rate, synergetic effect, cocoon production, multivoltine, atomic absorption spectrophotometer, DTPA, mineralization

Received: September 27, 2016 Accepted: November 14, 2016 Published: December 15, 2016

Citation: Faruque Ahmed, Rafia Sultana, Oli Ahmed and Toufiq Iqbal, 2017. Seriwaste compost enhances mulberry leaf yield and quality in Bangladesh. Am. J. Plant Nutr. Fert. Technol., 7: 1-10.

Corresponding Author: Md. Toufiq Iqbal, Department of Agronomy and Agricultural Extension, University of Rajshahi, 6205 Rajshahi, Bangladesh
Tel: 01819529813 Fax: 880721750064

Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Seriwaste could be used as a compost to obtain comparable yields to that obtained with inorganic fertilizers[1-3]. The healthy growth and economic traits of the silkworm are largely influenced by the nutritional status of mulberry leaves fed to silkworm[4]. Quality leaf production in mulberry is highly dependent on supply of various inputs especially nitrogen and phosphorus fertilizers[5]. Application of inorganic fertilizers though increased the leaf yield substantially but cannot sustain the soil fertility status[6]. The intensive mulberry cropping system causes depletion of nutrients in soil and excess usages of inorganic fertilizers and pesticides caused deleterious effect on soil health[7]. Recently a great attention was drawn towards the application of organic farming to avoid the heavy use of agrochemicals that resulted in numerous environmental dilemmas[8]. The organic waste materials mainly animal and plant origin are potential sources of organic matter and plant nutrient[9].

The waste in sericulture contains organic matter like larval excreta, leaf litter, dead larvae, moth and cocoons[10]. The seriwastes rich in organic matter are not utilized properly for any productive proposes by the tribal farmers. But presently the organic wastes from animal and plant origin are best utilized for vermin-composting by indigenous and exotic earthworms[11]. The manures derived from animal wastes like other organic manures have been found to be more economical than commercial fertilizers for plant nutrients. Seriwaste compost contains approximately 2.00-2.24% N, 0.93-1.00% P and 1.5-1.8% K besides Zn, Fe, Mn and Cu as micronutrient[12]. The application of compost manure produced out of sericulture waste including silkworm litter is highly beneficial for mulberry cultivation and is much effective than conventional use of farm yard manure[13]. However, the major difficulty in the utilization of spent silk worm pupae is that it cannot be stored for long periods as it has a bad odor[14].

Since the pupae contains high amount of nitrogen and protein, there is potential for the bio conversion of pupal waste to enriched compost and utilization as a nutrient source[15]. A study conducted in India found that seriwaste compost was rich in nutrient content than the farm yard manure and vermin-compost[16]. The effect of silkworm rearing waste compost on soil properties, mulberry plant production, leaf quality and rearing performance have not be known previously in Bangladesh. Hence, the study was undertaken to quantify the impact of silkworm rearing waste compost on changes in soil properties, yield components and leaf quality of mulberry plant and rearing performance of silkworm. It may be hypothesized that the soil nutritional status, leaf yield and quality of mulberry plant and rearing performance will be improved in BRBD+SWC treatment than the other treatments.

MATERIALS AND METHODS

Experimental site and design: The experiment was carried out in the experimental field of Bangladesh Sericulture Research and Training Institute (BSRTI), Rajshahi, Bangladesh (24°22'29" N and 88°37'3.84" E). This experiment was conducted in randomized complete block design with three replications. Same experiment was repeated for three years time.

Experimental condition: Three years old high-bush mulberry plantation system and BM-11 mulberry variety were selected. Mainly four commercial seasons for silkworm rearing followed in a year for Bangladesh. So, the mulberry leaves were required four times in a year for silkworm rearing. According to the need, mulberry garden was pruned four times in a year each after 3 months interval.

Experimental treatments: The experimental treatments were as follows:

- T_1 = Control (Nothing was added)
- T_2 = CDC (Cow dung compost at 20 Mt ha^{-1} year^{-1})
- T_3 = BRBD (Recommended basal doses of BSRTI at 305 kg N, 105 kg K and 66 kg P ha^{-1} year^{-1}, respectively with four split doses each after three months interval
- T_4 = BRBD+CDC (Recommended basal doses of BSRTI at 305 kg N, 105 kg K and 66 kg P ha^{-1} year^{-1}, respectively with four split doses each after three months interval+cow dung compost at 20 Mt ha^{-1} year^{-1})
- T_5 = SWC (Seriwaste compost at 20 Mt ha^{-1} year^{-1})
- T_6 = BRBD+SWC (Recommended basal doses of BSRTI at 305 kg N, 105 kg K and 66 kg P ha^{-1} year^{-1}, respectively with four split doses each after three months interval+seriwaste compost at 20 Mt ha^{-1} year^{-1})

Data collection on growth and yield contributing characters: Five plants in each replication were randomly selected for recording the impact of various treatments in terms of growth and yield parameters viz. total branch number/plant, total branch height/plant (cm), length of longest shoot (cm), node/meter, total shoot weight/plant (g), total leaf number/plant, 10 leaf area (cm^2), 10 leaf weight/plant, total leaf weight/plant (g) and leaf yields/ha/year.

Analysis of physical and chemical properties of soil, cow dung compost and seriwaste compost: Soil pH was determined in deionizer water using a soil-to-solution ratio of 1:2.5. Organic matter contents of soil, cow dung and seriwaste compost were determined by multiplying the percent value of organic carbon with the conventional Van Bemmelen factor of 1.724 and the nitrogen content of these samples were determined by distilling soil with alkaline potassium permanganate solution[17]. The distillate was collected in 20 mL of 2% boric acid solution with methyl red and bromocresol green indicator and titrated with 0.02 N sulphuric acids (H_2SO_4)[18]. Available S (mg kg^{-1}) of soil, cow dung and seriwaste compost were determined by calcium phosphate extraction method with a spectrophotometer at 535 nm[16]. The available K of soil, cow dung and seriwaste compost were determined was extracted with 1 NH_4OAc and determined by an atomic absorption spectrometer[17]. The available P of soil, cow dung and seriwaste compost were determined by spectrophotometer at a wavelength of 890 nm. The samples were extracted by Olsen method with 0.5 M $NaHCO_3$ as outlined by Biswas *et al.*[19]. After extracting with DTPA, the Zn in the soil sample, cow dung and silkworm rearing wastes compost was measured by an Atomic Absorption Spectrophotometer (AAS)[20] (Table 1).

