Environment & Ecology 35 (2) : 656—660, April—June 2017
Website: environmentandecology.com ISSN 0970-0420

Organic Based Nitrogen Nutritional Management on Growth and Foliar Constituents of S_{36} Mulberry (*Morus indica* L.) under Irrigated Condition

K. R. Shashidhar, T. K. Narayanswamy, K. S. Krishna, R. N. Bhaskar

Received 25 May 2016; Accepted 3 June 2016; Published online 30 June 2016

Abstract An investigation was carried out to know the effect of different types of organic based nutrients on S_{36} mulberry under irrigated condition. The pooled data of four crops revealed that mulberry raised with 100% Recommended N through 20% each of Compost + *Glyricidia maculate* + Castorcake + Vermicompost and Urea + 10 kg each of *Azospirillum brasilense* + *Aspergillus awamori* Bio-fertilizer + remaining P, K through chemical fertilizers (T_8) recorded significantly maximum plant height (51.99 and 104.82 cm), highest number of shoots per plant (12.76 and 14.46) and more number of leaves per plant (96.29 and 119.12) on 30th and 60th day after pruning. Leaf yield per plant and hectare was maximum in T_8 (327.62 g/plant and 45.45 tonnes/hr/yr). However, these parameters were lowest in 100% Recommended N through Neemcake + 10 kg each of *A. brasilense* + *A. awamori* Bio-fertilizer + remaining P and K kg/ha/year through chemical fertilizer (T_5) (44.25 and 82.69 cm, plant height), (8.16 and 9.76, number of shoots/plant) and (66.17 and 90.88, number of leaves/plant) on 30th and 60th day after pruning and the lowest fresh leaf yield (235.01 g/plant and 32.60 tones/ha) on 60th day after pruning. Similarly, highest leaf moisture (72.98%), chlorophyll 'a' (1.85 mg/g), chlorophyll 'b' (0.80 mg/g), total chlorophyll (2.55 mg/g), crude protein (20.15%), total soluble protein (10.44%) and total soluble sugar (13.02%) contents in S_{36} mulberry leaves was recorded in T_8. Whereas, all these quality parameters of mulberry was recorded lowest in T_5.

Keywords Green manures, Oilcakes, Biofertilizers, Inorganic fertilizers, S_{36} mulberry variety.

K. R. Shashidhar*
ICAR-Krishi Vigyan Kendra,
Kolar (Karnataka), India

T. K. Narayanaswamy, R. N. Bhaskar
Department of Sericulture,
University of Agricultural Sciences,
Bangalore (Karnataka), India

K. S. Krishna
Agriculture Research Station,
Sankeshwara (UAS, Dharwad), India
e-mail : sericulture2014@gmail.com
*Correspondence

Introduction

The nutrient management practices by using chemical fertilizers alone cause some negative impact on soil microbial load and fertility status of the soil as well as quality of mulberry leaf also. To keep the soil

alive, integrated nutrient management offers good scope. Use of chemical fertilizers in combination with organic source of fertilizers supports the microbial population, organic carbon and micronutrient status of the soil. Further, use of biofertilizers enriches the microbial population, which seldom secretes organic acids, resulting mobilization of available form of nutrients from non available form [1]. 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 [2]. Organic manures are eco-friendly help in improvement of soil health, besides maintaining the soil fertility for longer period. Many advanced countries have turned back their agriculture to traditional methods of using organic materials to improve the tilth, fertility and soil productivity. Organic materials contribute significantly to improve crop growth and yield, by providing major, secondary and micro nutrients. In view of this, an experiment was carried out to know the effect of organic based 'N' nutrient management concept on growth and foliar components of S_{36} mulberry under irrigated condition.

(The financial help received from the Government of India, University of Agricultural Science, Bengaluru is greatly acknowledged).

