Influence of nutrition on growth and yield of G4 mulberry variety (*Morus alba* L.) and bio-assay of multivoltine silkworm, Pure Mysore in Southern dry Zone of Karnataka, India

Abstract:

The experiment was carried out during 2019-20 at P-2 Pure Mysore Multivoltine Basic Seed Farm (BSF), National Silkworm Seed Organisation, Nagenahalli, Karnataka to know the effect of nutrient management on the growth and yield of G4 mulberry variety and its subsequent bioassay of multivoltine silkworm, Pure Mysore. The mulberry garden (three years old) with G4 variety planted in paired row system was used for the experiment with seven treatments and three replications. The growth parameters (average of 5 crops) *viz*., plant height, number of branches per plant, lowest number of leaf in 100g weight, weight of individual leaf, weight of 100 fresh leaf, leaf yield per plant and leaf yield per ha^{-1}were significantly highest (134.6 cm, 14.0, 24.0, 4.18g, 384g, 800g and 55.55 Mt) with the application of 100 % RDF, poshan spray and application of vermicompost at5 t/ha/year. The results of the bio-assay (average of five rearings) also showed the superiority forweight of 10 full grown larvae (27.2 gm), single cocoon weight (1.27g), single shell weight (0.18g), shell ratio (14.25%), ERR (95.00%) pupation (92.00%), number of cocoons/kg (787) and yield per 100 dfls (52.10 kg) in the treatment having 100 % RDF, poshan spray and application of vermicompost of at5 t/ha than other treatments. Combined application of organic and inorganic sources of nutrients increased the productivity of the mulberry in G4 variety and subsequentlybetter performance of Pure Mysore multivoltine seed cocoon parameters.

Key words: Mulberry nutrition, vermicompost, G4 mulberry variety, bio-assay of silkworm and nutrient management

Introduction:

Sericulture is an agro based industry which offers employment opportunity to about eight million people in India. Sericulture is the process of rearing silkworms for the production of silk, which is considered as a valuable and luxurious textile (Dutta et al.2023; Guo et al., 2019). Mulberry (*Morus alba* L.), the food plant of silkworm (*Bombyx mori* L.) is cultivated over 2.3 lakh hectares and exploited greatly for silkworm rearing and production of silk. It is a perennial crop and maintained continuously for about 15-20 years (Vanitha & Narayanaswamy 2019). Silk productivity and profit of the farmers mainly depends upon the quantum as well as quality of mulberry leaves produced as the former influences on rearing capacity of silkworms *i.e*., the quantum of larvae to be reared and the later plays vital role on their growth and development and silk yield (Vanitha and Narayanaswamy 2019). Therefore, regular agronomical practices *viz*.inter-cultivation, manuring, irrigation, weeding, pest and

disease management *etc*., are imperative in moriculture in order to improve the yield and quality of mulberry.

Pure Mysore, local, MSC (Mysore Seed Cocoon) are some of the synonyms of the famous polyvoltine silkworm breed of Karnataka. It has a glorious history of more than two centuries. It has been the foundation for sericulture development not only in Karnataka but also in the other Southern States. At present, more than 75% of the raw silk produced in South India is by Pure Mysore × bivoltine cross-breed combination. Hence selection of the suitable mulberry genotype and nutrition management is necessary to get good quality seed cocoons (Singh *et al* 2012).

Vermicomposting is one of the biological process in which the organic wastes are beingconverted into nutrient rich manure by the action of earthworms. The characteristic feature ofvermicompost *viz.*, high porosity withhigher moisture holding capacity, possesses antimicrobial and PGPR propertywhich enhances the growth of mulberry without diseases (Yadav & Garg, 2019). The process of vermicomposting enhances the microbial as well as soil enzyme activity which helps in degradation of waste material into stabilized humic substance. It also increases the root respiration; total organic C and total biomass C. Plants will readily uptake the nutrients from vermicompost in the form of soluble Potassium, Phosphorous, Calcium, Magnesium and other beneficial minerals (Atiyeh *et al*., 2000). The major factor contributing to plant growth is the occurrence of plant growth hormones and humic acid content in the vermicompost. The high yield and growth of the plants due to application of vermicompost increases the commercial value and agricultural sustainability (Arancon *et al*. 2006 and Ananthavalli *et al*., 2019).

