RESEARCH ARTICLE
Agricultural Science Digest, Volume 42 Issue 3: 312-316 (June 2022)

Effect of INM Practices on the Leaves Parameters of *Terminalia tomentosa* Food Plant of *Antheraea mylitta* Drury

Soma Karmakar[1], A.K. Srivastava[1], T. Pandiaraj[2], Jyostna Tirkey[3]

10.18805/ag.D-5441

ABSTRACT

Background: *Terminalia tomentosa* is a primary food plant of *Antheraea mylitta* Drury a polyphagous insect of Saturniidae family which is exploited commercially for the production of silk. Good quality of silk production depend on the nutrient of leaf. So, to optimize the nutrient of leaf integrated nutrient management practices has been used to increase soil fertility and to supply plant nutrient at an optimum.

Methods: In order to evaluate the effect of INM practices on the leaves parameters of *Terminalia tomentosa* food plant of *Antheraea mylitta* Drury. An experiment based on randomised complete block design with 21 treatments and three replication was conducted at Central Tasar Research and Training Institute, Nagri, Ranchi in the year 2019-20.

Result: Results revealed that the application of INM treatments are significant on various leaf parameters. Highest single leaf length and breadth mean was observed in T_{19} (23.29 cm; 11.96 cm) was applied with 75% RDF through fertilizer+25% through vermicompost+ *Azotobacter* + PSB, weight of single leaf was found to be highest in T_{13} (5.19 g). The number of leaf was recorded highest in T_{19} (1892). The fresh leave yield ranged from 1617.317-5208.224 g with average mean of 4085.72 g, T_{19} (5032.1 g) recorded the highest fresh leaf yield. The dry matter content was found highest in T_{19} (340.56 g). The moisture content was recorded higher in T_4 (71%) followed by T_{15} (69%).

Key words: *Antheraea mylitta*, Azotobacter, Moisture, *Terminalia tomentosa*, Vermicompost.

INTRODUCTION

Antheraea mylitta the wild silkworm which is commercially exploited for the production of Vanya silk (Bambhaniya *et al*., 2017) is a polyphagous insect and feeds on mainly three primary and dozens of secondary host plant (Suryanarayana *et al*., 2005). Tussar silk in sanskrit is known as “Kosa Silk” (Nakpathom *et al*., 2009; Pilanee Vaithanomsat *et al*., 2008) and is valued for its rich texture and natural deep gold colour (Vigneswaran *et al*, 2015). The tribes and people of weaker section residing in the hilly areas practices this culture since ancient time (Chakraborty, 2018) for their livelihood. The silkworm’s silk gland produces the silk fibre which is a protein mainly consist of fibroin and sericin. The fibroin is coated by a double filament gum called sericin. Sericin helps in the formation of silk cocoon because it acts as a binder which maintains the structural integrity (Patel and Modasiya, 2011, Takeda, 2009). The silk obtained post-cocoon processing depend upon the nutritional contents of leaves (Sinha *et al*., 2002), indicating the importance of leaf quality in the success of Tasar crops (Sahey *et al*., 2001). The foliage quality depend upon judicious management of inputs such as water, micro and macro-nutrients (Sahay and Kapila, 1993). Sufficient amount of balanced nutrients are made available by using organic resources like green manure, vermicomposts, biofertilizer and vermibed/ vermiwash as biopesticides having some antibiotic property and which helps in overcoming nutritional depletion (Zambare *et al*., 2008 and Subsashri, 2004). Fertilization with organic manure enhance the SOC, increase the concentration of nutrients like N, P, K and improves the yield and also influence the microbial biodiversity (Pratibha and Shachi, 2016) and also increases the total microbial community than those treated with chemical fertilizers (Islam *et al*., 2009). SOM provide 90% of plant available N, 80% of plant available P and 50% of plant available S as well as micronutrients (Duxbury *et al*., 1989). Nitrogen, Phosphorus and Potassium are considered primary nutrient as required in large quantities by plant than the rest of the nutrients (Hodges, 1995). Integrated nutrient management along with chemical fertilizers, organic manures and biofertilizers are found to maintain soil fertility and also reduce the cost of cultivation for sustaining increased productivity, an integrated manner is suitable for each farming situation in its ecological, social

[1]Department of Botany, Ranchi University, Ranchi-834 008, Jharkhand, India.
[2]Narendra Deva University of Agricultural Technology, Azamgarh-276 207, Uttar Pradesh, India.
[3]Central Muga Eri Research and Training Institute, Jorhat-785 700, Assam, India.

