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Studies on integrated nutrient management on leaf yield and quality of silk of mulberry (*Morus alba* L.) grown under rainfed situation

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ABSTRACT

The experiment was carried out during the consecutive years of 2007to 2009 under rainfed condition at Regional Sericultural Research Station, Ranchi, Jharkhand to study the effect of Integrated Nutrient Management (INM) in mulberry plants. Mulberry garden was established with Arbuscular Mycorrhizal fungi (AMF) inoculated saplings of S-1 variety under 90 cm x 90 cm plant spacing. Four INM combinations were tested against recommended package of practices for cultivation of mulberry and farmers' practices. Leaf quality and suitability for silkworm rearing was assessed through bioassay. Maximum leaf yield of 7.71 mt ha^{-1} yr^{-1} with 20% increase over the existing recommended package was obtained under INM package i.e. 50% of recommended dose of nitrogen (150 kg $ha^{-1}yr^{-1}$), full doses of phosphate and potash (i.e. 50 kg ha^{-1} yr^{-1}) combined with biofertlizer (Azotobacter chroococcum) @ 10 kg ha^{-1} yr^{-1} and vermicompost @ 10 mt ha^{-1} yr^{-1}. The results of bioassay also showed superiority of INM practiced over the recommended packages. INM increased productivity of mulberry leaf and 20% additional silkworm layings was possible to rear by the farmers, improve their economic condition and silk production as well.

***Key words*: Biofertilizers, integrated nutrient management, leaf quality, mulberry**

Mulberry the host plant of silkworm (*Bombyx mori* L.) is mainly cultivated for its foliage for rearing of silkworm to produce cocoon and silk yarn. Moreover, feeding of quality mulberry leaf being one of the important pre-requisite for producing quality leaf and cocoons, and hence, cultivation of mulberry with nutrient package is important. The state of Jharkhand is traditionally a tasar silk producing state, contributing around 766 mt to the national raw silk production annually. Mulberry sericulture has been popularized among the resource poor people in south Chhotanagpur plateau of the state since last two decades. The farmers in these areas being socio-economically poor, application of recommended doses of chemical fertilizers and farmyard manure in the mulberry field was found to be one of the limiting factors. Moreover, non availability of required quantity of FYM for application in mulberry garden, farmers do use less quantity of organic manures, thus, soil leads to ill health and lower mulberry leaf including its quality. However, integrated organic farming approach along with chemical fertilizers, organic manures, green manures and bio-fertilizers are found to maintain steady crop production for a longer time (Nambiar and Abrol, 1992; Anilkumar and John, 1999).

Use of AMF (*Arbuscular Mycorrhizal* fungi) and *Azotobacter* biofertilizers @ 40 kg ha^{-1} once in 4 years and 10 kg ha^{-1} yr^{-1}, respectively for rainfed areas in mulberry plantations reduces the requirement of inorganic nitrogen by 50% and phosphate by 70-80% and has shown that it maintained leaf yield and quality at per with the recommended doses of N and P. Moreover, under rainfed conditions, 50% of recommended dose of nitrogen can be supplemented with the use of *Azotobacter* biofertilizer (Das *et al.*, 1994 and Setua *et al.,* 2005). Therefore, a study was conducted to estimate the efficacy of IMN on leaf yield and quality of silk of mulberry grown under rainfed situation.

MATERIALS AND METHODS

The study was conducted consecutive of two years during 2007-08 and 2008-09 at Regional Sericultural Research Station, Ranchi under rainfed condition. AMF inoculated saplings of S1 mulberry variety were raised in nursery (Setua *et al.*, 1999) and one year old saplings were transplanted to the field at 90 cm x 90 cm spacing in complete randomized block design with 3 replications. Different treatments of combinations nutrient inputs combinations were tested against the traditional practices of mulberry cultivation as control. The treatments are as follows:

T_0: Farmers' practice (control)

T_1: N: P_2O_5: K_2O @ 150 kg: 50 kg: 50 kg +FYM @ 10 mt ha^{-1} yr^{-1} (recommended dose)

T_2: N: P_2O_5: K_2O @ 150 kg: 50 kg: 50 kg + vermicompost @ 10 mt ha^{-1} yr^{-1}