Analysis of bio-chemical constituents of mulberry leaf: The leaf samples of mulberry plant were collected in paper bags at 60 days after pruning at different heights of the plant (top, middle and bottom) and composite leaf samples were made. The collected leaves were shade dried for three days and then dried in hot air oven at 70°C for 1 h and were ground into powder for chemo-assay. The leaves obtained from different treatments were used for estimation of bio-chemical and mineral constituents viz: Leaf moisture contents and leaf moisture retention capacity (%) by the method of Soltanpour and Workman[21] method, total mineral (%) by the method of Vijayan *et al.*[22], total sugar and reducing sugar content by Dinitrosalicylic acid (DNS) method of Vijayan *et al.*[22] and procedure of AOAC[23], crude protein contents by the method of Miller[24] and soluble carbohydrate content by the method of Loomis and Shull[25] were estimated.

Silkworm rearing: Silkworm rearing experiment was conducted at 4 seasons in a year. For each treatment one egg lying was reared and three replications were maintained. After III molts, about 100 larvae/replication were maintained. Larve were fed four times daily (6 am, 10 am, 4 pm and 10 pm) with healthy, fresh mulberry leaves. Young age larvae were fed with tender, succulent leaves, while mature and coarse leaves were fed to larvae when they grow till ripening. Cocoons were collected on 5th day of mounting and were assessed for commercial parameters viz. weight of 10 matured larvae, ERR, single cocoon weight, single shell weight, SR%, highest filament length, rendita and yields/100 dfls (Disease free layings). Methods described by Wong[26] were employed for the assessment of cocoon quality.

Statistical analysis: All statistical analysis was conducted using GenStat 11th Ed for Windows (Lawes Agricultural Trust, UK).

RESULTS

Seriwaste compost changes in soil physical and chemical properties: Among the six treatments the percentage of nitrogen, phosphorus, potassium, sulphur, zinc and organic matter were highest for BRBD+SWC treatments followed by the BRBD+CDC, BRBD, SWC, CDC and control treatments. The percentage of nitrogen, phosphorus, potassium, sulphur, zinc and organic matter were 0.12, 15.80, 0.39, 18.13, 0.49 and 1.83, respectively for BRBD+SWC treated soil. The final soil pH was 8.27 in control plot. However, final soil pH was lower in other plots as compared to control plot (Table 2).

Seriwaste compost enhances the growth and yield performance of mulberry plant

Total branch number per plant: The total branch number per plant was differed significantly ($p \geq 0.001$) from various fertilizer treatments (Table 3). Among the six fertilizer treatments the maximum branch number per plant was found 14.38 in SWC+BRBD treated plot followed by the CDC+BRBD, BRBD, SWC, CDC and control treatments. The minimum total branch number per plant was 9.57 in control treatment (Fig. 1).

Table 1: Chemical compositions of matured cow dung compost and seriwaste compost

	Parameters								
Organic manure	Organic matter (%)	N (%)	P (%)	K (%)	Ca (%)	Mg (%)	Zn (mg kg^{-1})	Cu (mg kg^{-1})	Crude protein (%)
Cow dung compost	13.50	1.30	0.58	2.15	0.99	0.52	129.00	128	13.07
Seriwaste compost	16.08	1.60	1.00	1.50	0.38	0.37	24.00	45	18.73

Table 2: Post harvest soil properties for various fertilizers treatments

Treatments	Nitrogen (%)	Phosphorus (%)	Potassium (%)	Sulphur (%)	Zinc (%)	Organic matter (%)	Soil pH
Control	0.06±0.006	12.90±0.17	0.16±0.003	9.80±0.06	0.35±0.012	1.42±0.02	8.27±0.066
CDC	0.07±0.003	15.07±0.15	0.33±0.140	11.73±0.12	0.61±0.005	1.70±0.01	8.20±0.057
BRBD	0.09±0.012	14.93±0.09	0.26±0.005	11.73±0.09	0.47±0.008	1.56±0.02	8.10±0.057
BRBD+CDC	0.10±0.005	15.16±0.09	0.34±0.008	11.40±0.06	0.71±0.011	1.75±0.01	8.17±0.033
SWC	0.09±0.003	15.17±0.08	0.30±0.006	9.90±0.06	0.49±0.014	1.53±0.01	8.13±0.120
BRBD+SWC	0.12±0.003	15.29±0.06	0.39±0.011	18.13±0.09	0.49±0.008	1.83±0.03	8.23±0.088

C: Control, CDC: Cow dung, BRBD: Recommended basal doses of BSRTI, BRBD+CDC: Recommended basal doses of BSRTI+cow dung compost, SWC: Seriwaste compost, BRBD+SWC: Recommended basal doses of BSRTI+seriwaste compost