Corresponding Author: Soma Karmakar, Department of Botany, Ranchi University, Ranchi-834 008, Jharkhand, India.
Email: msmarten436@gmail.com

How to cite this article: Karmakar, S., Srivastava, A.K., Pandiaraj, T. and Tirkey, J. (2022). Effect of INM Practices on the Leaves Parameters of *Terminalia tomentosa* Food Plant of *Antheraea mylitta* Drury. Agricultural Science Digest. 42(3): 312-316. DOI: 10.18805/ag.D-5441.

Submitted: 06-07-2021 **Accepted:** 09-10-2021 **Online:** 19-11-2021

and economical conditions for a longer time. The present investigation was carried out to study the effect of INM practices on the leaf parameters.

Materials and Methods

The present study was carried out in the field of Central Tasar Research and Training Institute, Nagri, Ranchi in the year 2019-20 to determine the influence of inorganic, organic and biofertilizer on Leaf parameters of host plant of Tasar Silkworm (*Antheraea mylitta* Drury). Twenty different combination with three replication were laid out in randomized complete block design (Table 1).

Sample collection and processing

Leaf sample were collected from each treatments for further analysis.

Morphological parameters (Mallapa, 2015)

Length and breadth of leaf (cm)

Length and breadth of leaf were measured from each treatment.

Weight of single leaf (g)

Weight of single leaf from each treatment were recorded.

Number of leaves plant^{-1}

Total number of leaves per treatment were counted.

Leaf yield (g plant^{-1})

Leaf yield per plant was recorded on fresh weight basis in grams.

Dry matter production of leaf (g plant^{-1})

Leaves of each treatment were collected randomly and were air dried followed by oven drying 60°C to a constant weight and expressed in grams.

Table 1: Treatment details.

Treatments	Treatments detail
T_1	Absolute control
T_2	Control with recommended dose fertilizer (RDF)
T_3	50% RDF through fertilizer+50% through vermicompost
T_4	75% RDF through fertilizer+25% through vermicompost
T_5	100% RDF through fertilizer+2% through vermicompost
T_6	50% RDF+Azotobacter
T_7	75% RDF+Azotobacter
T_8	100% RDF+Azotobacter
T_9	50% RDF+Phosphorus solubilizing bacteria (PSB)
T_{10}	75% RDF+PSB
T_{11}	100% RDF+PSB
T_{12}	T_3 +Azotobacter
T_{13}	T_4 +Azotobacter
T_{14}	T_5 +Azotobacter
T_{15}	T_3 +PSB
T_{16}	T_4 +PSB
T_{17}	T_5 +PSB
T_{18}	T_3 +Azotobacter+PSB
T_{19}	T_4 +Azotobacter+PSB
T_{20}	T_5 +Azotobacter+PSB

Physiological parameters

Moisture content (%)

Fresh leaves were harvested from each treatment and weighed in electronic balance to note the fresh leaf weight. Then, the leaves were oven dried at 70°C for 48 hours and the dry weight was recorded and expressed on fresh weight basis (Gravimetric Method). The leaf moisture content was calculated as per the standard of A.O.A.C (1970).

$$\text{Moisture \%} = \frac{\text{Fresh weight of leaf - Dry weight of leaf}}{\text{Fresh weight of leaf}} \times 100$$

Statistical analysis

Statistical analysis was carried out using ANOVA and SPSS 20.0 and duncan's multiple range test (DMRT) was used to determine significance of the difference between individuals means (Gomez and Gomez,1984).

