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Effect of Nano Nitrogen Foliar Spray to Tree Mulberry on Growth and Cocoon Productivity of Mulberry Silkworm (*Bombyx mori* L.)

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ABSTRACT: A field experiment was conducted during 2020-21 on established Victory-1 (V-1) tree mulberry garden at Krishi Vigyan Kendra, Hassan situated in the Southern Transition Zone (Zone-7) of Karnataka to study the influence of nano nitrogen foliar application to tree mulberry on silkworm growth and cocoon productivity. The experiment was laid out in RCBD, comprising seven treatments replicated thrice. The results revealed that, significantly shorter 5th instar duration (7.29 days), higher 5th instar larval weight (54.69 g/10 larvae), ERR (97.33%), cocoon yield by number (9666.67 per 10,000 worms), cocoon yield by weight (25.15 kg per 10,000 worms), single cocoon weight (2.58 g), single cocoon shell weight (0.58 g), single pupal weight (2.00 g), cocoon shell ratio (22.55 %), longest filament length (1435.44 m) and filament weight (0.51 g) were observed from the silkworm batches fed with leaves harvested from the plot provided with 4 ml L^{-1} nano nitrogen foliar application on 25th and 35th day after pruning with soil application of 60 per cent N, 100 per cent P and K with recommended FYM (T_3). The research is conducted as a part of my Master's degree, so I am not able to conduct the research on all verities of mulberry and strains of silkworms. By spraying nano nitrogen will improves the yield substantially, through production of higher leaf yield and harvesting of good quality cocoons.

Keywords: Nano nitrogen, foliar spray, tree mulberry, silkworm, feeding.

INTRODUCTION

Mulberry (*Morus* spp.) being fast-growing deciduous perennial woody plant possesses deep rooting nature and grows under temperate to tropical climatic conditions. Mulberry is the sole food plant of silkworm, *Bombyx mori* L. Being monophagous, the silkworm requires specific quality of leaves during different phases of its growth and thus it reflects the importance of mulberry cultivation practices.

Presently, mulberry is being cultivated in heterogeneous agro-climatic conditions following diverse cultivation methods and practices as a low bush with a comparatively closer spacing of 2' x 6' to 3' x 3' in plains of Southern and Western parts of India. In hilly areas of Jammu and Kashmir, depending on soil topography, it is being cultivated as a large/medium tree with the spacing of 5' × 5' to 10' × 10'. However, when the mulberry plant is allowed to grow tall with a crown height of 4'-5' from the ground level having stem girth of 4 to 5 inches, it is referred as tree mulberry. They will be specially raised from well grown saplings of 8-10 months old of any variety recommended for rainfed areas (S-13 or S-34) and irrigated areas (V-1). These plants were pruned once in a year (July–August) at a height of 4'-5' from ground level and allowed to grow with 8-10 shoots at the crown. The leaf is harvested four to five times in a year. In recent years, the concept of tree mulberry cultivation is diffusing into plain area as it is comparatively advantageous over bush plantation for sustainable foliage production and hassle-free cultural operations (Das, 2010).

The mulberry silkworm being monophagous insect, takes all the nutrients required for its growth and development from the mulberry leaf, nearly 70 per cent of silk protein produced by silkworm is derived directly from proteins of mulberry leaves. Leaf quality and

quantity not only influence the silkworm growth and development but, reflects cocoon production and quality of raw silk. The soil fertility and its management affect the quality and quantity of mulberry foliage production. Periodical application of FYM and fertilizer plays a major role in quality of leaves and each essential nutrient has certain specific role to play in the plant. Therefore, application of different levels of both soil and foliar fertilizers is known to influence the nutritional status of the mulberry leaves for better performance of mulberry silkworm.

Nitrogen is one of the major nutrients in maintaining the quality of mulberry leaves and silkworm nutrition. Nitrogen is an integral component of amino acids, proteins, nucleic acids, enzymes and chlorophyll molecules that in turn helps in the photosynthesis. It is a primary building block for plant protoplasm and is vitally associated with the cellular activity. Nitrogen is also essential nutrient that normally produces greatest yield responses in crop plants, promoting rapid vegetative growth and development as well as the uptake of other nutrients. In mulberry, vegetative part is the main component, it encourages the aerial vegetative growth and imparts deep green colour to the leaves and also succulence. Thus, nitrogen is one of the key nutrients in cultivation of mulberry and to provide nutrition to silkworm.

