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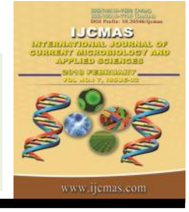

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Influence of Different Pruning Techniques and Integrated Nutrient Management on Growth, Leaf Yield of Mulberry and its Impact on Silkworm (*Bombyx mori* L.) Bioassay

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A B S T R A C T

Field experiments were carried out during *Kharif* and *Rabi* seasons of two years at the Department of Sericulture, Tamil Nadu Agricultural University, Coimbatore to study the influence of different pruning heights in mulberry and integrated nutrient management (INM) practices on growth, leaf and cocoon productivity as well as profitability in mulberry. The experiments were laid out in a strip plot design with three main plot treatments and six sub plot treatments replicated thrice. The results revealed that middle pruning (90 cm height) technique had positive impact on mulberry growth parameters such as less intermodal length with significantly high shoot length, number of branches per plant during both *kharif* and *rabi* seasons of the respective years. Further, the yield attributes *viz.*, leaf dry weight, 100 leaves weight, leaf yield per plant and leaf yield/ha/harvest were also significantly higher in middle pruning technique. Among the integrated nutrient management practices, 50% organic + 50% inorganic fertilizers (M_2) application showed significantly better mulberry growth and yield parameters. The same treatment contributed significantly higher silkworm economical parameters *viz.*, larval weight, cocoon weight, shell weight, shell ratio and ERR per cent in both the seasons. The mean economics of mulberry leaves production and silkworm cocoon production were enhanced with higher B: C ratio of 2.76, 2.16 in mulberry and 2.70, 2.06 in silkworm, respectively, during *kharif* and *rabi.*

Introduction

Mulberry leaf is the sole food material and its nutrition is necessary for growth regulating factors in silkworm, *Bombyx mori* L. Silkworm derives proteins directly from the mulberry leaves for producing nearly 70 per cent of silk. Hence, the mulberry leaves should be produced in abundant quantity with good quality and reasonable cost of production. Unpruned mulberry plant was found to produce less quantity of leaves with poor quality. Periodic pruning is important to maintain vigorous young shoots and foliage with proper nutrients. In irrigated condition, where intensive cultivation is carried out, it is necessary to prune the plants to maintain their peak production. The leaf yield varied with changes in the pruning heights *e.g.* progressive and significant decrease in leaf yield with the increase in number of shoot pruning at the ground level. Now-a-days, mostly the farmers take up bottom pruning at frequent intervals with shoot harvest *i.e.,* 5-6 times per year for continuous silkworm rearing. Consequent to severe pruning, the crop fails to produce more biomass and requires large quantities of nutrients for regeneration. This practice has directly or indirectly affected the soil fertility and plant growth rate. Hence, the pruning height affects the rate of plant growth, quality and quantity of mulberry leaves.

Mulberry leaf productivity is highly dependent on plant nutrients such as nitrogen, phosphorous and potassium and is known to respond well to the addition of organic manures (Jaiswal *et al.,* 2005). The chemical fertilizers are becoming costlier in recent times due to escalating costs and scarce availability of commodities. The highly intensive mulberry cropping system causes depletion of nutrients in soil and excess usage of inorganic fertilizers causes deleterious effect on soil health. During mulberry cultivation and rearing of silkworm, enormous amount of farm and rearing residue is converted into sericompost (Bhogesha *et al.,* 2005) and it can be done by using effective microorganisms (EMO). When it is mixed with organic manure, the beneficial microbes proliferate fermenting the waste into nutrient rich organic manure and antioxidant rich compost. Ram Rao *et al.,* (2007) proved the influence of VAM fungi and bacterial biofertilizer with reduction of recommended dose of nitrogen and phosphorous on leaf quality traits of mulberry and growth of silkworm. With the above ideas, the present investigation was carried out with different pruning techniques coupled with integrated nutrient management (INM) practices which are bound to have significant effect on growth, physiological parameters with enhanced quality leaf productivity and economics.