Results and Discussion

Morphological and yield parameters

The leaf parameters were found to be significant in different treatment with inorganic, organic and biofertilizer due to slow and steady release of nutrients in addition to supply of important macro and micro-nutrients besides supply of N and P by nitrogen fixing bacteria and phosphorus solubilizing bio-inoculants respectively (Khan and Pariari, 2012; Rashmi *et al.*, 2006 and Mallapa *et al.*, 2016). The length and breadth of single leaf increased after the application of different treatment. Highest mean of single leaf length was recorded in T_{19} (23.29 cm) was applied with 75% RDF through fertilizer + 25% through vermicompost + Azotobacter + PSB. The breadth was recorded highest in T_{19} (11.96 cm) over the control. Weight of single leaf was recorded highest in T_{13} (5.19 g) and lowest was recorded in T_{15} (2.64 g). The highest number of leaves was recorded in T_{19} (1892) was applied with 75% RDF through fertilizer + 25% through vermicompost + *Azotobacter*+PSB was followed by T_{15} (1704). Increase in number of leaves per plant, average leaf length, leaf width, plant girth was reported by Chaudhuri *et al.*, (2016). Increase in leaf number per plant was reported by Singh *et al.* (2012) and Mallapa *et al.* (2016). Leaf weight indicates the size of photosynthetic system (Adhikari, 2009). Leaf weight is directly related to the level of N applied (Puskarnath, 1976 and Taya *et al.*, 1994). The fresh leave yield ranged from 1617.317-5208.224 g with an average mean of 4085.72 g. The highest leaf yield was recorded in T_{19} was treated with 75% RDF through fertilizer + 25% through vermicompost + *Azotobacter* + PSB. Fresh leaf yield was reported Mallapa *et al.* (2016); Chakraborty, (2018) and Ram, (2017) and increments in leaf yield in Terminalia tomentosa was also reported by Singhvi, 2014. Increase in leaf yield using biofertilizer and INM was

Table 2: Effect of INM practices on leaf quality parameters.

Treatments	Length (cm)		Breadth (cm)		Weight (g)		No. of leave plant^{-1}		Leaf yield g plant^{-1}	
	Mean	Rank	Mean	Rank	Mean	Rank	Mean	Rank	Mean	Rank
T_1	14.53^{k}	20	6.05^{l}	20	3.45^{h}	16	816^{l}	20	1638.08^{k}	20
T_2	17.39^{j}	19	8.42^{h}	13	2.98^{ij}	18	970^{k}	19	2793.51^{j}	19
T_3	22.02^{bc}	4	10.15^{c}	3	4.47^{c}	5	1060^{j}	17	3764.4^{h}	15
T_4	21.25^{cd}	5	8.86^{g}	12	4.24^{d}	6	1006^{k}	18	4067.45^{g}	13
T_5	19.1^{fgh}	12	7.39^{j}	17	3.09^{i}	17	1433^{e}	6	4285.29^{f}	12
T_6	19.31^{fg}	10	9.4^{e}	7	3.93^{f}	13	1220^{gh}	11	3594.2^{h}	16
T_7	20.4^{dc}	7	9.3^{e}	9	4.18^{de}	9	1176^{h}	14	3959.92^{g}	14
T_8	18.37^{hij}	16	9.22^{ef}	10	4.23^{d}	8	1101^{ij}	16	3193.81^{i}	17
T_9	19.31^{fg}	9	9.4^{e}	6	3.93^{f}	14	1246^{g}	10	4796.78^{bc}	5
T_{10}	19.52^{ef}	8	9.48^{de}	5	4.49^{c}	4	1113^{i}	15	4697.37^{cd}	6
T_{11}	18.63^{hi}	13	9.37^{e}	8	3.98^{ef}	12	1315^{f}	9	4533.7^{de}	7
T_{12}	21.21^{cd}	6	8.0^{i}	15	4.24^{d}	7	1488^{d}	4	4396.93^{ef}	9
T_{13}	22.86^{ab}	2	10.54^{b}	2	5.19^{a}	1	1346^{f}	8	4376.4^{ef}	10
T_{14}	18.46^{hij}	15	8.26^{hi}	14	4.02^{ef}	11	1190^{h}	13	3139.1^{i}	18
T_{15}	18.16^{hij}	17	6.33^{l}	19	2.64^{k}	20	1704^{b}	2	4298.56^{f}	11
T_{16}	18.6^{hi}	14	6.95^{k}	18	2.87^{j}	19	1567^{c}	3	4397.29^{ef}	8
T_{17}	17.79^{ij}	18	7.58^{j}	16	3.65^{g}	15	1415^{e}	7	4954.75^{ab}	2
T_{18}	19.28^{fg}	11	8.93^{fg}	11	4.15^{de}	10	1204^{gh}	12	4896.6^{ab}	4
T_{19}	23.29^{a}	1	11.96^{a}	1	4.56^{c}	3	1892^{a}	1	5032.1^{a}	1
T_{20}	22.69^{ab}	3	9.79^{d}	4	4.75^{b}	2	1449de	5	4898.05^{ab}	3
Mean	19.608		8.768		3.952		1285.55		4085.72	
S.Em±	0.2783		0.1839		0.085		33.083		110.019	
Range	14.05-24.11		5.947-12.184		2.547-5.33		807.92-1935.52		1617.317-5208.224	
CD(95%)	0.557		0.3681		0.170		66.198		220.1476	

observed by Nambiar and Abrol, (1992) and Anil Kumar and Johan, (1999). Increase in yield is due to improving plant growth and accumulation of high amounts of sugar which play effective role for cell division and increase in total yield of plant (Waleed and Iman, 2017) (Table 2).

