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EFFECT OF COMBINATIONS OF POULTRY MANURE AND CHEMICAL FERTILIZERS ON MULBERRY LEAF AND SILKWORM COCOON PRODUCTIVITY IN INDIA

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Abstract

Sericulture is an important agro-based industry in India that produces all four types of commercially exploited silk, viz Mulberry, Eri, Tasar & Muga. Among these silks Mulberry silk accounts more than 80% total silk production in India. As mulberry leaf production alone covers more than 60% of the total production cost, mulberry leaf production plays a crucial role in the sustainability of Sericulture in a region. Keeping this in view research organization in India have developed a number of mulberry varieties suitable to different agro-climatic condition of India. G4 is one such mulberry variety that has been developed by Central Sericultural Research &Training Institute, Mysore with high productivity. Since the high leaf yield production potential mulberry varieties requires high input to produce quality leaf in higher quantities, large quantities of organic and chemical fertilizers have been recommended for their cultivation. For G4 mulberry verity the current recommended fertilizer dose is NPK of 350:140:140. However continuous application of high dosage of chemical fertilizers affect not only the soil structure but also the micro flora and funa of the soil. In order to minimize the negative impact of chemical fertilizers efforts have been made to replace chemical fertilizers partly of completely with organic fertilizers such as FYM, Cow dung, Poultry manure and other farm residuals. In southern part of India large numbers of poultry farms are operating to carter to the need of the meat industry in the region. From these poultry farms huge quantities of poultry manures are been produced daily. In order to utilize these manures effectively and efficiently for the production of mulberry leaf the present experiment was undertaken using G4 mulberry gardens. In this study the effect of application of different compositions of chemical, organic and poultry manures where evaluated.

The poultry manure with different treatment compositions ranging from T1 to T11 by taking T0 as absolute control. The results indicate that organic fertilizers, including poultry manure, can lead to increased plant growth and positively impact silkworm growth. The study supports the use of organic fertilizers as a more sustainable and environmentally-friendly approach to farming. While challenges such as nutrient imbalances and pathogen risk exist, they can be mitigated through proper handling and storage of the manure. The results obtained from ANOVA suggest that the use of organic fertilizers or poultry manure i.e., T1, T7 and T11, has a higher significance when compared with control T0 and other treatments. This can have positive effects on agricultural production while contributing to pollution control, and recommends that farmers and agricultural practitioners consider using organic fertilizers to improve soil health and promote sustainable agriculture.

Keyword: G4 mulberry variety; Poultry; Green Manure; Renditta

Introduction

Sericulture is a labour intensive, agro-based cottage industry that helps effective transferring of wealth among different strata of society, particularly from the rich to the poor (Hanumappa HG et al,1986). India is the world's second largest producer of silk after China (Statistical analysis of The International Sericultural Commission,2023) and has the unique distinction of producing all four commercially exploited types of silk, namely mulberry, tasar, muga, and eri. Among the four types of the silk, mulberry silk accounts more than 80% of the total production in India. Hence, mulberry sericulture plays a major role in the development of rural India by providing an excellent source of labour.

Mulberry (*Morus* spp.) is the sole food plant of the silkworm *Bombyxmori* L. and it is grown on more than 2.6 lakh hectares in India (Central Silk Board,2022). The sustainability of sericulture is heavily reliant on mulberry leaf production, as the cost of mulberry leaf production alone accounts for more than 52% of total silkworm cocoon production costs(Soundarya S. R, 2022). As a consequence, mulberry breeders are constantly working to develop new varieties with higher leaf productivity*(*Vijayan K et al, 2011*)*. G4 is one such mulberry variety that wasdeveloped in 2003 by CSR&TI, Mysuru through cross breeding between *M. multicaulis* and S-30 *(*Sudhakar P et al, 2019*)*. The foliage of G4 is of excellent quality and is ideally suited