Predominantly urea is used as the preferred N-fertilizer for crop due to presence of more nitrogen concentration *i.e.,* 46 per cent as well as lesser rate per unit nitrogen in comparison to other nitrogenous fertilizers. Despite its highest use, low use efficiency of urea is the greatest problem. At least half of the applied N- fertilizer is lost through water, air and other processes, resulting in negative environmental impacts such as leaching of nitrates into the ecosystem and the release of N oxides into the atmosphere (Johnson and Raun 2003).

Nanotechnology, specially the gold and others green nanotechnology develops with the help of atomic, molecular, and macromolecular interactions (Bhagavanth Reddy *et al*., 2015; Bhau *et al.,* 2015). In the present century, research activities with nanomaterials have dramatically increased (Patra et al. 2015). Most nanomaterials are shaped through nano-technological phenomenon that provides a possible role in the industry (Bhattacharyya and Debnath 2008; Bhattacharyya *et al*., 2011; Bhattacharyya *et al.,* 2012; Eldridge 2014; Bhattacharyya *et al.,* 2015). Nano particles are of many sizes and shapes few of them are Gold, DNA-tagged, mesoporous, buckeyballs, dendrimers, nanoshells, nanotubes and quantum dots etc. (Elia *et al.,* 2014). Engineered nanoparticles are being used in several areas like, drug delivery processes, imaging, photothermal ablation of tumours, radiation sensitizers, detection of apoptosis etc. (Zhenge *et al.,* 2012). Now a days, nano fertilizers are aimed to make nutrients more available to leaves, consequently increasing nutrient use efficiency. Regarding nano technology among N fertilizers, helps to release N when crops need it, eventually increases N efficiency by reducing N leaching, emissions and long-term incorporation by soil microorganisms. These nanoparticles can be used as fertilizer for efficient nutrient management and being more eco-friendly it reduces the environmental pollution. From plants perspective it increases rate of photosynthesis, dry matter and yield of the crop. It also prevents plant from different biotic and abiotic stress (Meena *et al.,* 2017).

By keeping above aspects and importance of nano fertilizers in view, the present investigation entitled "Effect of nano nitrogen foliar spray to tree mulberry on growth and cocoon productivity of mulberry silkworm (*Bombyx mori* L.)" was carried out.

MATERIAL AND METHODS

The experiment was conducted at Krishi Vigyan Kendra, Hassan in established Victory-1 (V-1) tree mulberry garden geographically located in Southern Transition Zone (Zone-7) of Karnataka state during 2020-21. The tree mulberry variety used in the study was Victory-1 (V-1) cultivated under irrigated conditions with wider spacing 10'×10' (between rows and plants). The commercial double-cross bivoltine hybrid FC_1 × FC_2 was used for the study. The experiment was laid in a completely randomized block design with 7 treatments with 3 replications each *viz.*,T_1:Control (RDF), T_2:100 % PK + 80 % N (RDF) soil application + nano N foliar spray @ 4 mL L^{-1}, T_3:100 % PK + 60 % N (RDF) soil application + nano N foliar spray @ 4 mL L^{-1}, T_4:100 % PK + 40 % N (RDF) soil application + nano N foliar spray @ 4 mL L^{-1}, T_5:100 % PK + 80 % N (RDF) soil application + Urea foliar spray @ 2%, T_6:100 % PK + 60 % N (RDF) soil application + Urea foliar spray @ 2% and T_7:100 % PK + 40 % N (RDF) soil application + Urea foliar spray @ 2%. RDF: Recommended dose of fertilizers (RDF) for tree mulberry is 350:140:140 kg of N: P_2O_5: K_2O kg ha^{-1} $year^{-1}$ and RD FYM is 20 tons ha^{-1} $year^{-1}$. Two sprays of nano nitrogen and urea done at 25th and 35th day after pruning.