Materials and Methods

A field experiment was carried out at Main Research Station, Hebbal, University of Agricultural Sciences, Bangalore in irrigated S_{36} garden with spacing of 60×60 cm. The experiment was laid out in a randomized complete block design (RCBD) with 10 treatments of 3 replication each. The mulberry cultivation practices were followed as per [3]. The different sources of nitrogen through organic and inorganic fertilizers were applied in two split doses. The treatments were as follows,

T_1 : 100% Recommended 'N' through *Glyricidia maculata* + 10 kg each of *Azospirillum brasilense* + *Aspergillus awamori* Bio-fertilizer + Rec. P, K through chemical fertilizers + Rec. FYM

T_2 : 100% Recommended 'N' through Sunhemp + 10 kg each of *Azospirillum brasilense* + *Aspergillus awamori* Bio-fertilizer + Rec. P, K through chemical fertilizers + Rec. FYM

T_3 : 100% Recommended 'N' through Pongamia leaves + 10 kg each of *Azospirillum brasilense* + *Aspergillus awamori* Bio-fertilizer + Rec. P, K through chemical fertilizers + Rec. FYM

T_4 : 100% Recommended 'N' through Castorcake + 10 kg each of *Azospirillum brasilense* + *Aspergillus awamori* Bio-fertilizer + Rec. P, K through fertilizers + Rec. FYM

T_5 : 100% Recommended 'N' through Neemcake + 10 kg each of *Azospirillum brasilense* + *Aspergillus awamori* Bio-fertilizer + Rec. P, K through chemical fertilizers + Rec. FYM

T_6 : 100% Recommended 'N' through Pongamiacake + 10 kg each of *Azospirillum brasilense* + *Aspergillus awamori* Bio-fertilizer + Rec. P, K through chemical fertilizers + Rec. FYM

T_7 : 100% Recommended 'N' through Compost + 10 kg each of *Azospirillum brasilense* + *Aspergillus awamori* Bio-fertilizer + Rec. P, K through chemical fertiliers + Rec. FYM

T_8 : 100% Recommended 'N' through 20% each of Compost + *Glyricidia maculata* + Castorcake + vermicompost and Urea + 10 kg each of *Azospirillum brasilense* + *Aspergillus awamori* Bio-fertilizer + remaining P, K through chemical fertilizers + Rec. FYM

T_9 : Recommended 40 tonnes FYM/ha/year + 225: 150: 150 N, P and K kg/ha/year through chemical fertilizer (control)

T_{10} : 10 kg each of *Azospirillum brasilense* + *Aspergillus awamori* Bio-fertilizer + Recommended 40 tonnes FYM/ha/year + 225: 150: 150 N, P and K kg/ha/year through chemical fertilizer.

The biofertilizer viz., *Azospirillum brasilense* and *Aspergillus awamori* were incorporated into the soil along with FYM ten days after application of organic manures and inorganic fertilizers. The 'P' and 'K' nutrients supplied in the form of Single Super Phosphate (SSP) and Muriate of Potash (NoP) respectively for all treatments.The observations on the growth and yield parameters were recorded at 30 and 60 days in-

Table 1. Growth and yield parameters of S_{36} mulberry as influenced by organic based nutrient management (pooled data of four crops). *Significant, DAP–Days after pruning.

Treatments	Plant height (cm)		No. of shoots/ plant (No.)		No. of leaves/ plant (No.)		Leaf yield (g/plant)	Leaf yield (tonnes/ha/yr)
	30 DAP	60 DAP	30 DAP	60 DAP	30 DAP	60 DAP	60 DAP	60 DAP
T_1	46.36	90.19	9.88	11.41	74.36	101.47	266.93	37.00
T_2	45.85	88.87	9.65	11.24	72.89	100.54	262.67	36.50
T_3	44.71	85.66	9.20	10.74	69.14	96.11	247.94	34.40
T_4	46.29	90.27	10.00	11.65	74.41	102.10	268.15	37.10
T_5	44.25	82.69	8.16	9.76	66.17	90.88	235.01	32.60
T_6	45.75	88.09	9.68	11.25	72.64	99.65	262.77	36.40
T_7	45.66	87.56	9.39	10.96	71.55	99.50	257.86	35.70
T_8	51.99	104.82	12.76	14.46	96.29	119.12	327.62	45.45
T_9	49.66	100.51	11.58	13.12	91.23	115.26	317.25	44.00
T_{10}	51.07	103.54	12.01	13.89	94.41	117.40	322.85	44.80
F-test	*	*	*	*	*	*	*	*
SEm±	0.08	0.20	0.07	0.13	0.27	0.52	0.36	0.25
CD @ 5%	0.25	0.60	0.22	0.41	0.83	1.56	1.10	0.75