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to rear medium to mature silkworms, as evidenced by the chemical content of the leaf, which shows that it contains a high protein content (24.63%) *(*Sudhakar P et al, 2019), which is required for the growth and development of silk glands and silkworms. The variety is a diploid one characterized by erect branches, thick dark-green glossy with smooth wavy surface leaves with large surface area of 280 cm^2 and short inter-nodal distance with high rooting ability. It is moderately resistant to major foliar pests like thrips caused by *Pseudodendrothrips mori,* millibug *(Maconellicoccus)* and leaf hoppers (*Wolbachia coexisting) (*Sudhakar P et al, 2019). Under the current package of practices where mulberry is harvested by cutting off the shoots to feed the silkworm, a plantation of the size of one hectare can yield up to 65 Mt of leaf annually*(*Sudhakar P et al, 2019). Since after every silkworm crop, the plant is pruned to promote sprouting of new flesh and sustained growth to get quality leaf, the plant absorbs huge quantity of nutrients from the soil leaving the soil depleted with nutrients. To compensate this loss of nutrients in the soil fertilizers, l fertilizers are applied (Rathore M.S and Y. Srinivasulu,2018). Chemical-based inputs are generally practiced by farmers due to the easy availability and for getting the immediate response from the plant. However, continuous use of chemical fertilisers alters the physical and chemical properties of the soil,pollutes the soil and groundwater, depletes naturally available essential nutrients, and also has a negative impact on beneficial macro and microorganisms that are important for better soil health and plant growth (Bisht N et al, 2021). As a result, the production of leaf declines and slowly the land becomes non-productive. In order to curtail this loss of fertility and to minimize the ill effect of chemical fertilizer, application of organic fertilizer has been adopted as an alternative means. Since, most of the organic fertilizers are more expensive andnot easy to get them, it was found necessary to find out a cheap source of manure. In Southern India, a number of poultry farms are in operation to carter to the need of the meat industry. Among the Southern Indian States, Tamil Nadu is now the second in the country in terms of egg production and fourth in broiler chicken production(Anonymous, 2023c). Tamilnadu state rears more than 120 million chickens annually (Anonymous, 2023d). In India, there are about 3430 million populations of poultry and it produces nearly 3.30 million tonnes poultry manure per year. Proper use of the poultry manure not only fetches additional income to the poultry farmers but also reduce the environmental issues caused by its accumulation in the farms (Ghosh PK et al, 2004). In general, the chemical content of poultry manure is in the range of 4.55 to 5.46 % Nitrogen, 2.46-2.82 % phosphorus, 2.02-2.32% potassium, 4.55-8.15% calcium, 0.52-0.73 % magnesium and appreciable quantities of micronutrients like Cu, Zn, Fe, Mn etc. In addition to this cellulose (2.26 to 3.62%), hemicellulose (1.89 to 2.77 %) and lignin (1.07 to 2.16 %) are also present in poultry waste. These components upon microbial action can be converted to value added compost with high nutrient status. Thus, poultry manure can be used as an alternative to the chemical fertilizer partly in combination with other organic and biofertilizers. It is observed that a combination of poultry manure, biofertilizer and chemical fertilizers provide better result than readily available cow dung(

Chen Z et al, 2014). Poultry manure is better fertilizer than cow dung (or other farmyard manure) in terms of availability of nitrogen, phosphorous and potassium contents, the nutrients that are mostly deficient in Indian soil. Against this back drop, the present study was taken up with an intention of reducing the excessive use of chemical fertilizers by utilizing the poultry manures available in plenty to reduce the environmental hazards and also to sustain the soil fertility without compromising the quality leaf yield of mulberry(Hanumappa HG,1986). Thus, growth and yield attributes ofmulberry and the effect of nutrient changes, if any, in the leaf on silkworm productivity and silk quality were also evaluated.

Materials and Methods

The field experiment was laid out inthe farmers field No. 30.2 at D.Perumapalayam village of Salem District and it is located at 11.71^{O} E Latitude and 78.22^{O}N Longitude at an altitude of 278 m above Mean Sea Level, during the year 2019 to 2021.The soil was black cotton type. The experiment was conducted with 12 treatment combinations (Table 1) under Randomized Block Design (RBD) with three replications.

