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Research article

EFFECT OF ORGANIC FERTILIZERS ON QUANTITATIVE AND QUALITATIVE PARAMETERS OF SILK COCOON PRODUCTION

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ABSTRACT: Mulberry silkworm *Bombyx mori L.* is monophagous and feeds on mulberry. The beneficial effects of various organics such as green manures, bio-fertilizers, vermicompost and application of certified organic fertilizers need to be highlighted adequately for increasing the yields in mulberry and consequent silk quality. Due to continuous application of chemical fertilizers which brings about the depletion of the soil fertility, sustainable yields of cocoons could not be achieved. As an alternative, application of organic manures which helps in the revival of soil health has to be tested for a sustainable increase of yield and quality of mulberry leaf in comparison with application of Chemical fertilizers. In this study six treatments comprising of organic nitrogen, organic phosphorous, organic potassium were applied and the bio-efficacy of all these inputs on the quantitative and qualitative parameters of silkworm and cocoon were studied in comparison with chemical fertilizers. Bioassay studies revealed that T-6 and T-4 have shown higher values compared to control.

Keywords: Cocoon, Mulberry, Organic fertilizers, Silkworm, Yield

INTRODUCTION

Silk, it is the most exquisite of all the textile fibers. Silk which is known for its richness, softness and flamboyance, is bright in color, soft in touch and elegant in look. Discovered accidentally by Queen Shiling Shi of China about 4600 years ago, this luxurious and romantic cloth, conjured from the tiny strand. Oozing out of a small worm has since been reigning supreme as "The Queen of Textiles". Sericulture is an ancient industry in India dating back at least to the second century B.C. According to some historians, raw silk was exported from India to Rome during the reign of Kanishka in 58 B.C. Silk is a way of life in India. Silk in India has always occupied a prime position, and carries an aura of royalty. The Indian silks are best known for their fine quality, lustrous shine, traditional colors and artwork. Sericulture is an agro-based industry and India enjoys a unique status by growing all the four varieties of natural silks, namely, Mulberry, Tasar, Eri and Muga of which mulberry silk accounts for 90% of India's total production. Mulberry silkworm *Bombyx mori L.* is monophagous and feeds only on mulberry. The beneficial effects of various organics such as green manures, bio-fertilizers, vermicompost and application of certified organic fertilizers need to be highlighted adequately for increasing the yields in mulberry and consequent silk quality. In mulberry, organic carbon and soil moisture have a tremendous influence on leaf yield and quality. The optimum level (> 0.75%) of organic carbon and soil moisture (~70%) is maintained in the soil to keep higher leaf productivity in mulberry. In addition to macro-nutrients (NPK), mulberry plants also require various micro-nutrients. All this can be achieved only by the application of organic fertilizers. Nutrition involves biochemical and physiological activities which transform food elements into body elements. The nutritive value of mulberry depends on various factors like variety and agronomical inputs.

The chemical composition of mulberry leaves varies greatly based on genotype and application of manures and fertilizers. The weight of the cocoons is directly correlated to the protein content of the leaves for normal silk production during the 5th instar of the caterpillar. The effect of feeding the leaves of the mulberry (*Morus spp.*) on the larval growth, cocoon yield and other economic characters of the cocoons has been reported by a number of investigators. The nutritiousness and palatability offer better criteria for the superiority of one type of leaf over the other as food for the silkworm [9, 11] concluded that the water content in the leaves may serve as one of the criteria in assessing their quality. Food quality greatly influences larval growth, weight of cocoons, silk yield and physical-mechanical properties of silk thread as reported by Samokhvalova [14]. Studies on the growth and development undertaken under tropical conditions showed that quality variation in the leaves has a direct effect on the growth and development of silkworm and cocoon quality as well as egg production [12]. The varieties of mulberry respond differently in different seasons of the year. The contents of various kinds of nutrients in mulberry leaves; the daily amount of nutrients ingested and absorbed by the larvae in relation to the quantitative requirements of nutrients in the silkworms was studied by [6]. The nutritional status of mulberry leaf which influences the economic characters of silkworm crop depends upon the level of leaf moisture, total protein, total carbohydrates and total minerals [3]. The influence of various agronomical practices in India on leaf quality of mulberry has been well documented by various authors [5]. The quantity of manure and chemical fertilizers recommended for mulberry cultivation is quite high compared to that of other agricultural crops. Excessive use of chemicals and improper selection of fertilizers in mulberry cultivation cause great concern on the survivability of soil fauna and flora besides soil health. Ultimately, the soil pH in most of the mulberry gardens is getting alkaline. Increase in soil pH has also resulted in widespread deficiencies of both macro and micro nutrients. Babu [2] have emphasized about ample scope of organic farming in mulberry cultivation to make sericulture more sustainable and remunerative. Due to the continuous application of Chemical Fertilizers which brings about the depletion of the soil fertility, sustainable yields of Cocoons could not be achieved. As an alternative, application of Organic manures which helps in the revival of soil health has to be tested for a sustainable increase of yield and quality of mulberry leaf in comparison with application of Chemical fertilizers. In light of the above and as well as growing need for maintaining soil fertility and health for sustainable sericulture, the present study was undertaken with the following objective