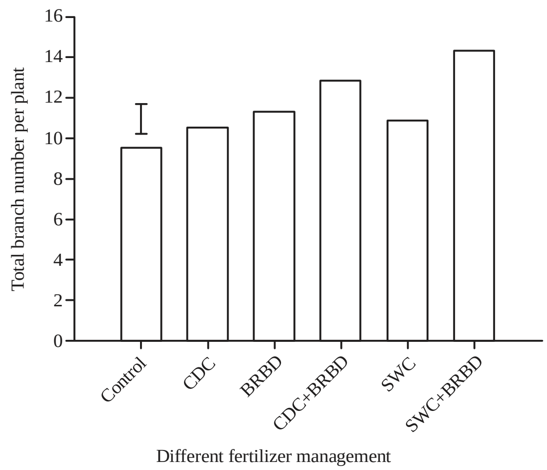

Fig. 1: Effect of fertilizer management on total branch number per plant of mulberry plant
Vertical bar represent LSD (p≥0.05) for several fertilizer treatment

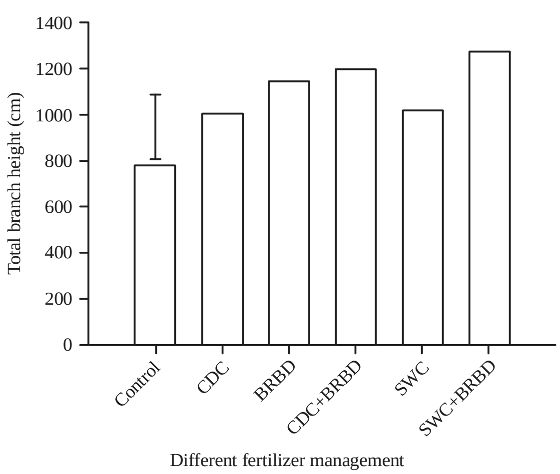

Fig. 2: Effect of fertilizer management on total branch height per plant of mulberry plant
Vertical bar represent LSD (p≥0.05) for several fertilizer treatment

Total branch height per plant: The SWC+BRBD treated plot showed the maximum total branch height per plant which was 1273.38 cm. On the other hand, the minimum total branch height per plant was 780.38 cm in control treated plot (Fig. 2). The total branch height per plant was also statistically significant (p≤0.01) for different fertilizer management (Table 3).

Table 3: Significance levels from the analysis of variance for the main effects of growth and yield parameters among various fertilizer management

Sources of variation	Treatments
Total branch number/plant	***
Total branch height/plant (cm)	**
Length of longest shoot (cm)	NS
Node/meter	***
Total shoot weight/plant (g)	**
Total leaf number/plant	***
Area of 10 leaves (cm^2)/plant	**
Weight of 10 leaves/plant (g)	***
Total leaf weight/plant (g)	NS
Total leaf yield/hector/year (Mt)	NS

NS,*,**,***Indicate p>0.05, p≤0.05, p≤0.01 and p≤0.001. Values were means of five replicates

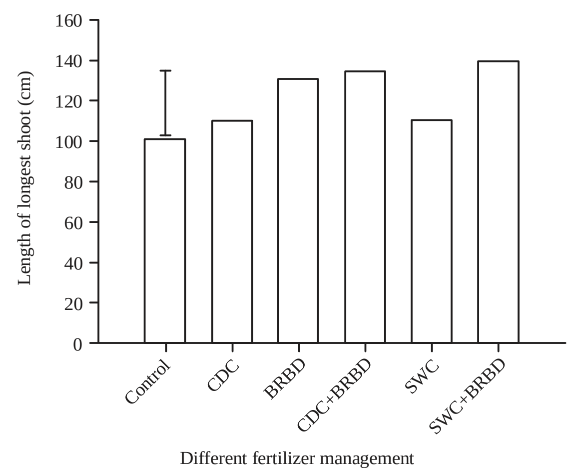

Fig. 3: Effect of fertilizer management on length of longest shoot of mulberry plant
Vertical bar represent LSD (p≥0.05) for several fertilizer treatment

Length of longest shoot: The length of longest shoot was not statistically significant by the fertilizer treatments (Table 3). But the highest length of longest shoot was obtained 139.38 cm for the SWC+BRBD treatment followed by the other fertilizer treatments. The average lowest length of longest shoot was 100.92 cm in control treated plot (Fig. 3).

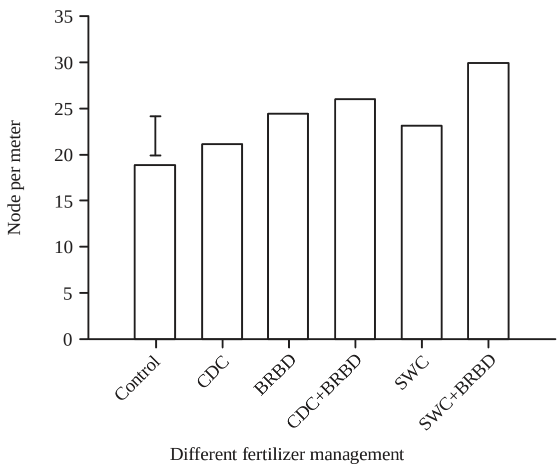

Fig. 4: Effect of fertilizer management on node per meter of mulberry plant
Vertical bar represent LSD (p≥0.05) for several fertilizer treatment

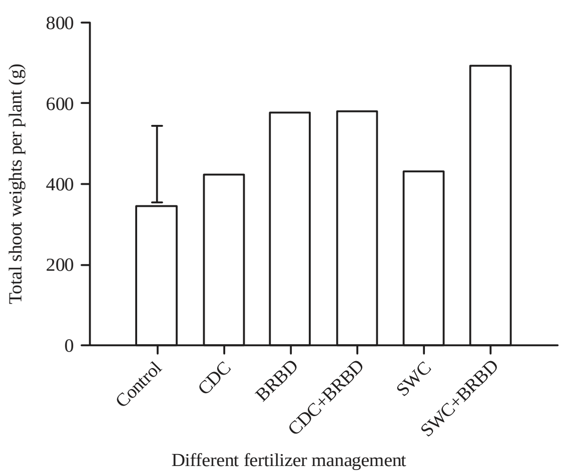

Fig. 5: Effect of fertilizer management on total shoot per plant of mulberry plant
Vertical bar represent LSD (p≥0.05) for several fertilizer treatment

Node per meter: The node per meter was significantly (p≥0.001) affected by the application of different SWC+BRBD, CDC+BRBD, BRBD, SWC, CDC and control fertilizer treatments (Table 3). The maximum average node per meter (25.22) was recorded in SWC+BRBD treatment and the minimum average node per meter (20.79) was recorded in control treatment (Fig. 4).