Materials and Methods

Field experiments were conducted during *kharif* and *Rabi* seasons of two years (four rearings) at Department of Sericulture, Tamil Nadu Agricultural University, Coimbatore to study the effect of different pruning heights and INM practices on growth, leaf yield and cocoon productivity and economics in mulberry. The experiments were laid out in a strip plot design with eighteen treatment combinations and replicated thrice. The main plot treatments comprised of pruning techniques (M) *viz.,* M_1 - Bottom Pruning (height of 30 cm); M_2 - Middle pruning (height of 90 cm); M_3 - Top pruning (height of 150 cm) and the subplot treatments (S) *viz.,* S_1 - Absolute control; S_2 - Organics 100% alone (vermicompost @ 2 tons/ha/yr + Seriwaste compost (Sericultural waste composted by using Effective Microorganisms) @ 2 tons/ha/yr + Biomix, which is a mixture of *Azospirillum* (20 kg $ha^{-1}year^{-1}$) + VAM (200 kg $ha^{-1}year^{-1}$) + Phospho bacteria (10 kg ha^{-1} $year^{-1}$) with zinc enriched FYM @ 2 tons $ha^{-1}year^{-1}$); S_3 - Organics 75% + inorganics 25%; S_4 - Organics 50% + inorganics 50%; S_5 - Organics 25% + inorganics 75% and S_6- Inorganics 100%$^{\#}$ (Recommended dose of N 375 kg in the form of urea, P 140Kg in the form of P_2O_5, K 140 kg in the form of K_2O, Zn 25 kg in the form of Zn So_4 ha^{-1}).

Already established mulberry garden with V1 variety was used as test crop at spacing of 90 x 90 cm. The soil of the experimental field was sandy clay loam in texture. The experimental soil was low in available nitrogen (261 kg ha^{-1}), medium in available phosphorous (12 Kg ha^{-1}) and high in available potash (450 Kg ha^{-}

[1]) and adequate amount of micro nutrients *viz.*, Copper (0.75 ppm), Iron (6.31 ppm), Manganese (2.11 ppm) and Zinc (1.05 ppm). A total quantity of 801.1mm rainfall was received in 42 rainy days during the period of investigations. Observations on growth and physiological parameters, leaf yield of mulberry and cocoon parameters are recorded during the course of investigation. Economics was also worked out for different treatment combinations.

Results and Discussion

Growth attributes of mulberry

Growth parameters of mulberry were influenced significantly by pruning techniques and INM practices in *kharif* and *rabi* seasons of two years (Table 1). Middle pruning (M_2) had significantly less inter nodal length (5.3 cm) in *kharif* and top pruning ($M_{3)}$ (6.6 cm) in *rabi*. INM practices of 50 per cent organic and 50 per cent inorganic fertilizer gave significantly less intermodal length of 5.4 and 6.3 cm in *kharif* and *rabi* respectively. The interaction effect was significantly higher in the treatment of M_2S_4 which registered less value of 5.4 and 6.6 cm in the respective seasons. Among the seasons, the inter nodal length was low in *kharif*. It might be due the reason of high sunlight and temperature prevailed during the *kharif* which resulted in shorter shoot length noticed in these treatments, which resulted in short internode and thereby accommodated more number of leaves. Chiranth (2009) noticed similar findings in mulberry cultivation with combined application of inorganic and biofertilizer in mulberry based inter cropping system. Sridhara *et al.,* (1995) established a positive association between internodal distances due to inorganic and organic.

Middle pruning along with 50 per cent organic and 50 per cent inorganic fertilizer (M_2S_4) recorded higher shoot length and number of leaves per plant in both seasons except in number of branches, and leaf area Index (LAI). Number of branches was significantly higher in top pruning during *kharif* followed by middle pruning. LAI has no significant effect during *rabi*. The interaction effect of both practices, pruning and INM practiced in middle pruning (M_2) with 50% organic and 50% inorganic fertilizer application (S_4) registered increased internodal length, shoot length, number of branches per plant, number of leaves per plant, LAI. The enhancement of leaf area due to *Azospirillum*, *Azotobacter* and *Phosphobacterium* application in mulberry was reported earlier by Das *et al.,* (1992).