To study the Bio-efficacy of Organic Agri inputs in increasing the yield and Quality parameters of Mulberry leaf in comparison with Chemical fertilizers.

MATERIALS AND METHODS

Following are the details of materials used and methods followed in the present study

Experimental Details

The experimental fields of sericulture farmers at V.Kota and Kuppam, Chittoor district of Andhra Pradesh were established with the improved mulberry variety V1 adapting the spacing of (90cm+150cm) x 60cm. Organic manures of the present study were supplied by Prathista Industries, Hyderabad.

Details of the treatments

T-0 (Control): Chemical fertilizer NPK @ 350:140:140 kg/ha + FYM 40 MT/ha as recommended for the V1 mulberry variety applied in 5 split doses.

T1: 1st Application: Aiswarya granules @75 Kg/ha [2 or 3 days after every pruning]
2nd Application: Biophos granules @37.5 Kg/ha + Biopotash granules@ 37.5 Kg/ha [15-20 days after every pruning]
3rd Application: Biophos granules@ 37.5 Kg/ha + Biopotash granules@ 37.5 Kg/ha [30-35 days after every pruning]

T2: **1st Application:** Organic NPK@ 312.5 ml/ha + New Suryamin @312.5 ml/ha [15 -20 days after pruning]
2nd Application: Organic NPK@ 312.5 ml/ha + New Suryamin@312.5 ml/ha [30-35 days after pruning]

T3: 1st Application: Aiswarya granules@ 37.5Kg/ha [2 or 3 days after pruning]
2nd Application: Organic NPK@ 312.5 ml/ha + New Suryamin @312.5 ml/ha [15 -20 days after every pruning]

3rd Application: Organic NPK@ 312.5 ml/ha + New Suryamin @ 312.5 ml/ha [30-35 days after every pruning]

T4: 1st Application: Organic NPK @ 312.5 ml/ha + New Suryamin @312.5 ml/ha [15 -20 days after every pruning]

2nd Application: Organic NPK @312.5 ml/ha + New Suryamin @312.5 ml/ha + Megacol@ 312.5 ml/ha [30-35 days after every pruning]

T5: 1st Application: Organic NPK @ 312.5 ml/ha + New Suryamin @312.5 ml/ha [15 -20 days after every pruning]

2nd Application: Organic NPK @312.5 ml/ha + New Suryamin @312.5 ml/ha + Biopotash @312.5 ml/ha [30-35 days after every pruning]

T6: 1st Application: 50% of RDF: NPK @175:70:70 kg/ha + Aiswarya granules @37.5 Kg/ha + Biophos granules @ 37.5 Kg/ha + Biopotash granules@ 37.5 Kg/ha [2 or 3 days after pruning]

2nd Application: Organic NPK@ 312.5 ml/ha + New Suryamin @312.5 ml/ha [15 -20 days after every pruning]

3rd Application: Organic NPK@ 312.5 ml/ha + New Suryamin @312.5 ml/ha [30-35 days after every pruning]

Note

FYM : 40tons/ha common for all treatments
Granules : Solely or mixing with sand or soil
Liquid fertilizer concentration : 0.25% (2.5 ml/ltr)

An experimental area of one acre was maintained with replications. Chemical fertilizers and organic manures were applied as per recommendations. A total number of five crops were harvested in a year at intervals of 70 days. Data was recorded on the following qualitative and quantitative parameters as indicated.

Bioassay Studies

Larval weight (g)

It was expressed as the weight of ten fully grown (matured) larvae. The worms were picked at random on the 6th day of 5th instar.