Total shoot weight per plant (g): Application of seriwastes compost with BSRTI recommended basal doses of NPK (SB+BD) significantly (p≥0.01) influenced the total shoot weight/plant (Table 3). The highest average total shoot weight per plant was 691.77 g recorded in SB+BD treatment and lowest value was 344.87 g in control treatment (Fig. 5).

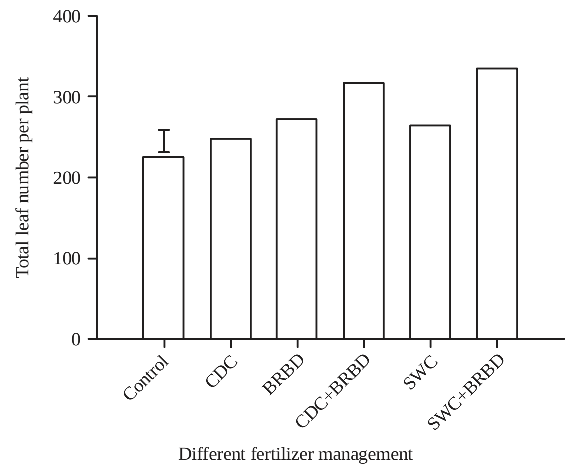

Fig. 6: Effect of fertilizer management on total leaf number per plant of mulberry plant
Vertical bar represent LSD (p≥0.05) for several fertilizer treatment

Total leaf number per plant: The total leaf number per plant was statistically (p≥0.001) influenced by the different fertilizer treatments (Table 3). Among the six fertilizer treatments the maximum average total leaf number per plant (334.69) was recorded in seriwaste compost with BSRTI recommended basal doses of NPK (SWC+BRBD) treated plot followed by the CDC+BRBD (316.59), BRBD (272.22), SWC (263.72), CDC (247.62) and control (224.65) treatments (Fig. 6).

Areas of ten leaves (cm^2): Statistical variation was observed among the different fertilizer treatments when applied to mulberry plant in respect of areas of 10 leaves of mulberry plant. The average area of ten leaves was 906.66 cm^2 significantly higher in (SWC+BRBD) treated plot followed by the CDC+BRBD (805.37), BRBD (799.23 cm^2), SWC (799.04 cm^2), CDC (664.22 cm^2) and control (620.56 cm^2) treatments (Fig. 7).

Weight of ten leaves per plant: The weight of ten leaves per plant was significantly (p≤0.001) influenced by the fertilizer treatments (Table 3). The average highest weight of ten leaves per plant 49.09 g was observed in (SWC+BRBD) treatment followed by CDC+BRBD, BRBD, SWC, CDC and control treatments. The lowest average 10 leaf weights per plant were 24.54 g in control treatment (Fig. 8).

Total leaf weight per plant: The results revealed that the total leaf weight per plant was not significantly influenced by the different fertilizer treatments (Table 3) but there was a great variation was observed in respect of average total leaf weight per plant. The highest average total leaf weight per plant was 1088.11 g in SWC+BRBD treatment where as the lowest value was 797.53 g in control treatment (Fig. 9).

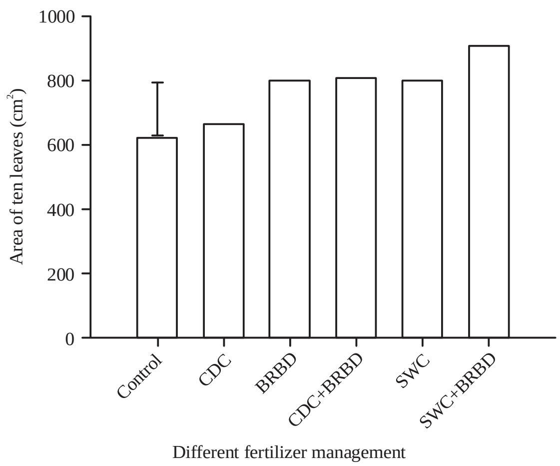

Fig. 7: Effect of fertilizer management on area of ten leaves of mulberry plant
Vertical bar represent LSD ($p\geq 0.05$) for several fertilizer treatment

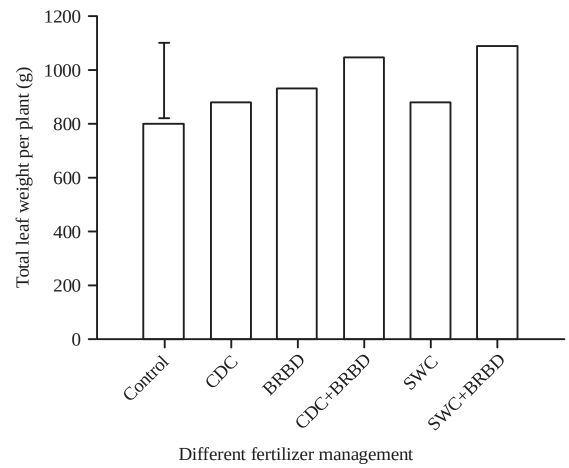

Fig. 9: Effect of fertilizer management on total leaf weights per plant of mulberry plant
Vertical bar represent LSD ($p\geq 0.05$) for several fertilizer treatment