Package of practices was followed as per the recommended standards. The chawki worms were reared by feeding tender leaves whereas the late age silkworms were reared in shelf reared seperatively as per treatments by feeding three times a day with chopped tender mulberry leaves of Victory-1 (V-1) tree mulberry variety raised under different treatments. During rearing optimum spacing was provided according to the age of worms. Lime powder and bed disinfectant were dusted on silkworms before settling for each moult to keep the bed dry and facilitate easy moulting. The ripe worms were hand-picked from each treatment and replications were mounted separately and distributed uniformly on the plastic collapsible mountages. Later on, the cocoons were harvested manually on the fifth day of mounting.

Silkworm growth and cocoon parameters *viz.,* larval instar duration (3rd, 4th and 5th instar duration in days), larval weight (3rd, 4th and 5th instar larval weight in grams), effective rate of rearing (ERR%), cocoon yield by number (No. per 10000 worms), cocoon yield by weight (kg per 10000 worms), cocoon weight (g), shell weight (g), pupal weight (g), shell ratio (%), single cocoon filament length (m), filament weight (g) and

filament denier were recorded treatment-wise as per the standard procedure and analysed statistically.

RESULTS AND DISCUSSION

Effect of nano nitrogen foliar spray to tree mulberry on rearing parameters of mulberry silkworm ($FC_1 \times FC_2$)

Larval duration (days). There was no significant difference in IIIrd instar larval duration noticed due to foliar application of nano nitrogen on tree mulberry. However, the shortest III$^{rd.}$ instar duration of 3.80 days was recorded in treatment T_3 (100 % PK + 60 % N (RDF) soil application + nano N foliar spray at 4 ml L^{-1}) followed by T_2 (3.81 days). The longest III$^{rd.}$ instar larval duration of 3.98 days was recorded in T_7.

There was no significant difference in IV$^{th.}$ instar larval duration due to foliar application of nano nitrogen on tree mulberry. However, the shortest IVth instar duration of 4.42 days was recorded in treatmentsT_2 and T_3, followed by T_5 (4.46 days). The longest IVth instar larval duration of 4.55 days was recorded in T_7.

The application of nano nitrogen foliar spray on tree mulberry altered the Vth instar larval duration significantly. The shortest Vth instar duration of 7.29 days was recorded in batches of silkworm fed on leaves harvested from T_3 (100 % PK + 60 % N (RDF) soil application + nano N foliar spray at 4 ml L^{-1}) followed by T_2 (7.40 days). The treatment T_7showed longest Vth instar larval duration of 7.81 days.

Larval weight (g). There was no significant difference in IIIrd and IVth instar larval weight noticed due to foliar application of nano nitrogen on tree mulberry. However, the higher larval weight of IIIrd and IVth instar (1.53 and 8.11 g per 10 larvae, respectively) was recorded in treatment T_3:100 % PK + 60 % N (RDF) soil application + nano N foliar spray at 4 ml L^{-1}, followed by T_2 (1.47 and 7.86 g per 10 larvae, respectively) and T_5 (1.45 and 7.64 g per 10 larvae, respectively). The lowest larval weight of IIIrd and IVth instar (1.38 and 7.25 g per 10 larvae, respectively) was recorded in T_7.

The grown-up larval weight was recorded on Vth day of Vth instar. Significantly higher larval weight (54.69 g per 10 larvae) was recorded when silkworms were fed with mulberry leaves treated with 100 % PK + 60 % N (RDF) soil application + nano N foliar spray at 4 ml L^{-1} (T_3) followed by T_2 (50.12 g per 10 larvae), T_4 (48.01 g per 10 larvae) and T_5 (46.99 g per 10 larvae). Significantly lowest larval weight was recorded in batches of silkworm fed on leaves from treatment T_7 (40.11 g per 10 larvae).

The results of current study are supported by Sannappa *et al*. (2022), Results indicated that treatment with CAN recorded the significantly highest mature larval weight (44.52 g/10 larvae), followed by treatment with urea (43.97 g/10 larvae,) and were lowest in the control (39.38 g/10 larvae,).