Cocoon weight (g)

The single cocoon weight was assessed as the average of 10 cocoons taken at random for each treatment.

Shell weight(g)

The single shell weight was calculated as the average of 10 shells used for cocoon weight assessment.

Shell Ratio (percentage)

It is calculated with the formula

$$\frac{\text{Weight of the cocoon shell}}{\text{Weight of the entire cocoon}} \times 100$$

Average Filament Length (m)

10 cocoons were cooked and reeled on an epprouvette (circumference 1.125m) and average filament length in meters is calculated as per the standard procedure..

Filament Denier

Denier which represents the size of the yarn is the weight in grams of 9000 meters of the yarn / filament. The denier (size) was calculated using the formula

$$\frac{\text{Weight in gram of filament}}{\text{Length in meter of filament}} \times 9000$$

Statistical Analysis

The data on all the morphological and biological parameters was statistically analyzed

RESULTS AND DISCUSSION

The results obtained and presented are the average values of all the observations for a period of one year as indicated in the section on 'Materials and Methods'.

Bioassay Studies

Silkworms and cocoons of different treatments were analyzed for larval weight, single cocoon weight, single shell weight, shell percentage, filament length and filament denier. The results are presented in Table – 1

Larval weight (g)

The weight of 10 larvae fed with the leaves of various accessions varied from 40.10 (T2) to 42.42 (T6). The highest value of larval weight was recorded with T6 followed by T3 (42.00), T4 (41.97) and T5 (41.68) compared to the Control (40.63)

Single cocoon weight (g)

The single cocoon weight varied from 1.63 (Control) to 1.74 (T4). All the treatments except T2, exhibited significantly higher Cocoon weight in comparison with the control.

Single Shell weight (g)

The weight of single shell was varied from 0.295 (Control) to 0.342 (T6). All the treatments except T2 were significantly superior for this parameter in comparison with the treatments involving inorganic fertilizers.

Shell percentage (%)

The shell percentage ranged from 18.09 (T2) to 20.68 (T6). T6 alone showed significantly higher shell percentage over control. All other treatments except T1 and T 2 were on par with Control.

Filament length (mt)

The length of silk filament ranged from 885.25 (Control) to 921.25 (T6). All the treatments except T2 (889.75) showed significantly superior value of filament length compared to control.

Filament Denier

The values ranged from 2.197 (T6) to 2.505 (T2). The quality of the silk is related to the lesser value of filament Denier. Treatment T6 is involving the integrated approach of both Organic and Inorganic Fertilizers in 1:1 ratio showed a desirable positive influence in this parameter contributing for the quality of the silk. The results of Bioassay parameters clearly indicate the influence of PRATHISTA organic fertilizers in significantly increasing the values in a desirable direction for improving the quality of the silk. The use of inorganic fertilizers, intensive tillage farming have greatly increased crop production but the high energy intensive nature of these systems and their adverse effects on soil productivity and the environment has led to increased interest in organic farming systems as they may reduce some of the adverse effects of chemical fertilizers on soil fertility and the environment. The organically farmed soil shows significantly higher organic content, thicker top soil, and depthless soil erosion than conventionally farmed soils. In the present study effect of six treatments of different organic fertilizers have been studied on the growth and development of mulberry and also silkworm cocoon parameters. Significantly higher values are recorded in most of the Organic treatments compared to control. A significant difference was observed in T6 followed by T4 both in quantitative and qualitative parameters.Treatment six which is a combination of all the five organic fertilizers and 50 % of the recommended dose of inorganic fertilizer has shown significant higher response both on quantitative and qualitative parameters of mulberry and silkworm cocoon characters. The reason for increased qualitative and quantitative characters may be due to the advantages of organic fertilizers which may be attributed as

- The nutrient supply is more balanced, which helps to keep plants healthy.
- Enhance soil biological activity, which improves nutrient mobilization from organic and chemical sources and decomposition of toxic substances.
- Enhance the colonization of mycorrhizae, which improves P supply.
- Enhance root growth due to better soil structure.
- Increase the organic matter content of the soil, therefore improving the exchange capacity of nutrients, increasing soil water retention, promoting soil aggregates and buffering the soil against acidity, alkalinity, salinity, pesticides and toxic heavy metals.
- Release nutrients slowly and contribute to the residual pool of organic N and P in the soil, reducing N leaching loss and P fixation; they can also supply micro nutrients.
- They supply food and encourage the growth of beneficial micro-organisms and earthworms.
- Help to suppress certain plant diseases, soil-borne diseases and parasites.