T_3: N: P_2O_5: K_2O @ 75 kg: 50 kg: 50 kg + vermicompost @10 *mt* ha^{-1} yr^{-1} + *Azotobacter* @10 kg ha^{-1} yr^{-1}

T_4: N: P_2O_5: K_2O @ 75 kg: 50 kg: 50 kg + vermicompost @ 10 mt ha^{-1} yr^{-1} + *Azotobacter* @ 10 kg ha^{-1} yr^{-1} + A M F @ 40 kg ha^{-1} once in four years

T_5 : N: P_2O_5: K_2O @ 75 kg: 50 kg : 50 kg + vermicompost @ 10 mt ha^{-1} yr^{-1} + *Azotobacter* @ 10 kg ha^{-1} yr^{-1} + AMF + PGR spray @ 0.1%.

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Table 1: Performance of INM on growth characters of mulberry plants

Treatment	Year	Plant height (cm)			Mean	No. of branches plant^{-1}			Mean
		Mar	Aug	Oct		Mar	Aug	Oct	
T_0	1_{st}	121.5	176.4	187.7	161.9	3.7	7.6	7.7	6.3
	2_{nd}	120.5	165.4	166.2	150.7	3.9	6.8	7.3	6.0
T1	1_{st}	115.6	170.9	185.3	157.3	3.2	7.3	8.0	6.2
	2_{nd}	124.1	170.8	171.3	155.4	6.6	7.2	8.2	7.3
T2	1_{st}	112.4	162.4	187.3	154.0	3.5	6.3	6.7	5.5
	2_{nd}	126.6	172.3	173.2	157.4	6.9	7.4	8.4	7.6
T3	1_{st}	115.2	151.6	182.0	149.6	3.3	7.0	7.7	6.0
	2_{nd}	125.4	179.6	182.4	162.5	7.3	8.5	9.2	8.3
T4	1_{st}	115.2	160.1	186.3	153.9	3.4	8.2	9.0	6.9
	2_{nd}	125.8	178.7	180.3	161.6	6.5	7.9	8.6	7.6
T5	1_{st}	121.2	150	172.3	147.8	3.2	8.1	8.0	6.4
	2_{nd}	123.5	177.8	178.3	159.9	7.3	8.0	7.9	7.7
Mean		120.6	168.0	179.4		4.9	7.5	8.1	
	T	S x T	Y x T	Y x S x T	T	S x T	Y x T	Y x S x T	
LSD (0.05)	**2.2***	**3.8****	**3.1****	**5.4****	**0.4****	**0.7***	**0.6****	**NS**	
CV %			**2.11**					**9.42**	

Table 2: Effect of integrated nutrient management on number of leaves per plant and leaf yield

Treatment	Year	No. of leaves plant^{-1}			Mean	Leaf yield (mt acre^{-1})			Total (mt acre year^{-1})
		Mar	Aug	Oct		Mar	Aug	Oct	
T_0	1st	26.4	156.5	107.7	96.9	1.6	2.50	1.73	5.83
	2nd	34.9	166.5	171.3	124.2	0.9	2.97	3.07	6.99
T1	1st	33.6	159.3	103.7	98.9	1.6	3.22	1.78	6.67
	2nd	36.6	172.4	171.2	126.7	0.9	3.05	2.20	6.24
T2	1st	31.7	156.7	110.3	99.6	1.8	2.55	1.74	6.13
	2nd	36.9	178.2	176.4	130.5	1.0	3.24	3.34	7.61
T3	1st	32.6	178.9	123.3	111.6	1.7	3.25	1.75	6.80
	2nd	37.2	180.8	182.6	135.6	1.1	3.68	3.81	8.61
T4	1st	32.2	146.7	102.3	93.7	1.7	2.50	1.83	6.07
	2nd	49.9	176.3	178.4	134.9	1.0	3.35	3.52	7.94
T5	1st	38.0	175.1	101.7	104.9	1.8	2.50	2.06	6.52
	2nd	50.7	176.4	179.8	133.5	1.1	3.42	3.61	8.19
Mean		36.7	168.7	142.4		1.3	3.03	2.54	
LSD (0.05)	T	S x T	Y x T	Y x S x T	T	S x T	Y x T	Y x S x T	
	3.2**	**5.5****	**4.5****	**7.7****	**182****	**315***	**257****	**446***	
CV %			**4.08**					**11.78**	