Effective rate of rearing (ERR %). Significant difference was observed among the treatments with respect to ERR percentage. Significantly maximum ERR (97.33%) was recorded in batches of silkworm fed on leaves harvested from treatment T_3 (100 % PK + 60 % N (RDF) soil application + nano N foliar spray at 4 ml L^{-1}) which was on par with that reared on leaves from T_2 (95.68 %), T_4 (94.33 %) and T_5 (03.56%). The lowest ERR (87.67 %) was observed in batches of silkworms reared on leaves from T_7.

The results of current study are supported by Sannappa *et al*. (2022), Results showed that treatment with CAN recorded the significantly highest effective rate or rearing (ERR) (93.38 followed by treatment with urea (92.59%) and were lowest in the control (87.35%)

Cocoon yield by number (numbers per 10000 worms). Significant differences in the cocoon yield by number of $FC_1 \times FC_2$ hybrid was evident with mulberry leaves raised through foliar application of nano nitrogen. Significantly a greater number of cocoons (9666.67 No. per 10000 worms) was recorded from T_3:100 % PK + 60 % N (RDF) soil application + nano N foliar spray at 4 ml L^{-1} which was on par with treatments T_2, T_4 and T_5 which recorded 9400, 9366.67 and 9333.33 No. per 10000worms, respectively. While, minimum cocoon number (8633.33 No. per 10000 worms) was recorded in T_7.

Cocoon yield by weight (Kg per 10000 worms). Significant influence was exerted on cocoon weight by feeding silk worms on tree mulberry leaves obtained through foliar application of nano nitrogen. The highest cocoon yield by weight (25.15 kg per 10000 worms) was recorded from T_3:100 % PK + 60 % N (RDF) soil application + nano N foliar spray at 4 ml L^{-1} which was on par with T_2 (23.87 kg per 10000 worms). Whereas, minimum cocoon weight (18.78 kg per 10000 worms) was recorded in T_7.

Silkworms fed with tree mulberry leaves obtained by foliar application of nano nitrogen were greatly influenced with respect of rearing performance as well as cocoon productivity, which in turn had stimulated the metabolic activities in silkworm thus fulfilling the requirement of nutrients both qualitatively and quantitatively. This could be due to foliar application of nano nitrogen which enhanced the leaf quality, succulency, protein content and absorption of essential mineral form the soil, which apparently stimulated the metabolic actives of silkworm.

The nutritive feed especially with nitrogen would act as a stimulant for rapid growth of silkworm. Similar findings were noticed by Mancha Shetty (1979) who found that, foliar application of 0.5 per cent urea increased the larval weight. Mahmood *et al*. (2002) recorded better larval weight and length after feeding with nitrogen supplemented mulberry leaves. Maqbool (1991) reported that, feeding mulberry leaves treated with nitrogen increased the growth and development of silkworm. Zaman (1995) noticed that, silkworms fed on mulberry leaves treated with 0.2 per cent nitrogen + magnesium 0.15 per cent, consumed more food and having significantly highest larval weights compared to other treatments. Rasool (1995) concluded that, silkworm fed with mulberry leaves treated with 0.2 per cent nitrogen and 0.15 per cent manganese increased food consumption and significant increase in larval weight. Ashfaq *et al.* (1998) reported that, silkworms fed with mulberry leaves treated with 0.2 per cent

nitrogen and 0.05 per cent copper significantly improved larval weight. Etebari *et al*. (2007) recorded significant improvement in the larval parameters when silkworms were fed with mulberry leaves treated with 0.1 per cent nitrogen over other treatments.

Prabu *et al*. (2011); Patil *et al.* (2016) reported that, silkworms fed with mulberry leaves sprayed with nano-particles showed significantly highest larval weight. Nano particles which improve the feed efficiency of silkworms, might have stimulated the metabolic activity in silkworms leading to improved rearing performance, cocoon quality and reeling parameters. According to Nithya (2017), adequate supply of zinc nano particles accelerates the larval parameters of silkworm, *B. mori*. Pramila *et al*. (2019) reported that, nano micronutrients stimulated the metabolic activities in silkworm resulting in better growth and development.