There is increased emphasis on the impact on environmental quality due to continuous use of chemical fertilizers. The integrated nutrient management system is an alternative and is characterized by reducing the input of chemical fertilizers and combined use of chemical fertilizers with organic materials such as animal manures, crop residues, green manure and composts. Management systems that rely on organic inputs as plant nutrient sources have different dynamics of nutrient availability from those involving the use of chemical fertilizers. For sustainable crop production, integrated use of chemical and organic fertilizers has proved to be highly beneficial. Several researchers have demonstrated the beneficial effect of combined use of chemical and organic fertilizers to mitigate the deficiency of many secondary and micronutrients in fields that continuously received the only N, P and K fertilizers for a few years, without any micronutrient or organic fertilizer. Pain [10] and Ray [13] indicated that feeding of mulberry leaves obtained by application of FYM resulted in increased silk content and filament length. This further supports the present findings and confirms that organically produced mulberry leaves can supplement the nutritional requirement of silkworm by virtue of producing nutritionally balanced mulberry leaf. Reported that the use of organic fertilizers together with chemical fertilizers, compared to the addition of organic fertilizers alone, had a higher positive effect on microbial biomass and hence soil health. Application of organic manure in combination with chemical fertilizer has been reported to increase absorption of N, P and K in sugarcane leaf tissue in the plant and ratoon crop, compared to chemical fertilizer alone compared the change of chemical and biological properties in soils receiving FYM, poultry manure and sugarcane filter cake alone or in combination with chemical fertilizers for seven years under a cropping sequence of pearl millet and wheat. Results showed that all treatments except chemical fertilizer application improved the soil organic C, total N, P, and K status. Studies conducted by Jayaraj [8] on integrated nutrient management (INM) in farmers' fields also confirmed the possibility of reducing NPK application by 25% after the first year and by 50% after the second year in mulberry cultivation, besides improving the chemical, physical and biological properties of soil. Thippeswamy [15] validated through an experiment that it is possible to harvest quality mulberry leaf ranging from 55 – 60 metric tons per year by adoption of the integrated technology package (ITP). Field experiment conducted for seven years continuously to evaluate the influence of combined applications and organic and chemical fertility build up and nutrient uptake in a mint (*Mentha arvensis*) and mustard (*Brassica juncea*) cropping sequence indicated that integrated supply of plant nutrients through FYM (farmyard manure) and fertilizer NPK, along with *Sesbania* green manuring, played a significant role in sustaining soil fertility and crop productivity. Based on the evaluation of soil quality indicators, use of organic manures has been found to be promising in arresting the decline in productivity through correction of deficiencies of secondary and micronutrients and its beneficial influence on the physical and biological properties of soil [16]. Various growth parameters of mulberry were enhanced due to the application of different organic and biological material as sources of nutrients in the place of chemical fertilizers [2]. Earlier it has been well established that the practice of integrated nutrient management (INM) in mulberry sustains the crop production with quality foliage and quality cocoons [1, 4, 7, 15]. Thus the present study confirms that by adopting INM i.e. following the organic farming in mulberry cultivation, by reducing the quantity of chemical fertilizers it is possible to produce quality mulberry leaf for silkworm rearing. This would further benefit the sericulture industry and particularly the small and marginal farmers who cannot afford to apply the recommended dose of chemical fertilizers in mulberry cultivation resulting in loss of cocoon crops.

Table 1: Effect of Different Organic Fertilizers on Bioassay Parameters

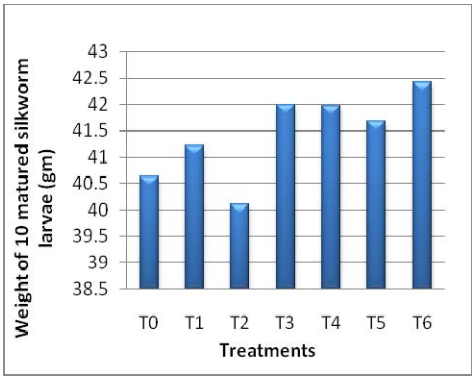
Treatments	Weight of 10 matured silkworm larvae	Single cocoon weight (g)	Single shell weight (g)	Shell percentage (%)	Filament length (mt)	Filament denier
T1	41.22	1.70**	0.300**	17.62	896.00**	2.408
T2	40.10	1.67	0.290**	17.36	889.75	2.505
T3	42.00*	1.69**	0.309**	18.28	909.75**	2.367
T4	41.97*	1.74**	0.328**	18.88	914.75**	2.247
T5	41.68**	1.73**	0.318**	18.38	912.25**	2.286
T6	42.42**	1.72**	0.342**	20.68**	921.00**	2.197*
T0 (Control)	40.63	1.63	0.295	18.09	885.25	2.489
CD at 1%	0.665	0.035	0.036	0.952	8.064	0.173
CD at 5%	0.679	1.007	1.029	0.972	8.238	0.177