Yield parameters and leaf yield of mulberry

Mulberry leaf yield parameters recorded during both *kharif* and *rabi* seasons of two years significantly differed due to treatments (Table 2). In main plot, middle pruning technique (M_2) showed significantly higher mean leaf dry weight (260 and 255 g), 100 leaves weight (400 and 467 g), leaf yield per plant (941.5 and 1060 g) and leaf yield per hectare per harvest (11798 and 12641 kg) during *kharif* and *rabi*, respectively. In sub plot, 50% organic fertilizers + 50% inorganic fertilizer (S_4) showed significantly higher yield parameters in both the seasons followed by 25% organic + 75% inorganic fertilizers (S_5) application. During both the seasons, the interaction effect showed in middle pruning with 50% organic + 50% inorganic fertilizer (M_2S_4) in almost all the yield attributes except leaf dry weight, there was no interaction effect during *kharif* season. More studies were support to this present study, Chiranth (2009) noticed that combined application of inorganic fertilizers and bio fertilizers enhanced mulberry leaf yield. Susheelamma *et al.,* (2004) reported that the leaf yield during rainy season was higher under *in situ* organic farming when compared to control.

Table.1 Effect of pruning techniques and integrated nutrient management practices on growth parameters of mulberry during *kharif* and *rabi* seasons (Mean data of two years)

Treatment	Inter nodal length (cm)		Shoot length (cm.)		Number of branches/plant		Number of leaves/ plant		Leaf area Index	
	Kharif	*Rabi*	*Kharif*	*Rabi*	*Kharif*	*Rabi*	*Kharif*	*Rabi*	*Kharif*	*Rabi*
Main plot										
M_1 – Bottom pruning	6.3	7.0	107	113	12	21	223	280	3.4	5.8
M_2 – Middle pruning	5.9	6.6	123	124	14	22	246	291	3.9	6.6
M_3 – Top pruning	5.3	6.7	104	112	13	26	236	264	3.4	5.3
SEd	0.1	0.1	5.1	3.04	0.39	1.75	7	8	0.2	0.3
CD (P =0.05)	0.2	0.2	12.5	7.4	1.0	4.3	18	NS	NS	0.7
Sub plot										
S_1 – Absolute control	6.5	7.5	102	98	10	16	143	182	1.7	3.0
S_2 - Organics 100%	5.8	6.5	105	110	13	21	207	239	2.8	4.4
S_3 - Organics 75% + inorganics 25%	5.5	6.6	110	115	14	23	240	275	3.6	5.5
S_4 - Organics 50% + inorganics 50%	5.4	6.3	128	132	16	28	305	363	5.2	9.1
S_5 - Organics 25% + inorganics 75%	6.0	6.7	114	126	14	25	266	317	4.5	7.0
S_6 - Inorganics 100%	5.7	7.0	110	118	14	24	247	294	3.5	6.0
SEd	0.1	0.1	5.1	2	0.2	1.1	6	8	0.2	0.3
CD (P =0.05)	0.2	0.2	13	4	1	3	14	20	0.5	0.8

NS – Non significant

Table.2 Effect of pruning techniques and integrated nutrient management practices yield parameters and leaf yield of mulberry during *kharif* and *rabi* seasons (Mean data of two years)