Effect of nano nitrogen foliar spray to tree mulberry on cocoon parameters of mulberry silkworm (FC_1 × FC_2)

Cocoon weight (g). Significant influence was exerted on single cocoon weight when silkworms were reared on tree mulberry leaves treated with foliar application of nano nitrogen. The single cocoon weight was significantly more (2.58 g) in the batch of worms reared on leaves from T_3 (100 % PK + 60 % N (RDF) soil application + nano N foliar spray at 4 ml L^{-1}) followed by T_2, T_4 and T_5 which recorded the single cocoon weights of 2.35, 2.30 and 2.26 g, respectively. Whereas, minimum single cocoon weight of 2.03 g has recorded in batches of cocoons spun by worms fed on leaves of treatment T_7.

Cocoon shell weight (g). The weight of single cocoon shell spun by double crossed hybrid silkworm FC_1 × FC_2 significantly varied among different treatments. Silkworm fed on tree mulberry leaves raised by T_3: 100 % PK + 60 % N (RDF) soil application + nano N foliar spray at 4 ml L^{-1} exhibited significantly higher shell weight of 0.58 g followed by T_2, T_4 and T_5 which recorded 0.52, 0.50 and 0.49 g, respectively. On the other hand, the batches of cocoons harvested from the treatment T_7 registered the lowest cocoon shell weight of 0.40 g.

Pupal weight (g). Significantly higher single pupal weight was recorded for the cocoons spun by double hybrid silkworm FC_1 × FC_2 in (2.00 g) in batches of cocoons harvested from treatment T_3: 100 % PK + 60 % N (RDF) soil application + nano N foliar spray at 4 ml L^{-1} which was on par with treatment T_2 (1.84 g). While, the minimum pupal weight (1.61 g) was exhibited in batches of cocoons harvested from the treatment T_7.

Shell ratio (%). Significant difference in shell ratio of FC_1 × FC_2 double hybrid was evident with mulberry leaves raised through foliar application of nano nitrogen. Significantly higher shell ratio (22.55 %) was recorded in the cocoons harvested from batches of silkworm fed on leaves obtained by the application of 100 % PK + 60 % N (RDF) soil application + nano N foliar spray @ 4 ml L^{-1} (T_3) and was statistically on par with the treatment T_2 (22.08 %). The per cent cocoon shell ratio was least in batches of cocoons obtained from the treatment T_7 (19.93 %).

Filament length (m). There was a significant difference among the treatments with respect to filament length with the foliar application of nano nitrogen to tree mulberry. Significantly longest filament length (1435.44 m) was recorded in the cocoons harvested from T_3: 100 % PK + 60 % N (RDF) soil application + nano N foliar spray @ 4 ml L^{-1} followed by T_4 (1359.75 m) and T_2 (1327.74 m). Significantly shorter (1184.30 m) filament length was recorded in batches of cocoons obtained from treatment T_7.

Filament weight (g). Significantly higher filament weight of 0.51 g was recorded in the cocoons spun by the silkworms fed on leaves harvested from treatment T_3 (100 % PK + 60 % N (RDF) soil application + nano N foliar spray at 4 ml L^{-1}) followed by T_4 (0.46 g) and T_2 (0.45 g). Significantly lowest filament weight0.40 g was recorded in batches of cocoons obtained from treatment T_7.

Filament denier. The filament denier was non-significant among the different treatments. However, denier recorded was in the order of T_3 (3.20) and T_1 (3.09) and it was lowest in the treatment T_4 (3.04) and T_7 (3.04) which indicated that the denier is not altered with varied treatments.

The increased economic parameters of cocoon and filament were attributed to the increased nutrient content in mulberry and intern-increased metabolic activity in silkworm. The foliar application of nano nitrogen enhanced the leaf quality, succulency, protein content and absorption of essential mineral form the soil, which apparently stimulated the better larval growth and development with qualitatively enriched leaves of mulberry which intern enhanced the larvae to spun good quality cocoons with highest cocoon weight, cocoon shell weight, pupal weight, shell ratio, filament length and weight.