**Significant at 1% level, *Significant at 5% level

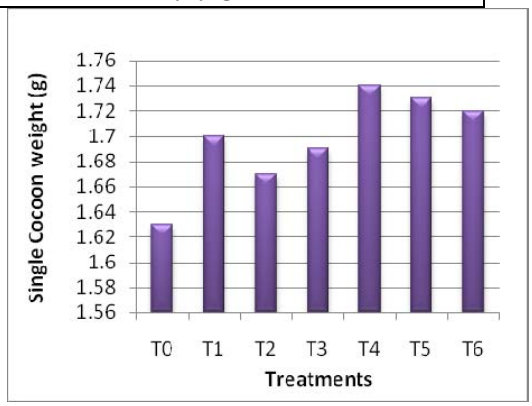
	Between treatments			Within Treatments			df a+b	SS a+b	F value	Sig
	df (a)	Sum of Square	Mean Square	df (b)	Sum of Square	Mean Square				
Weight of 10 matured silkworms (g)	6	16.481	2.747	21	6.183	0.294	27	22.664	9.329	0.000 **
Single cocoon weight (g)	6	0.029	0.005	21	0.018	0.001	27	0.047	5.500	0.001 **
Single shell weight (g)	6	0.010	0.002	21	0.004	0.000	27	0.014	9.944	0.000 **
Shell percentage (%)	6	18.636	3.106	21	10.781	3.106	27	29.417	6.050	0.001 **
Filament length (m)	6	7957.929	1326.321	21	674.500	32.119	27	8632.429	41.294	0.000 **
Filament denier	6	0.350	0.058	21	0.332	0.016	27	0.682	3.688	0.012 *

Table 2: Cost Benefit Ratio (CB Ratio)

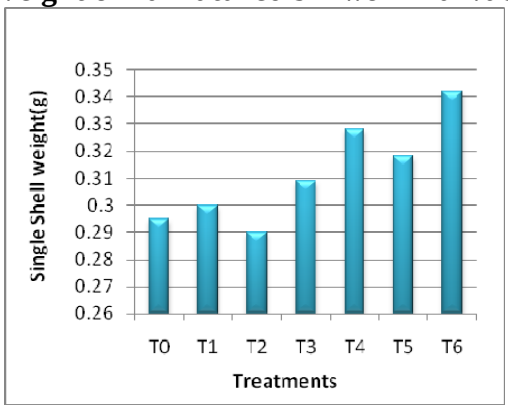
Treatments	CB ratio
T1	**1:1.48**
T2	**1:1.33**
T3	**1:1.60**
T4	**1:1.76**
T5	**1:1.65**
T6	**1:1.90**
T0 (Control)	**1:1.48**



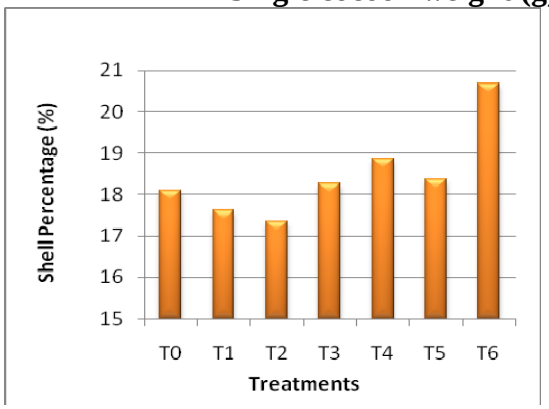
Weight of 10 matured silkworm larvae (gm)