T_0	Absolute Control without any fertilizer.
T_1	Control (100% RDF)+ Farm Yard Manure(FYM) (GM)
T_2	5 MT Poultry Manure+ 100% Recommended Dose of Fertilizer(RDF) + Green Manure *(Sesbania aculeata)*
T_3	7.50MT Poultry Manure+ 100% RDF + Green Manure
T_4	10MT Poultry Manure+ 100% RDF + Green Manure
T_5	5MT Poultry Manure+ 75% RDF + GM+ Recommended dose of Bio-Fertilizer (*Azosprillum* spp., Phospho bacteria and potash mobilizing
T_6	7.5MT Poultry Manure+ 75% RDF + GM+ Recommended dose of Bio-Fertilizer (*Azosprillum* spp., Phospho bacteria and potash mobilizing bacteria)
T_7	10 MT Poultry Manure+ 75% RDF + GM+ Recommended dose of Bio-Fertilizer (*Azosprillum* spp., Phospho bacteria and potash mobilizing bacteria)

T_8	5MT Poultry Manure+ 50% RDF + GM+ Recommended dose of Bio-Fertilizer (*Azosprillum* spp., Phospho bacteria and potash mobilizing bacteria)
T_9	7.5MT Poultry Manure+ 50% RDF + GM+ Recommended dose of Bio-Fertilizer (*Azosprillum* spp., Phospho bacteria and potash mobilizing bacteria)
T_{10}	10MT Poultry Manure+ 50% RDF + GM+ Recommended dose of Bio-Fertilizer (*Azosprillum* spp., Phospho bacteria and potash mobilizing bacteria)
T_{11}	100 % RDF + GM+ Farm Yard Manure(FYM)

(PM: Poultry Manure, RDF: Recommended Dose of Fertilizer, GM: Green Manure, BF: Bio Fertilizer, FYM: Farm Yard Manure)

Selection of plant

Five plants in each treatment were selected at random and labelled for recording observations in each of the three replications. The following characters were recorded during 45th and 65th days after pruning the crop.

Rearing parameters of plant

Number of shoots per plant, Number of leaves per shoot, Leaf area, Leaves per plant, Shoot length, Plant height, Area of leaf length, Area of leaf breadth were tested.

Larval weight

Ten mature larvae were selected randomly and weighed on fifth day of the fifth instar and the weight is expressed in grams.

Cocoon weight

After harvesting, ten cocoons from each treatment were randomly picked up and weighed individually and the average weight was calculated and expressed as gram per cocoon.

Single shell weight

The same cocoons which were collected for recording the cocoon weight were cut open and pupae were removed. Then each empty shell was weighed individually and the average weight was worked out and expressed in gram.

Shell Ratio (%)

After recording the shell weight and cocoon weight the shell percentage was determined by using the formula given below:

$$\text{Shell Ratio} = \frac{\text{Shell weight}}{\text{Cocoon weight}} \times 100$$

Renditta

Quantity of silkworm cocoons used to produce one kilogram of raw silk

$$\text{Renditta} = \frac{\text{Quantity of cocoon taken for reeling}}{\text{Silk obtained}}$$

Results

a. Effect of poultry manure on the growth and development of mulberry var. G4

i) Number of Shoot Per Plant:

The number shoots developed from each plant after pruning showed significant differences among all the treatments (Table 1). The no. of shoot per plant ranged from 6.93 in T0 to 10.80 in T7. However, the difference between plants in full dose of chemical fertilizer and that of T7 with 75% Chemical fertilizer and 10 MT poultry manure also give almost similar results indicating the possibility of replacing 25% of chemical fertilizer with 10 MT poultry manure.

ii) Number of leaf per Plant

The number of leaves per plant showed significant variation among the treatments as it ranged from 183.87 in T0 to 321.60 in T7 (Table 1). Since silkworm feeds only the leaf, the number leaf per plant plays a major role in deciding the amount of shoots to be fed to the silkworm.

iii) Leaf Area (cm^2)

The area of leaf also showed significant variations among the treatments (Table 1). The total leaf area per plant was in the range of 44874.33cm^2 in T0 to 119465.64 cm^2 in T7. Here also it could be observed that the difference between T1 and T7 is almost negligible indicating that T7 combination of fertilizers can be adopted.

iv) Plant height in cm

Plant height is an indication of the growth rate of plants and in sericulture high growth rate is a desirable character as it decides the amount of leaf available for silkworm rearing. In this experiment, the height of the plant showed significant variation indicating that fertilizer application affected the growth rate of the plant. The highest plant height was recorded in T1 (215.13 cm) which was significantly higher compared to all other treatments but at par with that of T7 (211.33cm).