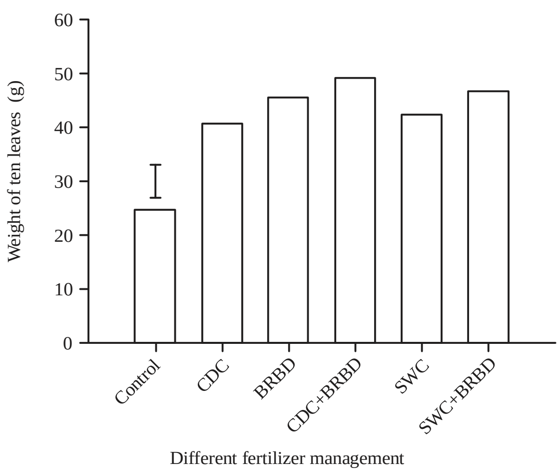

Fig. 8: Effect of fertilizer management on weight ten leaves per plant of mulberry plant
Vertical bar represent LSD ($p\geq 0.05$) for several fertilizer treatment

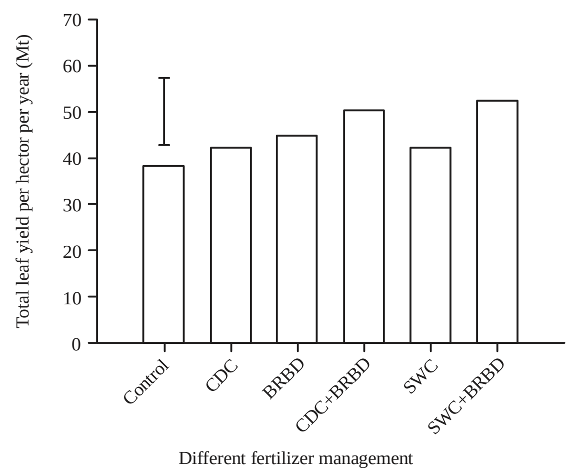

Fig. 10: Effect of fertilizer management on total leaf yield per hector per year of mulberry plant
Vertical bar represent LSD ($p\geq 0.05$) for several fertilizer treatment

Total leaf yield/ha/year (Mt): Application of different fertilizer treatments in mulberry plant was not significantly differed in respect of total leaf yield ha^{-1} $year^{-1}$ (Table 3). However, the average total leaf yield ha^{-1} $year^{-1}$ was differed from treatments to treatments. The highest total leaf yield ha^{-1} $year^{-1}$ 52.23 Mt was observed in (SWC+BRBD) treated plot followed by the other treatments. The lowest total leaf yield ha^{-1} $year^{-1}$ 38.28 Mt was recorded in control treatment (Fig. 10).

Seriwaste compost improving the bio-chemical constituents of mulberry leaf: Among the six treatments the percentage of moisture, moisture retention capacity, crude protein, reducing sugar, total mineral, total sugar and soluble carbohydrate were maximum for BRBD+SWC treatment followed by the BRBD+CDC, BRBD, SWC, CDC and control treatments. The bio-chemical constituents of mulberry leaf viz. moisture, moisture retention capacity, crude protein, reducing sugar, total mineral, total sugar and soluble carbohydrate percentage were 76.63, 54.30, 20.54, 3.76, 12.97, 6.29 and 10.81, respectively for BRBD+SWC treated mulberry plant (Table 4).

Seriwaste compost influence the silkworm rearing performance: Among the six fertilizer treatments the highest weights of 10 matured larvae (g), effective rate of rearing by

Table 4: Bio-chemical constitutions of mulberry leaf for various fertilizers management

Treatments	Moisture (%)	Moisture retention capacity (%)	Crude protein (%)	Reducing sugar (%)	Mineral (%)	Total sugar (%)	Soluble carbohydrate (%)
C	70.32±0.42	50.03±0.16	16.82±0.27	3.07±0.02	9.09±0.06	4.96±0.04	8.51±0.106
CDC	71.80±0.49	50.76±0.18	18.45±0.24	3.29±0.05	9.99±0.17	5.14±0.04	9.63±0.034
BRBD	74.15±0.56	51.89±0.26	19.47±0.24	3.40±0.09	10.23±0.29	5.23±0.05	9.95±0.050
BRBD+CD	74.72±0.42	53.24±0.14	20.23±0.13	3.61±0.02	12.32±0.23	6.07±0.04	10.51±0.023
SWC	73.19±0.42	51.22±0.18	18.47±0.24	3.37±0.03	9.86±0.12	5.25±0.07	9.77±0.044
BRBD+SWC	76.63±0.47	54.30±0.23	20.54±0.08	3.76±0.06	12.97±0.21	6.29±0.09	10.81±0.015

C: Control, CDC: Cow dung, BRBD: Recommended basal doses of BSRTI, BRBD+CDC: Recommended basal doses of BSRTI+cow dung compost, SWC: Seriwaste compost, BRBD+SWC: Recommended basal doses of BSRTI+seriwaste compost

Table 5: Economic characters of silkworm rearing for various fertilizers management

Treatments	Weight of 10 matured larval (g)	Effective rate of rearing by number	Single cocoon weight (g)	Single shell weight (g)	Shell ratio (%)	Highest filament length (m)	Rendita	Yield/100 dfls (kg)
Control	31.69±0.388	7924.33±15.919	1.35±0.012	0.21±0.021	15.18±0.259	855.67±7.055	12.98±0.23	51.69±0.388
CDC	32.47±0.450	8870.09±9.539	1.41±0.008	0.23±0.003	15.47±0.258	904.33±1.76	12.20±0.173	69.55±0.450
BRBD	33.83±0.172	8781.67±8.762	1.50±0.017	0.26±0.005	16.84±0.159	936.33±6.429	10.93±0.145	73.77±0.172
BRBD+CDC	35.57±0.227	9287.33±6.173	1.61±0.014	0.27±0.003	18.41±0.254	1005.33±3.84	9.60±0.25	79.01±0.227
SWC	33.11±0.846	8859.00±3.527	1.42±0.017	0.25±0.010	16.35±0.098	911.00±1.15	11.54±0.055	75.08±0.846
BRBD+SWC	37.14±0.319	9393.00±2.309	1.65±0.011	0.29±0.003	19.15±0.117	1064.33±6.565	9.92±0.096	81.73±0.319