Present study is in agreement with the result of Mancha Shetty (1979) who found that, foliar application of 0.5 per cent urea increased the number of cocoons, weight of cocoons, weight of shells, weight of pupae, filament length and weight of silk filament. Mahmood *et al*. (2002) recorded better cocoon and reeling parameters when silkworms were fed with nitrogen supplemented mulberry leaves. Maqbool (1991) reported that, feeding mulberry leaves treated with nitrogen significantly increased the quality of cocoons, filament length and weight of silk filament. Cocoon and reeling parameters of silkworms fed with 0.2 per cent nitrogen treated mulberry leaves increased significantly compared to untreated leaves (Zaman, 1995; Rasool, 1995; Ashfaq *et al*., 1998). Etebari *et al*. (2007) recorded significant improvement in the cocoon traits and filament length, when silkworms were fed with mulberry leaves treated with 0.1 per cent nitrogen, compared to other treatments.

Prabu *et al.* (2011); Patil *et al.* (2016) reported that, silkworms fed with mulberry leaves sprayed with nano-particles showed significantly highest cocoon weight, shell weight, filament length and filament weight. According to Nithya (2017) adequate supply of nano

zinc particles which was applied through foliar spray, accelerated the activity of enzymes and auxin metabolism in the plants, improved the larval and cocoon parameters, thereby increased reeling parameters of silkworms. Similarly, Pramila *et al.* (2019) reported that, nano micronutrients have stimulated the metabolic activities in silkworm resulting in better growth and development of silkworm, resulting in good quality cocoons and silk production.

Table 1: Rearing parameters of mulberry silkworm (FC_1× FC_2) as influenced by feeding leaves from tree mulberry sprayed with nano nitrogen.

Treatments	Larval duration (days)			Larval weight (g/10 larvae)		
	IIIrd Instar	IVth Instar	Vth Instar	IIIrd Instar	IVth Instar	Vth Instar
T_1: Control (RDF)	3.91	4.48	7.58	1.42	7.50	44.26
T_2: 100 % PK + 80 % N (RDF) soil application + nano N foliar spray @ 4 ml L^{-1}	3.81	4.42	7.40	1.47	7.86	50.12
T_3: 100 % PK + 60 % N (RDF) soil application + nano N foliar spray @ 4 ml L^{-1}	3.80	4.42	7.29	1.53	8.11	54.69
T_4: 100 % PK + 40 % N (RDF) soil application + nano N foliar spray @ 4 ml L^{-1}	3.89	4.48	7.49	1.44	7.58	48.01
T_5: 100 % PK + 80 % N (RDF) soil application + Urea foliar spray @ 2%	3.87	4.46	7.50	1.45	7.64	46.99
T_6: 100 % PK + 60 % N (RDF) soil application + Urea foliar spray @ 2%	3.93	4.51	7.64	1.41	7.46	43.10
T_7: 100 % PK + 40 % N (RDF) soil application + Urea foliar spray @ 2%	3.98	4.55	7.81	1.38	7.25	40.11
F- Test	NS	NS	*	NS	NS	*
S. Em ±	0.12	0.13	0.07	0.04	0.23	1.16
CD @ 5 %			0.20			3.57
CV %	5.16	5.15	1.50	5.13	5.13	5.12

Note: Two foliar sprays of nano nitrogen and urea done at 25th and 35th days after pruning; * Significant at 5 %; NS: Non-significant

Table 2: Influence of nano nitrogen foliar spray to tree mulberry on ERR, cocoon number and weight in mulberry silkworm (FC_1× FC_2).

Treatments	ERR (%)	Cocoon yield by number (No./10000 worms)	Cocoon yield by weight (kg/10000 worms)
T_1: Control (RDF)	91.67	9033.33	21.77
T_2: 100 % PK + 80 % N (RDF) soil application + nano N foliar spray @ 4 ml L^{-1}	95.68	9400.00	23.87
T_3: 100 % PK + 60 % N (RDF) soil application + nano N foliar spray @ 4 ml L^{-1}	97.33	9666.67	25.15
T_4: 100 % PK + 40 % N (RDF) soil application + nano N foliar spray @ 4 ml L^{-1}	94.33	9366.67	22.60
T_5: 100 % PK + 80 % N (RDF) soil application + Urea foliar spray @ 2%	93.56	9333.33	22.31
T_6: 100 % PK + 60 % N (RDF) soil application + Urea foliar spray @ 2%	90.44	8966.67	20.03
T_7: 100 % PK + 40 % N (RDF) soil application + Urea foliar spray @ 2%	87.67	8633.33	18.78
F- Test	*	*	*
S. Em ±	1.43	112.33	0.72
CD @ 5 %	4.40	346.14	2.22
CV %	2.66	2.11	5.66

Note: Two foliar sprays of nano nitrogen and urea done at 25th and 35th days after pruning; * Significant at 5 %

Table 3: Cocoon parameters of mulberry silkworm (FC_1× FC_2) as influenced by feeding leaves from tree mulberry sprayed with nano nitrogen.