Mulberry is a perennial, deciduous deep rooted fast growing and high biomass producing plant. The quality of the mulberry leaves play an important role in the nutrition of silkworm and in turn cocoon /silk production for the success of sericulture industry (Choudhury *et al*., 1991) on the other hand Kunigal multivoltine seed area is one of the highest seed cocoon producing taluk in Karnataka with about 400 seed farmersand 750 ha mulberry acreage. Mulberry variety V1is predominantly cultivated in multivoltine seed areawith an average leaf biomass potential of 60-65 MT/ hain irrigated conditions. However, majority of seed producing farmers do not know the integrated nutrient management practices for the mulberry cultivation and seed crop rearing. Most of the farmers apply only chemical fertilizers leading to continuous soil nutrient depletion under intensive cropping system (5 to 6 crops in a year) further declining in soil fertility resulting into lower crop yields.Moreover, non availability of requiredquantity of organics for application in mulberry garden,farmers do use less quantity of organic manures, thus,leading to poor health of soil and lower

leafproductivityand its quality. However, integrated organicnutrient management approach of using chemical fertilizers,organic manures, green manures and bio-fertilizersare found to maintain steady crop productivity for alonger time (Nambiar and Abrol, 1992; Anilkumarand John, 1999). G4 is recently developed high leaf biomass yielding mulberry variety introduced to multivoltineseed area (Kunigal taluk) in the year 2018 with a salient features of quick sprouting after pruning, high rooting ability (92 %), tolerant to pest and diseases, leaf yield potential of 65 MT/ha/year and respond positively to the integrated nutrition. Therefore, a study wasconducted inP-2 Multivoltine Basic Seed farm Nagenahally, Karnatakato know the response of G4 mulberry variety to the different nutrition and its subsequent bio-assay on multivoltine silkworm underirrigated situation as an alternative to V1.

Materials and Methods

Location, Soil and Climatic Conditions

The study was conducted during 2020 at Multivoltine P-2 Basic Seed Farm, Nagenahalli, Karnataka. This Basic Seed Farm (BSF) is the only prestigious Pure Mysore Silkworm Seed Farm under Central Silk Board supplies the Pure Mysore seed cocoons to the south India grainages for the production of the cross breed layings. This farm is located at an altitude of 773 metersabove MSL and has latitude and longitude of 13.0255˚ N and 77.0255˚ East. BSF, Nagenahalli is surrounded by the Gidadapalya, Taredakuppe, Manninapalya and Hebbur villages and those are highly potential villages for Pure Mysore seed cocoon production in Kunigal multivoltine seed area. Study area located 40 km away from the Tumkur, 15 km from Kunigal and 80 km away from National Silkworm Seed Organization, CSB, Bangalore. The experimental sitecomprisingof sandy loamy soil with pH 7.1, electrical conductivity 0.09 dSm^{-1}, soil organic matter 0.72%, available nitrogen (N) 162 kg ha^{-1}, available phosphorus (P2O5) 78 kg ha^{-1}, available potassium (K2O) 382 kg ha^{-1} and the bulk density in the experimental farm was optimum.The average rainfall of the study area is 750 to 900 mm. (majority of rainfall due to South-West monsoon in June–September).

Experimental Design and Treatments

Existing three year-old G4 mulberry garden withpaired row system plantation was utilized for the experiment. Experiment was conducted during 2020 in randomized block design (RBD) consisting of seven treatments withthree replications.The treatments are as follows:

T1-75 % RDF alone (263:105:105 kg NPK/ ha)

T2: 100 % RDF alone (350:140:140 kg NPK/ ha)

T3: 125 % RDF alone (438:175:175 kg NPK/ ha)

T4: T1 + Poshan spray + VC 5 ton /hectare/year

T5: T2 + Poshan spray + VC 5 ton /hectare/year

T6 : T3 + Poshan spray + VC 5 ton /hectare/year

T7 : Control (fertilizer, poshan and vermicompost all three not applied)

During June 2020, bottom pruning was adopted followed by weeding and digging as per recommended practices given by CSTRI, Mysore. The recommended dose of fertiliser and vermicompost used for the study is 350:140:140 kg NPK/ ha and at 5 t/ha respectively. During the study period five pruning's were made and five rearings were taken. After 10 days of bottom pruning vermicompost at 1t/ha/cropwas applied and properly incorporated into the soilby intercultivation followed by flood irrigation.Further, RDF was applied after 25 days of pruning followed by poshan foliar spray at 7ml/ lit as per the treatment.Vermicompost application and poshan spray remained constant for all the five crops and with respect to chemical fertilizers first and third crops were given with all recommended NPK; second, fourth and fifth crops were provided with recommended dose of nitrogenous fertilizers. Irrigation wasregularly given at an interval of once in ten daysand there were no incidence of pests and diseases in the experimental mulberry plantation. For each treatment with three replications, the experimental area consists of two paired rows of 30 meters each and each replication has 60 to 65 plants. Special care has been taken to demarcate the treatments with a paired row of mulberry with no organic and inorganic additions except for intercultivation and irrigation. After the harvest of eachcrop, next crop was planned and accordingly five crops were planned for this research programme.