Table 1: Growth and development of mulberry var. G4 as **influenced by different dosage of Poultry Manure**.

Treatment	No. of shoot per plant	No of leaf per shoot	Leaf area (cm2)	Plant height (cm)	Leaves per plant	Shoot length (cm)
T0	6.93	27.22	44874.33	179.33	183.87	147.02
T1	10.73	29.48	115550.28	215.13	316.60	179.53
T2	9.47	29.23	85911.96	203.60	278.01	168.22
T3	9.40	29.02	84378.80	205.67	267.79	168.40
T4	9.93	29.86	83027.87	206.93	287.88	168.20
T5	8.00	29.02	72757.89	199.53	233.51	161.98
T6	8.93	29.17	82227.64	201.93	262.36	167.04
T7	10.80	29.81	119465.66	211.33	321.68	172.09
T8	9.40	29.54	85938.75	198.67	273.35	160.22
T9	9.20	29.58	80462.37	202.67	262.56	168.91
T10	9.20	29.23	86704.00	205.53	267.37	165.09
T11	10.40	29.76	99777.52	210.67	300.75	171.36

b. Rearing performance of silkworm as influenced by different dosage of fertilizer and poultry manure.

The data on average larval weight (Table 2) revealed significant differences among different treatments of fertilizers. The highest larval weight was recorded in silkworms fed with leaves from the treatment T7.The weight of mature silkworm larvae varied from 31.93 gm larval weight with T0 followed by 49.67 gm by T7, this we can conclude that T7 has significantly superior over all other treatments.

Cocoon Weight

The current study revealed significant differences among different treatments. The highest cocoon weight was recorded in treatment T6 (2.14 g) followed by T5 (2.13 g). The lowest cocoon weight

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was observed in control T0 (1.52 g). However the cocoon weight revelled that there is a significant difference among all the treatments studied (Table 2).

Shell Weight

The current study revealed significant differences among different treatments. The highest Shell weight was recorded in treatment T1 (0.45 g) and it was at par with T7 (0.45 g). The lowest shell weight was observed in control T0 (0. 31 g). However the shell weight revelled that there is a significant difference among all the treatments studied (Table 2).

Shell Ratio

The highest Shell ratio was recorded in treatment T1 (21.92 %) and it was at par with T7 (21.80 %). The lowest shell ratio was observed in control T0 (13.4510 %). However the shell ratio revelled that there is a significant difference among all the treatments studied (Table 2).

Renditta

The current study revealed significant differences among different treatments with respect to Renditta. The highest Renditta was recorded in treatment T7 (5.64 kg) and it was at par with T1 (5.70 kg). The lowest Renditta was observed in control T0 (10.39 kg). However, the Renditta revelled that there is a significant difference among all the treatments studied (Table 2).

Table 2: Rearing parameters of silkworm influenced by feeding mulberry leaves harvested from different treatments of Poultry Manure.

Treatment	Larval weight (gm)	Cocoon weight (gm)	Shell weight (gm)	Shell ratio (%)	Renditta
T0	31.93	2.28	0.31	13.41	10.39
T1	48.47	2.03	0.45	21.94	5.70
T2	43.53	2.06	0.39	18.98	6.96
T3	44.40	2.08	0.40	19.40	6.41
T4	42.73	2.11	0.41	19.69	6.36
T5	42.47	2.13	0.39	18.34	6.80
T6	45.20	2.14	0.40	18.48	6.82
T7	49.67	2.04	0.45	21.80	5.64
T8	42.53	2.10	0.38	18.12	7.12
T9	42.73	2.10	0.40	19.10	6.68
T10	43.20	2.08	0.39	18.50	7.53
T11	45.40	2.10	0.38	18.26	7.06

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Discussion

It is clear from the above results that poultry manure can be used to reduce the excess use of chemical fertilizers without compromising the leaf yield and leaf quality in mulberry. It is well reported that excess instead of chemical fertilizers can have a number of effects on agricultural production as well as in sericulture and the environment. There are huge benefits of using poultry manure over chemical fertilizers(Hoover NL et al, 2019).

Organic matter: Poultry manure is a rich source of organic matter, which helps to improve soil structure and water holding capacity. It also provides essential nutrients such as nitrogen, phosphorus, and potassium(Kaur A et al, 2020).