Treatment	Leaf dry weight (g)		100 leaves weight (g)		Leaf yield per plant (g)		Leaf yield (kg /ha/harvest	
	Kharif	*Rabi*	*Kharif*	*Rabi*	*Kharif*	*Rabi*	*Kharif*	*Rabi*
Main plot								
M_1 – Bottom pruning	198	207	336	378	778.2	817.7	9802	10178
M_2 – Middle pruning	260	255	400	467	941.5	1060.0	11826	12641
M_3 – Top pruning	241	206	392	345	860.5	874.0	10598	10651
SEd	8	7.6	3.8	4.4	25.8	48.1	195	226
CD (P =0.05)	20	18.5	9	10.7	63.2	117.8	478	553
Sub plot								
S_1 – Absolute control	137	127	342	354	487.7	565.4	6187	7147
S_2 - Organics 100%	206	188	356	395	758.5	813.4	9419	10041
S_3 - Organics 75% + inorganics 25%	247	224	372	401	885.5	945.3	11221	11448
S_4 - Organics 50% + inorganics 50%	300	285	415	423	1238.8	1189.8	14098	14521
S_5 - Organics 25% + inorganics 75%	268	262	398	411	954.1	1050.7	12888	12749
S_6 - Inorganics 100%	241	249	373	395	835.8	938.7	10636	11033
SEd	6.9	4.9	5.3	7.2	15.4	23.4	236	134
CD (P =0.05)	16.8	12.1	13	17.6	37.7	57.1	578	327

Table.3 Effect of pruning techniques and Integrated Nutrient Management practices on silkworm economical parameters during *kharif* and *rabi* seasons (Mean data of two years)

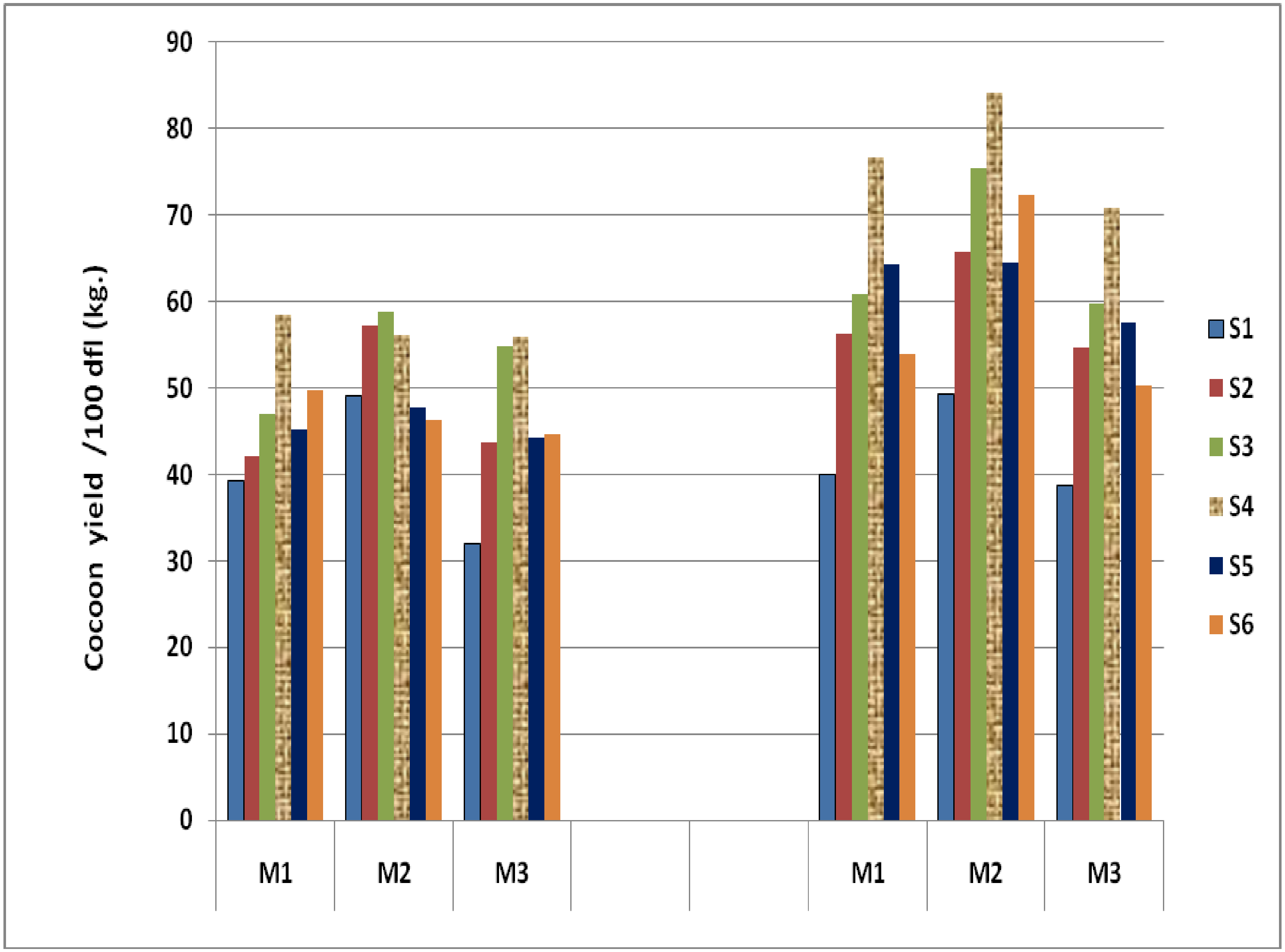