tervals and leaf yield was recorded on 60th day after pruning.Moisture percentage in leaf was estimated through gravimetric method by taking the difference between fresh and dry weights and expressed in percentage on fresh weight basis and crude protein estimation was carried out by microkjeldahl method [4]. Chlorophyll content in mulberry leaves was determined by procedure described earlier [5]. Total soluble proteins were estimated by using the procedure of Lowry et al. [6]. The total sugars in all the samples were estimated by the phenol sulfuric acid method [7]. The data were analyzed statistically by using simple RCBD as outlined by Cochran and Cox [8].

Results and Discussion

The pooled data of four crops on the growth and yield parameters of S_{36} mulberry variety as influenced by application of different types of organic manures and inorganic fertilizers showed significant increase in growth and yield parameters (Table 1).

Growth parameters of S_{36} mulberry

The significantly maximum plant height (51.99 and 104.82 cm), highest number of shoots per plant (12.76 and 14.46) and more number of leaves per plant (96.29 and 119.12) at 30th and 60th day after pruning were recorded in S_{36} mulberry growth with 100% Recommended N through 20% each of Compost + *Glyricidia maculate* + Castorcake + Vermicompost and Urea + 10 kg each of *Azospirillum brasilense* + *Aspergillus awamori* Bio-fertilizer + remaining P, K through chemical fertilizers (T_8). The next best treatments were application of 10 kg each of *Azospirillum brasilense* + *Aspergillus awamori* Bio-fertilizer + Recommended FYM + N, P and K kg/ha/year through fertilizer (T_{10}) (51.07 and 103.54 cm), (12.01 and 13.89) and (94.41 and 117.40) and Recommended FYM + N, P and K kg/ha/year (T_9) (49.66 and 100.51 cm), (11.58 and 13.12) and (91.23 and 115.26) respectively. The profound increased in plant height, more number of shoots and leaves may be due to addition of nitrogen to the soil through different types of organic manures with inorganic fertilizers. The use of bio-fertilizers like *Azospirillum brasilense* might have helped in fixing the atmospheric nitrogen and in addition to this *Aspergillus awamori*, a phosphorus solubilizing fungus might helped in releasing the phosphorus which is fixed in the soil was made available to the plant. Similarly, higher plant height, number of shoots per plant and numbers of leaves per plant were recorded significantly when S_{36} mulberry garden supplemented with combined application of different types of organic manures along with biofertilizers and inorganic fertilizers [9]. Similar results have been observed with findings of Setua et al. [10] on mulberry.

Leaf yield of S_{36} mulberry

Notable variation was registered with regard to leaf yield per plant and leaf yield per hectare of mulberry among different organic manures when applied to S_{36} mulberry (Table 1). Among the different treatments, significantly maximum leaf yield per plant and leaf yield per hectare was recorded in T_8 (327.62 g/plant and 45.45 tonnes/ha) followed by T_{10} (322.85 g/plant and 44.80 tonnes/ha/yr) and T_9 (317.25 g/plant and 44.00 tonnes/ha/yr). The lowest fresh leaf yield of (235.01 g/plant and 32.60 tonnes/ha) was recorded in T_5. The positive influence of organic based nutrient management on leaf yield in terms of fresh weight can also be attributed to the fact that combined application of green manures, oilcakes, vermicompost, FYM and urea might have helped in slow and steady release of nutrients in addition to supply of important macro and micro-nutrients besides efficient supply of N and P by nitrogen fixing and phosphorus solubilizing bio-inoculants [9]. The lowest leaf yield in 100% neemcake application may be due to insufficient availability of nutrients in the root zone of mulberry plants to be absorbed by the roots. Application of different kinds of organic manures and combination of organic manures + inorganic fertilizers recorded significantly higher number of shoots per plant, higher number of leaves and leaf yiel per plant as compared to NPK alone through chemical fertilizers in S_{36} mulberry [11].