Data collection and analysis:

Data on growth and yield parameters of both mulberry and silkwormswere recorded. In a replication for each treatment, five randomly selected plants were labeledforrecording mulberry growth parameters observations.For silkwormbioassay study, 300 larvae per replication weremaintained from second instar onwards and such three replicates were maintained per treatment. A disease free laying of Pure Mysore per replication was incubated under ideal conditions of temperature an relative humidity, when the laying attains eye spot stage, black boxing treatment was given to get uniform hatching. After first moult, 300 worms were kept per replication and followed the standardrearing package (Krishnaswami, 1979) for all rearings.The observations were recorded for all fivecrops on growth and development parameters of silkworm *viz*., larval weight, effective rearing rate, cocoon weight and shell weight.The dataon growth and development parameters of the mulberry as well as silkworms were averaged and statistically analyzed.

RESULTS AND DISCUSSION

Growth Attributing Characters:

The experimental resultsof the studies on the Influence of nutrition on growth and yield of G4 mulberryrevealed that the application of vermicompost at 5t/ha, 100% RDF with foliar application of poshan showed significantly higher plant height (134.6 cm), number of branches per plant (14), lowest number of leaf in 100 g weight (24), higher weight of individual leaf (4.18g), weight of 100 fresh leaf (384g), leaf yield per plant (800g) and leaf yield per hectare (55.55mt) than other treatments. However this treatment was on par with the treatment which received vermicompost at 5t/ha, 125 % RDF along with poshan foliar spray. Significantly lowest plant height (75 cm), number of branches per plant (6), higher number of leaf in 100 g weight (48), lower weight of individual leaf (1.72g), lowest weight of 100 fresh leaf (153g), leaf yield per plant (128g) and leaf yield per hectare(8.8mt) in control treatment when compared to rest of the treatment combinations (Table1).

Bioassay study:

The bio-assayof multivoltine silkworm, Pure Mysore on G4 mulberry grown under different nutrient combination treatmentsin Southern dry Zone of Karnatakawas conducted by adopting cellular rearing during 2019-2020. Experimental results on the bio-assay of the multivoltine silkworm revealed that the silkworms reared on leaves obtained by the application of vermicompost at 5t/ha/year, 100% RDF along with poshan foliar spray for each crop recorded significantly highest weight of 10 larvae (27.2g), effective rearing rate (96.00%) single cocoon weight (1.26g),single shell weight (0.19g), shell ratio (15.10%), pupation (92.50%), number of cocoons per kg weight (787) and cocoon yield per 100 dfls (52.10 kg) and it was on par with the silkworms which received the leaves produced by the application of vermicompost a 5t/ha, 125% RDF along with foliar spray of poshan (Table 2.). The silkworm bio-assay parameters were significantly lowest for weight of 10 larvae (14.1g), effective rearing rate (86.00%), single cocoon weight (0.79g), single shell weight (0.10g), shell ratio (12.75%), pupation (81%), number of cocoons per kg weight (1260) and cocoon yield per 100 dfls (26.3 kg) in the treatment which received nil application of organic and in organic amendments.

In the present study, the increased growth and yieldparameters in respect of G4 mulberry was obtained in the treatment with application of 100% RDF, vermicompost at 5t/haalong with poshan foliar spray at 7ml/lit and this was due to supplementation of all nutrients in right proportion.The application of vermicompost to mulberry will enhance the soil fertility physically, chemically and biologically. Vermicompost improves the aeration, porosity, bulk density, PH, EC and organic matter content in the soil which in turn promotes better growth which ultimately increases the quality and quantity of the mulberry leaf (Das *et al*., 2002) (Gururaj, 2005). Further, poshan is a multi-nutrient liquid fertilizer contains all the

essential micro and secondary nutrients required for the mulberry growth and development. Since poshan is applied to the leaf surface and nutrients absorption is very high by the plant. Poshan helps to boost the leaf yield to the tune of 20% and thereby rearing capacity of farmers will get enhanced. Vermicompost rich source of micro, secondary and macronutrients apart from it contains beneficial microbes which help in transformation of nutrients into plant available form. Vermicompost also contain anti microbial property which protect the plants from pathogens and provide resistance to plants. Vermicompost contain plant growth promoting substances (PGPRs), which promote plant growth. The G4 mulberry which received balanced application of nutrients through different sources put up healthy profuse growth along with higher biomass with quality foliage. The silkworms which have been reared on nutrient rich quality leaves tend to put up with more weight with better survival parameters. Consequently, therewasincreasedlarval and cocoon weights; seed cocoon yield with better survival parameters *viz.*,effective rearing rate, pupationand moth emergence and this will help the farmer to get good marketable uniform sized cocoons (Technology Deccriptor, CSRTI-Mysore, 2016).Hence application of the recommended dose of fertilizers to the soil along with foliar spray of poshan and vermicompost is blend of eco-friendly and chemical approach. This combination will supply all the essential nutrients, PGPRs and beneficial microbes to the soil, which enhances the soil fertility and increases leaf yield to the tune of 20 per cent with higher cocoon yield when compare with RDF application alone (Deepa *et al*., 2006)**.**