Treatment	Larval weight (g.)		Cocoon weight (g.)		Shell weight (g.)		Shell ratio (%)		ERR (%)	
	Kharif	***Rabi***	***Kharif***	***Rabi***	***Kharif***	***Rabi***	***Kharif***	***Rabi***	***Kharif***	***Rabi***
Main plot										
M_1 – Bottom pruning	3.2	3.9	1.54	1.84	0.33	0.39	20.86	20.66	91.8	96.8
M_2 – Middle pruning	3.3	4.0	1.66	1.99	0.35	0.42	21.05	20.73	91.7	97.4
M_3 – Top pruning	3.1	3.9	1.59	1.83	0.33	0.39	20.53	21.01	91.5	97.1
SEd	0.08	0.08	0.03	0.04	0.01	0.01	0.43	0.32	0.95	0.21
CD (P =0.05)	0.18	NS	0.07	0.06	0.03	0.03	NS	NS	NS	0.52
Sub plot										
S_1 – Absolute control	2.8	3.5	1.59	1.78	0.30	0.36	19.07	19.37	88.6	95.4
S_2 - Organics 100%*	3.0	3.9	1.63	1.91	0.33	0.39	19.90	20.68	90.3	97.0
S_3 - Organics 75% + inorganics 25%	3.2	4.0	1.65	1.90	0.36	0.41	21.26	20.37	93.6	97.2
S_4 - Organics 50% + inorganics 50%	3.6	4.2	1.63	2.02	0.37	0.44	22.65	22.33	94.5	98.3
S_5 - Organics 25% + inorganics 75%	3.3	4.1	1.55	1.83	0.34	0.40	21.13	20.72	91.4	97.5
S_6 - Inorganics 100%**	3.2	4.0	1.54	1.89	0.33	0.41	20.89	21.34	91.6	97.1
SEd	0.03	0.08	0.02	0.02	0.01	0.00	0.45	0.42	0.79	0.52
CD (P =0.05)	0.07	0.19	0.06	0.05	0.02	0.01	1.10	1.02	1.94	0.35