Foliar constituents of S_{36} mulberry

Application of different sources of organic manures, bio-inoculants and inorganic fertilizers had registered positive response with respect to quality parameters of mulberry viz., moisture content, chlorophyll 'a', 'b', and total chlorophyll, crude protein, soluble protein and soluble sugar contents. Pooled data of two observations (II and IV crop) are mentioned in Table 2.

Moisture content (%) in S_{36} mulberry

Leaf moisture percentage of S_{36} mulberry differed significantly among the treatments (Table 2). The mulberry plot which received 100% Recommended N through 20% each of Compost + *Glyricidia maculata* + Castorcake (CC) + Vermicompost (VC) and Urea + 10 kg each of *Azospirillum brasilense* + *Aspergillus awamori* Bio-fertilizer + remaining P, K through chemical fertilizers (T_8) recorded maximum leaf moisture (72.98%). The next best treatment was T_{10} (72.50%) over other treatments. Similarly, the lowest moisture content in leaf of 70.98% was registered in T_5. The increase in leaf moisture content may be due to water retention capacity of organic manures which steadily supply the moisture and there by increased the moisture content in leaf and fresh leaf weight. These results are in line with findings of Setua et al. [10] on mulberry.

Table 2. Biochemical constituents of S_{36} mulberry leaf as influenced by organic based nutrient management on 60th day after pruning (pooled data of two crops). *Significant.

Treatments	Moisture content (%)	Chlorophyll 'a' (mg/g)	Chlorophyll 'b' (mg/g)	Total chlorophyll (mg/g)	Crude protein (%)	Total soluble protein (%)	Total soluble sugar (%)
T_1	72.72	1.67	0.64	2.36	17.46	8.56	12.44
T_2	72.54	1.63	0.63	2.33	17.34	8.53	12.41
T_3	71.78	1.55	0.59	2.23	17.12	8.32	12.08
T_4	72.48	1.68	0.66	2.37	17.56	8.61	12.55
T_5	70.98	1.52	0.51	2.21	16.75	8.11	11.22
T_6	72.06	1.59	0.61	2.32	17.25	8.44	12.30
T_7	71.99	1.54	0.61	2.35	17.34	8.58	11.71
T_8	72.98	1.85	0.80	2.55	20.15	10.44	13.02
T_9	71.53	1.76	0.78	2.52	20.01	10.31	12.91
T_{10}	72.50	1.79	0.79	2.53	20.08	10.37	12.96
F-test	*	*	*	*	*	*	*
SEm±	0.06	0.01	0.01	0.02	0.01	0.09	0.05
CD @ 5%	0.20	0.04	0.03	0.07	0.04	0.28	0.17

Chlorophyll content (mg/g) in S_{36} mulberry

Supplying nitrogen to the plants by different sources of organic manures and in-organic fertilizers significantly influenced the chlorophyll contents in leaves of S_{36} mulberry (Table 2). Maximum chlorophyll 'a' (1.85 mg/g), chlorophyll 'b' (0.80 mg/g) and total chlorophyll (2.55 mg/g) contents of leaf was recorded in 100% Recommended N through 20% each of Compost + *Glyricidia maculata* + Castorcake (CC) + Vermicompost (VC) and Urea + 10 kg each of

Azospirillum brasilense + *Aspergillus awamori* Biofertilizer + remaining P, k through chemical fertilizers (T_8) on 60th day. It was followed by T_{10} (1.79, 0.79 and 2.53 mg/g), T_9 (1.76, 0.78 and 2.52 mg/g) respectively. While it was minimum in T_5 treated plots (1.52, 0.51 and 2.21 mg/g) respectively. The increase in chlorophyll content may be due to adequate supply of nutrients to the plants through different organic manures, inorganic fertilizers and also by application of biofertilizers. These observations are in agreement with findings of [2] revealed that, the organic manure (FYM) supplemented with varied levels of inorganic fertilizers caused increment in chlorophyll content of leaves in mulberry. The improvement in chlorophyll content might be due to synergistic interaction of both biofertilizers in (VAM and BBF, 50% cut in both N and P fertilizers) reduced dose of chemical fertilizers can be manipulated by the addition of both nitrogenous and phosphorous biofertilizers [12].