Conclusion:

This study reveals the importance of organic manures and inorganicfertilizers for mulberry growth, yield and cocoon quality. From the Analysis of data and results, it may be concluded that application of 100% RDF along with vermicompost at5t/ha and poshan foliar spray at 7ml/l showed significantly higher performance on growth attributing characters of mulberry *viz*., plant height, number of branches/plant and number of leaves/shoot, leaf weight and ultimately leaf yield. Further, the quality of the leaf was superior in the treatment with the application of 100% RDF along with poshan and vermicompost at5t/hawhich was evidenced by better rearing parameters *viz.*,higher ERR and pupation coupled with better cocoon parameters leading to the production of quality multivoltine seed cocoons in the Basic Seed Fram Nagenahalli. Therefore, the treatment T5 (100% RDF + Poshan spray + vermicompost at5T ha^{-1}) could be useful for realizing maximum productivity in mulberry as an efficient nutrient management strategy and recommended for adoption by the multivoltine sericulture farmers of Kunigal and Magadi Pure Mysore seed areas of Karnataka in sandy loamy soils. The results obtained are in line with the earlier findings of (Das *et al.*, 1994 and

Setua *et al*., 2005) that application of 100% RDF along with poshan application and vermicompost at5t/hec effective in maintaining the soil health, supply of balanced nutrients, yield and quality of G4 mulberry leaf and seed cocoon of Pure Mysore multivoltine silkworm as well.

COMPETING INTERESTS:

Authors have declared that they have no known competing financial interests OR non-financial interests OR personal relationships that could have appeared to influence the work reported in this paper.

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Table 1. Growth parameters and leaf yield (Average of 5 prunings)of G4 Mulberry variety as influenced by graded nutrition

Treatments	Plant height (cm)	Number of branches /plant	Number of leaf in 100 g	Weight of individual leaf (g)	Weight of 100 fresh leaf (g)	Leaf yield per plant (g)	Leaf yield per ha/Year (MT)
T1-75 % RDF alone	123.3	10.0	34.0	2.93	290	347	24.09
T2-100 % RDF alone	128.4	11.0	30.0	3.30	326	520	36.10
T3-125 % RDF alone	130.3	12.0	30.0	3.50	328	539	37.42
T4-T1 + Poshan spray + VC 2.5 ton /hectare	128.1	12.0	32.0	3.12	300	456	31.66
T5-T2 + Poshan spray + VC 2.5 ton /hectare	134.6	14.0	24.0	4.18	384	800	55.55
T6-T3 + Poshan spray + VC 2.5 ton /hectare	134.8	13.5	24.0	4.16	382	780	54.16
T7-Control	75.0	6.0	48.0	1.72	153	128	8.80
S Em ±	**2.23**	**1.09**	**0.87**	**0.11**	**8.73**	**22.61**	**2.18**
C D (P=0.05)	**6.87**	**3.36**	**2.69**	**0.34**	**26.90**	**69.66**	**6.72**

Control: No fertilizers applied, RDF: Recommended Dose of Fertilizers VC: Vermicompost

Table 2. Bio-assay (Average of 5 Rearings)of G4 mulberry variety on Pure Mysore multivoltine silkworm under graded nutrition

Treatments	Larval duration (days)	Weight of 10 matured larvae (g)	Weight of single cocoon (g)	Weight of single shell (g)	Shell ratio (%)	Pupation (%)	Number of cocoons per kg	Yield per 100 dfl (kg)
T1-75 % RDF alone	29	23.2	0.92	0.12	12.50	88	1086	38.5
T2-100 % RDF alone	29	24.4	1.16	0.16	13.62	89	862	41.3
T3-125 % RDF alone	29	25.3	1.15	0.16	13.82	89	869	42.3
T4-T1 + Poshan spray + VC 2.5 ton /hectare	29	25.1	1.13	0.14	12.65	90	885	39.2
T5-T2 + Poshan spray + VC 2.5 ton /hectare	29	27.2	1.27	0.18	14.25	92	787	52.1
T6-T3 + Poshan spray + VC 2.5 ton /hectare	29	27.1	1.25	0.18	14.00	92	800	51.4
T7-Control	30	14.1	0.72	0.09	11.80	75	1200	26.3
S Em ±	**0.44**	**0.44**	**0.02**	**0.005**	**0.44**	**1.35**	**21.82**	**0.79**
C D (P=0.05)	**NS**	**1.34**	**0.07**	**0.01**	**1.34**	**4.16**	**67.24**	**2.46**

Control: No fertilizers applied, RDF: Recommended Dose of Fertilizers, VC: Vermicompost