Table.4 Effect of pruning techniques and Integrated Nutrient Management on economics of mulberry and silkworm during *kharif* and *rabi* seasons (Mean data of two years)

Treatment	Mulberry						Silkworm					
	Kharif			***Rabi***			***Kharif***			***Rabi***		
	Gross return	**Net return**	**B:C ratio**	**Gross return**	**Net return**	**B:C ratio**	**Gross return**	**Net return**	**B:C ratio**	**Gross return**	**Net return**	**B:C ratio**
M_1S_1	12350	1103	0.99	17324	4839	1.73	39011	11567	1.42	39525	12081	1.44
$M1S_2$	20378	1884	1.03	21039	8247	1.22	42028	14584	1.53	55195	27751	2.01
M_1S_3	25026	6256	1.25	24406	10945	1.39	47410	19966	1.73	55842	28398	2.03
M_1S_4	36151	17105	1.78	35341	19577	1.98	55261	27817	2.01	65187	37743	2.38
M_1S_5	29328	10005	1.43	30886	15471	1.71	46623	19179	1.70	56267	28823	2.05
M_1S_6	23793	4193	1.14	23671	9602	1.29	46946	19502	1.71	56208	28764	2.05
M_2S_1	17387	6799	1.47	20657	11759	2.21	45145	17701	1.64	45499	18055	1.66
M_2S_2	26559	8725	1.39	28651	14729	1.73	51335	23891	1.87	58168	30724	2.12
M_2S_3	31816	13706	1.64	34127	18700	2.02	54123	26679	1.97	67515	40071	2.46
M_2S_4	42349	23963	2.16	39975	23028	2.33	56667	29223	2.06	74006	46562	2.70
M_2S_5	34298	15635	1.72	34756	19332	1.99	49150	21706	1.79	59916	32472	2.18
M_2S_6	31642	12702	1.57	31450	16127	1.78	46243	18799	1.69	65369	37925	2.38
M_3S_1	15835	4917	1.30	15618	7314	1.61	35689	8245	1.30	39293	11849	1.43
M_3S_2	24541	6376	1.26	25617	12581	1.51	46115	18671	1.68	52032	24588	1.90
M_3S_3	27318	8878	1.39	27328	13665	1.59	53463	26019	1.95	55328	27884	2.02
M_3S_4	38482	19766	1.93	33594	18535	1.92	55250	27806	2.01	62668	35224	2.28
M_3S_5	35953	16960	1.78	29977	15517	1.69	46074	18630	1.68	53892	26448	1.96
M_3S_6	31838	12568	1.55	27627	13637	1.53	43753	16309	1.59	50715	23271	1.85

- Data not statistically analyzed

Fig.1 Interaction effect of pruning techniques and Integrated Nutrient Management on cocoon yield for two seasons (Mean values of two years)



Economical parameters of silkworm

Effect of pruning and INM practices were found significant on silkworm economical parameters during *kharif* and *rabi* seasons of two years (Table 3). Silkworm larval weight (33 and 40g), cocoon weight (1.66 and 1.99 g), shell weight (0.35 and 0.42 g) were significantly higher during *kharif* and *rabi*, respectively. The pruning techniques had no significant effect on shell ratio during both seasons and effective rearing rate (ERR%) during *kharif*. Application of 50% organic + 50% inorganic fertilizers (S_4) was found significant effect on all economical parameters of silkworm in the irrespective of the seasons. During the *kharif* season, the cocoon weight was significantly higher under 75% organic + 25% inorganic fertilizer application treatment (S_3). The silkworm cocoon yield per hundred disease free layings (dfls) the interaction effect was found in middle pruning with 50% organic + 50% inorganic fertilizer application (M_2S_4) during *kharif* season (Fig. 1). Philomena *et al.*, (2003) have observed higher ERR in silkworms fed on mulberry leaves which were grown by applying lower dose of inorganic fertilizer and higher dose of organic manures.

Economics of mulberry and silkworm

Economics of mulberry leaf production and silkworm rearing was estimated during *kharif* and *rabi* seasons of two years (Table 4). Gross return, net return and B:C ratio of Rs.42349, Rs.23963 and 2.16 in kharif; Rs. 39975, Rs.23985 and 2.33 in *rabi* seasons under the mulberry cultivation and Rs.56667, Rs.29223 and 2.06 in kharif; Rs.74006, Rs.46562 and 2.70 in *rabi* for silkworm rearing showed higher in middle pruning with 50% organic + 50% inorganic fertilizer application (M_2S_4). Chiranth (2009) also noticed 100% recommended dose of fertilizer had higher gross returns but comparatively lower B: C ratio (1.78) than biofertilizers (Azophos + 50% cut in nitrogen and phosphorous fertilizers) applied mulberry which recorded the higher B: C ratio 2.07.

Thus from the present study it may be concluded that middle pruning along with integrated nutrient management practice of application of 50 per cent organic and 50 per cent recommended dose of inorganic fertilizers are found optimum for mulberry higher growth and yield attributes, yield economics of mulberry and silkworm with enhanced net return and B: C ratio in both *kharif* and *rabi* under irrigated condition.

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