Crude protein (%), total soluble protein (%) and total soluble sugar (%) contents in S_{36} mulberry

Significant improvement was noticed in crude protein total soluble protein and total soluble sugar content of S_{36} mulberry among the treatments (Table 2). The highest crude protein (20.15%), total soluble protein (10.44%) and total soluble sugar (13.02%) content in S_{36} mulberry leaves were recorded in plots that received 100% Recommended N through 20% each of Compost + *Glyricidia maculata* + Castorcake (CC) + Vermicompost (VC) and Urea + 10 kg each of *Azospirillum brasilense* + *Aspergillus awamori* Biofertilizer + remaining P, K through chemical fertilizers (T_8) followed by T_{10} (20.08, 10.37 and 12.96%) and T_9 (20.01, 10.31 and 12.91%) respectively. Similarly, the lowest crude protein, total soluble protein and total soluble sugar contents (16.75, 8.11 and 11.22%) were observed in T_5. The increased in crude protein may be due to slow releasing nature of nutrients from organic manures might have resulted in higher crude protein content in leaf. Similarly, combination of organic manures + bio-inoculants + inorganic fertilizers recorded significantly higher total soluble sugars in S_{36} and M_5 mulberry leaves [13].

The combined application of different organic manures such as FYM, vermicompost, oilcakes, along with biological inputs such as green manures, biofertilizers and small quantities of chemical fertilizers to the soil, improves the fertility as well as mulberry leaf yield and quality. However, this package was most suitable to organic cultivation in mulberry by supplementing the required nutrients for sustainable mulberry production.

References

1. Vairavan K (2011) Integrated nutrient management in *rabi* black gram. Madras Agric J 98 : 367—369.
2. Singh MK, Roychowdhuri S, Naqui AH, Ghosh MK, Bindroo BB (2012) Studies on integrated nutrient management on leaf quality of silk of mulberry (*Morus alba* L.) grown under rainfed situation. J Crop and Weed 8 : 80—82.
3. Dandin SB, Jayaswal J, Giridhar (2003) Hand book of sericulture technologies. CSB Bangalore, pp 259.
4. AOAC (1980) Official methods of analysis Banes daniel (ed.) published by AOAC, Washington DC Bangalore, pp 105.
5. Hiscox JD, Israelstam GF (1979) A method for the estimation of chlorophyll from leaf tissue without maceration. Can J Bot 57 : 1332—1334.
6. Lowry OH, Rosebrough N, Farr A, Randall R (1951) Protein measurement with Folin phenol reagent. J Biol Chem 193 : 265—275.
7. Dubios M, Giles KA, Hamilton TK, Robeos RA, Smith R (1956) Calorimetric determination of sugars and related substances. Anal Chem 28 : 350—356.
8. Cochran WG, Cox GM (2000) Experimental design procedures for the behavioral sciences. Cole Publ Co, pp 319—380.
9. Rashmi K, Shankar MA, Shashidhar KR, Narayanaswamy TK (2009) Growth and foliar constituents of mulberry (M_5) cultivated under organic based nutrient management. Int J Indust Ent 19 : 165—169.
10. Setua GC, Setua M, Ghosh A, Debnath S, Daata AK, Banarjee ND, Sarkar A (2007) Effect of integrated nutrient management on sustainable quality leaf production in mulberry (*Morus alba* L.) under rainfed alluvial soil condition. Ind J Agric Sci 77 : 286—290.
11. Narayanswamy TK, Rajegowda, Shankar MA, Sreeramulu KR (2006) Effect of different organic manures on growth and yield parameters of M_5 and S_{36} mulberry varieties. Res Crops 7 : 541—543.
12. Ram Rao DM, Kodandaramaiah J, Reddy MP, Katiyar RS, Rahmathulla VK (2007) Effect of VAM fungi and bacterial biofertilizers on mulberry leaf quality and silkworm cocoon characters under semiarid conditions. Caspian J Env Sci 5 : 111—117.
13. Sunil SH (2005) Influence of organic based nutrient management on biochemical parameters of mulberry leaf and silkworm, *Bombyx mori* L. MSc (Ag.) thesis. UAS, Bangalore, pp 110.