C: Control, CDC: Cow dung, BRBD: Recommended basal doses of BSRTI, BRBD+CDC: Recommended basal doses of BSRTI+cow dung compost, SWC: Seriwaste compost, BRBD+SWC: Recommended basal doses of BSRTI+seriwastes compost

number, single cocoon weight (g), single shell weight (g), cocoon shell ratio (SR%), highest filament length (meter), lowest rendita and highest cocoon yield/100 dfls (Disease free layings) (kg) were recorded by the silkworm reared of BRBD+SWC treated mulberry leaf followed by the BRBD+CDC, BRBD, SWC, CDC and control treated mulberry leaf. The weight of 10 matured larvae (g), effective rate of rearing by number, single cocoon weight (g), single shell weight (g), cocoon shell ratio (SR%), highest filament length (m), rendita and cocoon yield/100 dfls (kg) were 37.14, 9393.00, 1.65, 0.29, 19.15, 1064.33, 9.92 and 81.73, respectively for feed on BRBD+SWC treated mulberry leaf (Table 5).

DISCUSSION

Effect of seriwaste on soil properties: Seriwaste compost has potential effect on soil properties. The combined application of seriwaste compost and recommended dose of inorganic fertilizer provided highest NPK value as compared to other treatments. Highest N, P and K percentage were 0.12, 15.80 and 0.39, respectively for the BSRTI recommended basal dose of NPK plus seriwaste compost treated soil. A study conducted by DuBois *et al.*[27] found that the combined application of 50% N recommended dose of fertilizer+50% N seri-compost increased the nitrogen, phosphorus and potassium contents in soil compared to the application of 100% N through seri-compost, inorganic recommended dose of fertilizer+farmyard manure 25 t ha^{-1} and 50% N recommended dose of fertilizer+50% N farmyard manure. However, they did not observed the others soil properties status in soil. But in our study we also observed the other soil properties, where the highest sulphur (18.13%), zinc (0.49 %) and organic matter (1.83%) were found also in soil treated by the combined application of BSRTI recommended basal dose of NPK and seriwaste compost than the other treatments. This could be due to the highest available residual nitrogen, phosphorus and potassium contents with higher decomposition and releasing rate of seriwaste compost enhanced the nutrient availability within soil as compared to other treatments. Likewise, silkworm litter was also utilized as an organic fertilizer and analyzed the silkworm excreta which revealed the higher composition of nitrogen, phosphorus, potassium, sodium and carbon when compared to cow dung or FYM[28]. Similarly, 12-15 million tons of seriwaste has a tremendous manorial value of nitrogen (280-300 kg), phosphorus (90-100 kg) and potassium (150-200 kg) as well as micronutrients like iron, zinc, copper etc[29]. Likewise, other study found that the seriwaste of various regimes (25, 50, 75 and 100%) were applied along with nitrogen (N), phosphorus (P), potassium (K) levels (150:75:75 kg ha^{-1}) at different levels (25, 50, 75 and 100%). The results revealed that plant growth, dry matter production, yield, soil fertility and economics were found to be higher with integrated nutrient supply through 100% of RDF+75% of organic manure from Integrated Farming System components with increased net returns and B:C ratio which was on par with 50% RDF+50% organic manure in maize-sunflower sequential cropping system[30].

The assumption revealed that combined application of recommended basal dose of N, P, K and seriwaste compost contents comparatively resulted in maximum amount of plant nutrients (macro and micro) with higher decomposition rate within shorter period of time. Besides seriwaste compost also enhance the population of some beneficial micro flora or microorganisms like bacteria, fungi, actinomycetes etc resulting enhancement in the mineralization and decomposition of soil available nutrient.

Effect of seriwaste compost on plant growth and yield: Mulberry plant production was highest in the combined application of recommended basal dose of NPK and seriwaste compost treatment. Present findings showed that the average plant height was 110.43 cm and average leaves number/plant was 263.72 for the seriwaste compost treated plot after 90 days of pruning. A similar type of study was conducted by Naik[30]. He has conducted a field experiment by using silk-worm litter-pupal waste compost and recommended basal dose of NPK for mulberry plant production. However, he did not observe the combined effect of NPK fertilizers+silkworm litter-pupal waste compost in his study. He found that the silkworm litter-pupal waste compost treatment 60 days after pruning the average plant height was 153.8 cm and average leaves number/plant was 140. Though the average plant height and average leaves number per plant of present findings was not similar with his finding but the silkworm litter-pupal waste compost treatment influenced these growth parameters. This could be due to other mulberry variety and also 30 days more growth period for data collection. They speculated that the SLPW compost might have increased the release of macro as well as micronutrients, resulting increased the production of dry matter, plant height and nutrient uptake by the mulberry plant, interns, influenced the higher leaf production.

Naik[30] did not observed combined effect of silkworm litter-pupal waste compost and recommended basal dose of NPK. The combined application of results showed that BRBD of NPK+seriwaste compost was comparatively higher than the only seriwaste compost treated plot, where the average plant height was 139.83 cm and average leaves number/plant was 334.64. Besides the others growth parameters like total branch number, total branch height, node per meter, total shoot weight, area of ten leaves, weight of ten leaves, total leaf weight per plant and total leaf yield/hector/year were significantly highest in BRBD+SWC treated plot than the other treatments (Table 3). This could be due to the reason that combined BRBD plus SWC release both macro and micro nutrients for mulberry plant uptake from the soil. There may be other possibility that the SWC helps mineralization process within soil during decomposition of SWC. Likewise, the SWC may enhance the beneficial microbial activity in soil which would have influenced the nutrients uptake from soil to mulberry plants. These beneficial effects promote higher yield attributes and leaf yield of mulberry plant in the combined application of BRBD and SWC.