Cost-effective: Using poultry manure can be more cost-effective than using chemical fertilizers, especially for small-scale farmers. Poultry manure can be sourced locally and is often available for free or at a lower cost than chemical fertilizers (Kaur A et al, 2020).

Environmentally friendly: Poultry manure is a natural product, so it is less likely to have negative effects on the environment. Additionally, using poultry manure reduces the need for chemical fertilizers, which can have harmful effects on the soil and water(Kaur A et al, 2020).

Apart from all the above benefits there are still few challenges of using poultry manure

Nutrient imbalances: Poultry manure can have imbalances in the nutrient composition, which can lead to over-fertilization of certain nutrients and deficiencies in others. It is important to test the manure and adjust nutrient application rates accordingly.

Pathogen risk: Poultry manure can contain pathogens that can be harmful to human health, such as E. coli and salmonella. Proper handling and storage of poultry manure is important to minimize this risk. Overall, using poultry manure can be a sustainable and cost-effective alternative to chemical fertilizers, especially for small-scale farmers. However, it is important to be aware of the potential challenges and take steps to mitigate them.

In the current study we focus on the efficacy of poultry manure with different treatment ranging from T1 to T10 in comparison with T0 (control) in rearing parameters of plant. Here we have considered the different parameters of the plant such as number of leaf per shoot, shoot length, number of shoot per plant, height of the plant, area of the leaf length, area of leaf breadth and leaves per plant. Here from the results obtained and analysed using ANOVA revelled that the Treatment T1 [Control (100% RDF) + Farm Yard Manure (FYM)], T7 [10 MT Poultry Manure+ 75% RDF + GM+ Recommended

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dose of Bio-Fertilizer (Azosprillum spp., Phospho bacteria and potash mobilizing bacteria)] and T11 [100 % RDF + GM+ Farm Yard Manure (FYM)] has higher significance when compared to others as well as T0 (Absolute Control). The above mentioned treatments has increased the quality as well, as quantity of the plant cultured and are suitable for silkworm rearing.

The another study focuses on the Rearing parameters of silkworm influenced by feeding mulberry leaves harvested from different treatments of Poultry Manure ranging from T1 to T 11 in comparison with T0 (control). Here we have considered the different parameters of the silkworms such as weights of Larval, Cocoon, Shell as well as Shell ratio and Renditta. Here from the results obtained and analysed using ANOVA revelled that the silkworms feed with the same treated mulberry plant i.e., Treatment T1 [Control (100% RDF) + Farm Yard Manure (FYM)], T7 [10 MT Poultry Manure+ 75% RDF + GM+ Recommended dose of Bio-Fertilizer (Azosprillum spp., Phospho bacteria and potash mobilizing bacteria)] and T11 [100 % RDF + GM+ Farm Yard Manure (FYM)] has higher significance when compared to others as well as T0 (Absolute Control) except cocoon weight, the cocoon weight has increased in the T6 [7.5MT Poultry Manure+ 75% RDF + GM+ Recommended dose of Bio-Fertilizer (Azosprillum spp., Phospho bacteria and potash mobilizing bacteria)] and T5 [5MT Poultry Manure+ 75% RDF + GM+ Recommended dose of Bio-Fertilizer (Azosprillum spp., Phospho bacteria and potash mobilizing].

Conclusion

Based on the findings of the study, it can be concluded that using poultry manure, along with other organic fertilizers, can lead to increased plant growth and also positively impact the growth of silkworms that feed on these plants. This suggests that organic fertilizers can be a viable alternative to chemical fertilizers, as they offer a more sustainable and environmentally-friendly approach to farming. The benefits of using poultry manure as an organic fertilizer include its rich source of organic matter, cost-effectiveness, and reduced negative impact on the environment. Although there are potential challenges such as nutrient imbalances and pathogen risk, these can be mitigated through proper handling and storage of the manure. Overall, this study supports the notion that using organic fertilizers, such as poultry manure, can have positive effects on agricultural production while also contributing to pollution control. Therefore, it is recommended that farmers and other agricultural practitioners consider the use of organic fertilizers as a means to improve soil health, reduce pollution, and promote sustainable agriculture.

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