Treatments	Cocoon weight (g)	Cocoon shell weight (g)	Pupal weight (g)	Cocoon shell ratio (%)
T_1: Control (RDF)	2.19	0.45	1.74	20.42
T_2: 100 % PK + 80 % N (RDF) soil application + nano N foliar spray @ 4 ml L^{-1}	2.35	0.52	1.84	22.08
T_3: 100 % PK + 60 % N (RDF) soil application + nano N foliar spray @ 4 ml L^{-1}	2.58	0.58	2.00	22.55
T_4: 100 % PK + 40 % N (RDF) soil application + nano N foliar spray @ 4 ml L^{-1}	2.30	0.50	1.80	21.66
T_5: 100 % PK + 80 % N (RDF) soil application + Urea foliar spray @ 2%	2.26	0.49	1.77	21.65
T_6: 100 % PK + 60 % N (RDF) soil application + Urea foliar spray @ 2%	2.17	0.45	1.72	20.57
T_7: 100 % PK + 40 % N (RDF) soil application + Urea foliar spray @ 2%	2.03	0.40	1.61	19.93
F- Test	*	*	*	*
S. Em ±	0.07	0.01	0.05	0.24
CD @ 5 %	0.21	0.03	0.16	0.74
CV %	5.12	3.98	5.13	1.95

Note: Two foliar sprays of nano nitrogen and urea done at 25th and 35th days after pruning; * Significant at 5 %

Table 4: Reeling parameters of mulberry silkworm (FC_1× FC_2) as influenced by feeding leaves from tree mulberry sprayed with nano nitrogen.

Treatments	Filament length (m)	Filament weight (g)	Filament denier
T_1: Control (RDF)	1253.45	0.43	3.09
T_2: 100 % PK + 80 % N (RDF) soil application + nano N foliar spray @ 4 ml L^{-1}	1327.74	0.45	3.05
T_3: 100 % PK + 60 % N (RDF) soil application + nano N foliar spray @ 4 ml L^{-1}	1435.44	0.51	3.20
T_4: 100 % PK + 40 % N (RDF) soil application + nano N foliar spray @ 4 ml L^{-1}	1359.75	0.46	3.04
T_5: 100 % PK + 80 % N (RDF) soil application + Urea foliar spray @ 2%	1297.25	0.44	3.05
T_6: 100 % PK + 60 % N (RDF) soil application + Urea foliar spray @ 2%	1236.06	0.42	3.06
T_7: 100 % PK + 40 % N (RDF) soil application + Urea foliar spray @ 2%	1184.30	0.40	3.04
F- Test	*	*	NS
S. Em ±	23.19	0.01	0.05
CD @ 5 %	71.46	0.04	
CV %	3.09	5.12	3.02

Note: Two foliar sprays of nano nitrogen and urea done at 25th and 35th days after pruning; * Significant at 5 %, NS: Non-significant

CONCLUSIONS

It can be concluded that with the foliar application of nano nitrogen to tree mulberry. Among all treatments T_3: 100 % PK + 60 % N (RDF) soil application + nano N foliar spray @ 4 ml L^{-1} showing the better results compare to all others, with regards to larval duration, larval weight, ERR, cocoon number and weight, Cocoon parameter and Reeling parameters of mulberry silkworm hence following T_3: 100 % PK + 60 % N (RDF) soil application + nano N foliar spray @ 4 ml L^{-1} in cultivation of mulberry is optimum.

FUTURE SCOPE

In the future it can focus on similar works on macro, micro nutrient, other major nutrients and with all verities of mulberry is essential.

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Conflict of Interest. None.

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