Effect of seriwaste compost on leaf quality: The nutritional quality of mulberry leaf was highest in the combined BSRTI recommended and Seri-waste treated plot. The average moisture percentage was 73.19 in this treatment. Earlier Naik[30] used combined seriwaste compost and NPK for mulberry plant production. They also found that the average moisture percentage was 71.40. Similarly, a study was conducted by Chakraborty and Kundu[31]. They applied combined silkworm rearing waste+AZB+50% N+40% P+100% K to the experimental plot with other treatments like (FYM+NPK), weed compost+AZB+50% N+40% P+100% K, poultry manure+AZB+50% N+40% P+100% K and pig manure+AZB+50% N+40% P+100% K for evaluating the leaf quality. Among the five treatments they found that the mean leaf moisture content (72.31%), leaf moisture retention capacity (88.83%) and leaf protein (17.96 mg g^{-1} fresh weight) for the leaf of silkworm rearing waste+AZB+50% N+40% P+100% K treated mulberry plot which was comparatively higher than the (FYM+NPK) and weed compost+AZB+50% N+40% P+100% K treated plot. Their assumption could be due to the beneficial combined effect of silkworm rearing waste+AZB+50% N+40% P+100% K to the soil fertility status, overall plant growth and biochemical constituents of mulberry leaf, resulting the leaf quality was comparatively high than the other treatments.

However, in present case it may be due to the superior nutritive value of seriwaste rearing compost that enhanced the organic matter content, water holding capacity and flourishing the various beneficial microorganisms within soil. These beneficial synergetic effects improved production of plant growth substances and enzyme activity within mulberry plant which in turns improved the nutritional status of mulberry leaf treated by the recommended basal dose of NPK+seriwaste compost treatment.

Effect of seriwaste compost on silkworm rearing performance: The rearing performance as well as cocoon productivity of silkworm was significantly increased by the combined application of BSRTI recommended basal dose of

NPK and seriwaste compost treatment. A similar type of study was conducted by Yashoda *et al*.[12]. In their study they used two types of compost in mulberry plant like silkworm rearing wastes compost and FYM for evaluating the rearing performance of silkworm. They observed that the silkworm feed on silkworm rearing waste compost treated mulberry leaf were the highest single cocoon weight 1.51 g, single shell weight 0.34 g, SR% 22.19 and cocoon yield/100 dfls (Disease free layings) 81.73 kg than the silkworm reared to feed on the FYM treated mulberry leaf. Other study showed that the impact on silkworm rearing was also observed and found better with all the rearing parameters viz., single larval weight, single shell weight and single cocoon weight and shell ratio % better besides improvement in cocoon yield[11]. However, they did not observed the combined effect of recommended basal dose of NPK+seriwaste compost treated mulberry leaf to feed on silkworm and their rearing performance. They speculated that the improvement of mulberry leaf qualitative parameters and also added some of benefits like decomposer microbial association contribute for maximum level of nutrients to the compost which intern reflect on mulberry leaf and cocoon productivity.

However, current observation was that the mulberry leaves of combined recommended basal dose of NPK+seriwaste compost treated plots have more nutritional value than that of other treatments which interns influences the successful and nutritious growth of silkworm, resulting rearing performance and cocoon production was comparatively increased.

CONCLUSION

This study demonstrated that the combined application of seriwaste compost with BSRTI recommended basal dose of NPK in mulberry plant produces high yield of mulberry plant. The healthy leaves also improve the cocoon production. Seriwaste serves as good source of organic nutrients. The findings of the present study indicated that application of seriwaste compost with BSRTI recommended basal dose of NPK would be an advisable treatment that produces quality and quaintly mulberry leaf and cocoon production through improving the soil properties. This could be due to the presence of maximum nutrients (macro and micro) in available forms and rapidly balanced uptake of nutrients by the mulberry plant. Further studies will be conducted to optimization of seriwaste compost for mulberry leaf production in Bangladesh.

SIGNIFICANT STATEMENTS

- Seriwastes (larval excreta, leaf litter, dead larvae, moth etc.) are the major by-product of sericulture which are obtained after reeling
- Dried silkworm pupae contain about 8% nitrogen and crude protein extracted with 0.5% sodium hydroxide contains 12.22% nitrogen. But these valuable materials are totally unused in Bangladesh
- A little study of seriwaste compost on mulberry leaf yield and quality has been conducted previously in India but its utilization in Bangladesh as a compost fertilizer is a entirely new idea
- Seriwaste compost contains high amount of nitrogen and protein, thereby effective utilization of sericulture waste minimize the environmental pollution, reduce the cost of inorganic fertilizers uses and good alternative to restrict the use of inorganic fertilizers

ACKNOWLEDGMENT

The authors are highly grateful to the Director of Bangladesh Sericulture Research and Training Institute, Rajshahi, for valuable help and providing laboratory facilities for analytical and physio-chemical analysis. The authors would like to thank the technical personnel of Soil Resources Development Institute (SRDI), Rajshahi, Bangladesh for their constructive suggestion regarding soil samples collection and analysis. The authors also would like to thank the technical staff of Bangladesh Sericulture Research and Training Institute, Rajshahi, Bangladesh for their help regarding the experiment.

REFERENCES

1. Heenkende, A.P. and V.R.R. Parama, 2011. Effect of silkworm pupae compost on soil N mineralization, nutrient uptake, crop yield and plant nutrient contents of french bean (*Phaseolus vulgaris* L.). Trop. Agric. Res., 21: 391-397.
2. Nagaraj, G. and H.M. Basavanna, 1969. Proteins from silkworm pupae. Silkworm Info. Bulletin, Vol. 1, pp: 29-30.
3. Krishnaswami, S., M.N. Narasimhanna, S.K. Suryanarayan and S. Kumarraj, 1973. Manual on Sericulture. Vol. 2, Silkworm Rearing. Food and Agricultural Organization, Rome, Italy, Pages: 131.
4. Nasreen, A., G.M. Cheema and M. Ashfaq, 1999. Rearing of silkworm *Bombyx mori* L. on alternative food parts. Pak. J. Biol. Sci., 2: 843-845.