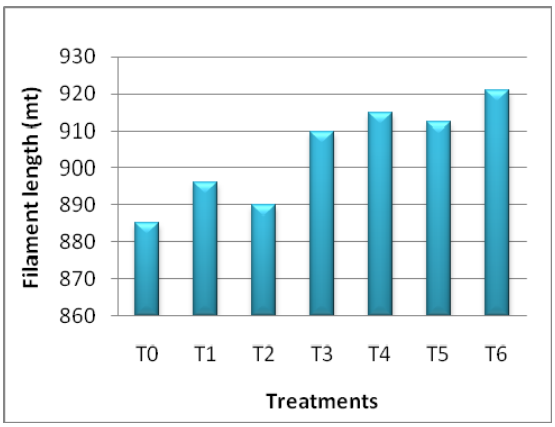
Single cocoon weight (g)



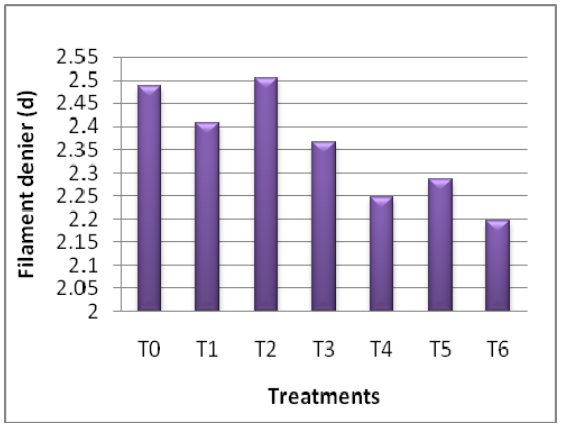
Single shell weight (g)



Shell percentage (%)



Filament length (mt)



Filament denier (d)

Figure-1: Effect of Different Organic Fertilizers on Bioassay parameters

Economics of organic farming *vis-à-vis* chemical fertilizers based farming in mulberry cultivation

Though the mulberry leaf production is only a part of a long chain of activities involved in silk production, the cost of production of mulberry leaves plays an important role in making sericulture a profitable only when the cost of mulberry leaf production is minimized, as it accounts for almost 60% of the total cost of cocoon production (Dandin and Verma; 2002). The cost of mulberry leaf production comprises of fixed costs (establishment of mulberry garden) and viable cost (garden maintenance). Cost of chemical fertilizers forms a major part of the cost of production of mulberry. Thippeswamy [15] reported that the cost of fertilizers can be curtailed to the event of 50% by adopting the integrated nutrition technology package developed at the Central Sericultural Research and Training Institute (CSR & TI), Mysore.

Cost Benefit Ratio

The comparative economics and cost benefit ratio was worked out by considering the cost of production and returns. (Productivity). The analysis of cost benefit ratio indicated the higher values in most of the treatments with organic fertilizers compared to the recommended dose of chemical fertilizers. The maximum CB ratio was recorded in the treatment with an integrated approach of organic and inorganic fertilizers (T6 – 1:1.90) compared to the control treatment with inorganic fertilizers (T0 – 1:1.48). The data was presented in Table -2

CONCLUSION

The study clearly indicates that the leaf quality was not adversely affected even after partial reduction or full replacement of chemical fertilizers and supplementation through the application of various organic fertilizers in mulberry cultivation. Application of Aishwarya as a basal dose showed a positive effect in significantly increasing values in all the quality parameters of cocoon production. Organic farming is a proactive ecological management strategy. This strategy improves soil fertility, enhances Organic content of the soil, increases microbial and enzymatic activity thus facilitating efficient uptake of nutrients by the plant resulting in improvement of quality parameters of the cocoons Treatments with Organic manures have significantly increased the quality parameters viz. weight of 10 matured Silkworm larvae, Single cocoon weight, Single shell weight, shell percentage and filament length compared to the application of chemical fertilizers. Significant reduction in the value of filament denier was noticed in treatment 6 (Integrated approach) compared to the recommended dose of chemical fertilizers. The cost benefit ratio is significantly higher in the treatment with organic manure compared to chemical fertilizer which indicates the reduction of cost of production and increase in quality parameters of cocoons. Hence the finding of the present study promises to be of immense importance to sericulture farmers for sustainable production of quality cocoons. Out of the six treatments, Treatment six (T6) followed by treatment four (T4) have shown overall better performance compared to other treatments. These can be recommended to the sericulture farmers to obtain a higher leg yield with good nutritive value for the healthy growth and development of silkworm larvae and to get good quality cocoons.

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