Table 3: Bioassay study of silkworm hybrid: PM x CSR 2

Treatment	Wt. of 10 mature larvae (g)	Cocoon yield 10000^{-1} larvae brushed		Weight (g) of single		Shell %
		no.	wt. (kg)	Cocoon	Shell	
T_0	33.0	8867	11.26	1.32	0.23	17.24
T_1	33.3	8996	12.12	1.35	0.23	17.13
T_2	33.7	9147	12.28	1.35	0.24	17.76
T_3	34.8	9400	12.87	1.37	0.25	18.56
T_4	33.9	9269	12.54	1.37	0.25	18.25
T_5	33.9	9162	12.40	1.35	0.24	18.15
LSD (0.05)	**0.37**	**153.98**	**0.17**	**0.008**	**0.0044**	**0.34**

Data were recorded on mulberry plant height, number of branches per plant, leaves per plant, leaf yield, leaf moisture and leaf moisture retention capacity for three seasons namely, February-March, August and October in a year after one year of plantation. Quality of leaves through silkworm bioassay study was conducted with the Multi x Bi Silkworm hybrid (PM x CSR2) in three replications with 300 worms per replication following the standard rearing package of practices (Krishnaswami, 1979). Data were recorded on cocoon shell %, effective rate of rearing (by number and weight). Data were compiled and statistically analyzed.

RESULTS AND DISCUSSION

Two years data recorded on different plant growth attributing characteristics of mulberry and revealed that mulberry plant height was significantly differed with the INM treatments imposed in the experiments, where, the treatment T_3 showed significantly higher plant height (162.5 cm) than other treatments (Table 1). Though there was significant difference in number of branches per plant with treatments and treatments vs. season, number of branches per plant was highest in the treatment T_3 also (8.3) followed by T_4 (7.6) and T_5 (7.7) and performance shown in T_2 (5.5).

Number of leaves per plant was significantly higher in T_3 (111.6; 135.6) followed by T_4 (134.9) and T_5 (104.9; 133.5) though in the first year the result was *at par* with the control (93.7). Leaf yield per annum was also significantly higher in T_3 (6.8 and 8.6 mt) followed by T_5 (6.5 and 8.1 mt) and T_4 (6.1 and 7.9 mt) (Table-2). The increased performance in leaf yield obtained in T_3 with steady crop production with INM and biofertilizers corroborates the observation of Nambiar and Abrol (1992) and Anilkumar and Johan (1999).

Bio-assay study

Silkworm rearing conducted with Multi x Bi hybrid (PM x CSR2) during the seasons i.e., Spring (February-March), Summer (August) and Autumn (October.-November) feeding the leaves from different treatments and control plots. Analysis of data revealed that the weight of 10 matured larvae was significantly higher in T_3 (3.49) than the control. However, the results were *at par* with other treatments (Table-3).

The cocoon yield per 10, 000 larvae by number and weight was recorded maximum in treatment T_3 (9400; 12.87 kg) which was significantly higher than the other treatments. However, the single cocoon weight though was higher in treatment T_4 (1.373 g) but was at par with the treatment T_3 (1.37 g). Results on single cocoon shell weight and single shell ratio were maximum in T_3 (0.25g, 18.56%) and was followed by T_4.

Analysis of data and results, recorded that among the different nutrient management packages, T_3 showed significantly higher performance on growth attributing characters *i.e*. plant height, number of branches/ plant and number of leaves/branch ultimately leaf yield. Moreover, the quality of the leaf obtained in T_3 showed superiority in producing the cocoons is due to good quality of mulberry leaves and mulberry crop productivity improvement in rainfed condition. Therefore, the treatment T_3 (N: P2O5:K2O @ 75 kg: 50 kg: 50 kg + vermicompost @ 10 mt ha^{-1} year^{-1} + *Azotobacter* @10kg ha^{-1} year^{-1}) may be recommended for adoption by the sericulture farmers of Jharkhand state under rainfed condition. The results obtained with the integrated nutrient management with increased mulberry leaf yield and quality which produced quality cocoon supports the similar findings obtained by earlier workers (Das *et al*., 1994 and Setua *et at*., 2005) that use of AMF and *Azotobactor* biofertilizers with reduced doses effectively maintains the yield and quality of mulberry leaf and silkworm cocoon as well.

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