5. Bharadwaj, V. and P. Omanwmar, 1994. Long term effects of continuous rotational cropping and fertilization on crop yields and soil properties. II: Effects on EC, pH, organic matter and available nutrients of soil. J. Indian Soc. Soil Sci., 42: 387-392.
6. Shashidhar, K.R., T.K. Narayanaswamy, R.N. Bhaskar, B.R. Jagadish, M. Mahesh and K.S. Krishna, 2009. Influence of organic based nutrients on soil health and mulberry (*Morus Indica* L.) production. J. Biol. Sci., 1: 94-100.
7. Lampkin, N., 1990. Organic Farming. 1st Edn., Farming Press, Ipswich, UK.
8. Adediran, J.A., L.B. Taiwo and R.A. Sobulo, 2003. Effect of organic wastes and method of composting on compost maturity, nutrient composition of compost and yields of two vegetable crops. J. Sustain. Agric., 22: 95-109.
9. Kamili, A.S. and A.M. Mosoodi, 2000. Principle of Temperate Sericulture. Kalyani Publisher, New Delhi, pp: 105-116.
10. Nath, G., K. Singh and D.K. Singh, 2009. Chemical analysis of vermicomposts/vermiwash of different combinations of animal, agro and kitchen wastes. Aust. J. Basic Applied Sci., 3: 3671-3676.
11. Ravikumar, J., P. Samuthiravelu, S.M.H. Qadri, L. Hemanthkumar and R. Vijayakumar *et al*., 2014. Role of decomposer microbial consortium in sericultural waste management. Acta Biol. Indica, 3: 668-671.
12. Yashoda, K.P., N.M. Sachindra, D.N. Rao and N.S. Mahendrakar, 2001. Changes in microbial population during fermentation of silkworm pupae. Sericologia, 41: 253-267.
13. Singhal, B.K., A. Dhar, B.B. Bindroo, P.M. Tripathi, S.M.H. Qadri and M.M. Ahsan, 2001. Medicinal Utilities of Mulberry and Non-Mulberry Food Plants of the Silkworm: Recent Progress in Medicinal Plants. Research Periodicals and Book Publishing House, Texas.
14. Sangeetha, R., C.A. Mahalingam and P. Priyadharshini, 2012. Effect of Silkworm Litter-Pupal Waste (SLPW) compost on mulberry leaf yield. eJ. Acad. Res. Rev., Vol. 5.
15. Bhogesha, K., P.K. Das and Y.R.M. Rao, 1997. Effect of various sericultural composts on mulberry leaf yield and quality under irrigated condition. Indian J. Sericult., 36: 30-34.
16. Subbiah, B.V. and G.L. Asija, 1956. A rapid procedure for the estimation of available nitrogen in soils. Curr. Sci., 25: 259-260.
17. Podder, M., M. Akter, A.S.M. Saifullah and S. Roy, 2012. Impacts of plough pan on physical and chemical properties of soil. J. Environ. Sci. Natural Resour., 5: 289-294.
18. Petersen, L., 1996. Soil Analytical Methods Soil Testing Management and Development. Soil Resources Development Institute, Dhaka, Bangladesh, pp: 1-28.
19. Biswas, A., M. Alamgir, S.M. Haque and K.T. Osman, 2012. Study on soils under shifting cultivation and other land use categories in Chittagong hill tracts, Bangladesh. J. For. Res., 23: 261-265.
20. Huq, S.M.I. and M.D. Alam, 2005. A Handbook on Analyses of Soil, Plant and Water. BACER-DU, University of Dhaka, Bangladesh, pp: 13-40.
21. Soltanpour, P.N. and S. Workman, 1979. Modification of the NH_4 HCO_3-DTPA soil test to omit carbon black. Commun. Soil Sci. Plant Anal., 10: 1411-1420.
22. Vijayan, K., A. Tikader, K.K. Das, B.N. Roy and T.P. Kumar, 1996. Genotypic influence on leaf moisture content and moisture retention capacity in mulberry (*Morus* spp.). Bull. Sericult. Res., 7: 95-98.
23. AOAC., 1980. Official Methods of Analysis. Association of Official Analytical Chemists, Washington, DC., pp: 105.
24. Miller, G.L., 1959. Use of dinitrosalicylic acid reagent for determination of reducing sugar. Anal. Chem., 31: 426-428.
25. Loomis, W.E. and C.A. Shull, 1937. Methods in Plant Physiology. McGraw Hill, New York.
26. Wong, T., 1923. Soybean industries. J. Biol. Chem., 55: 427-427.
27. DuBois, M., K.A. Gilles, J.K. Hamilton, P.A. Rebers and F. Smith, 1956. Colorimetric method for determination of sugars and related substances. Anal. Chem., 28: 350-356.
28. Shanmugam, R. and K. Ramamoorthy, 2014. Effect of nutrient recycling in seri-based integrated farming system on soil fertility, productivity and profitability in maize-sunflower cropping system. Trends Biosci., 7: 317-321.
29. Snowalker, T.N., 1991. Handbook of Silk Technology. Wiley Eastern Limited, New Delhi.
30. Naik, R., 2001. Silkworm excreta good source of organic manure. Agro. India, 5: 28-28.
31. Chakraborty B. and M. Kundu, 2015. Effect of biofertilizer in combination with organic manures on growth and foliar constituents of mulberry under rainfed lateritic soil condition. Int. J. Eng. Sci., 4: 16-20.