The dry matter content of leaf was found highest in T_{19} (340.56 g) which was applied with 75% RDF through fertilizer +25% through vermicompost+ Azotobacter+PSB and was as per with T_{20} (333.27 g). Increase in dry matter production was reported by Sajan *et al*., (2002) (Table 3).

Physiological characters

The moisture content was recorded higher in T_4 (71%) followed by T_{15} (69%) and T_6, T_{10} (67%). Increase in leaf moisture content was reported by Chowdhury *et al*., (2009); Sujathamma *et al*., (2014) and Ram, 2017. The beneficial effect of organic resources result in improvements of growth attributes, leaf yield and quality due to proper decomposition, mineralization of solubilizing effects and availability of sufficient nutrients. This was corroborated with the findings of Das *et al*.,(1990); Sudhakar *et al*., (2000) and Setua *et al*., (2007) (Table 4).

Combined application of chemical fertilizer and organic fertilizers mitigate the deficiency of many secondary and micronutrients (Sujathamma *et al*., 2014) and biofertilizer application improves the growth and yield parameters by enhancing the uptake of nutrient by plants (Borea,1991).

Table 3: Dry matter content (g plant^{-1}) of *Terminalia tomentosa* influenced by INM practices.

Treatments	Dry matter g plant^{-1}	
	Mean	Rank
T_1	24.48^{l}	20
T_2	48.5^{k}	19
T_3	84.8^{hi}	16
T_4	70.42^{j}	18
T_5	128.97^{h}	12
T_6	85.4^{hi}	15
T_7	235.2^{c}	5
T_8	88.08^{hi}	14
T_9	186.9^{f}	8
T_{10}	55.65^{k}	18
T_{11}	236.7^{c}	4
T_{12}	178.56^{g}	11
T_{13}	255.74^{b}	3
T_{14}	83.3^{i}	17
T_{15}	185.74^{f}	10
T_{16}	94.02^{hi}	13
T_{17}	226.4^{d}	6
T_{18}	204.68^{f}	7
T_{19}	340.56^{a}	1
T_{20}	333.27^{a}	2
Mean	157.368	
S.Em±	11.967	
Range	23.49-351.54	
CD (95%)	23.947	

Table 4: Influence of INM practices on moisture (%) of *Terminalia tomentosa.*

Treatments	Moisture %	
	Mean	Rank
T_1	60.67^{g}	20
T_2	61.66^{fg}	19
T_3	64.33^{cdef}	11
T_4	71^{a}	1
T_5	66^{bcde}	5
T_6	67^{bcd}	4
T_7	63^{efg}	13
T_8	64^{cdef}	8
T_9	62^{fg}	16
T_{10}	67^{bc}	3
T_{11}	64.33^{cdef}	7
T_{12}	63.33^{efg}	15
T_{13}	64.33^{cdef}	10
T_{14}	63.33^{efg}	14
T_{15}	69^{ab}	2
T_{16}	62^{fg}	18
T_{17}	64.33^{cdef}	9
T_{18}	62^{fg}	17
T_{19}	65.33^{cde}	6
T_{20}	63.67^{defg}	12
Mean	64.415	
S.Em±	0.3699	
Range	59.608-73.449	
CD (95.0%)	0.740	

Azotobacter and Azospirillium aid in increased growth due to their nitrogen fixing capacity and also produced growth promoting substances like IAA and GA (Jackson and Brown 1966). PSB was able to solubilise the insoluble form of phosphorus and make it easily available to plants (Sajan *et al*., 2002).

CONCLUSION

The INM practices was found to effect significantly different parameters of leaf and also increased the leaf yield. The inorganic fertilizer is costly and also has hazardous effect on the environment and health hazard to human. On the other hand biofertilizer are cost-effective and non-toxic. Combined application of organic manure along with inorganic and biofertilizer improves nutrient efficiency, protect nutrient from lose and cause less degradation to soil and environment.

ACKNOWLEDGEMENT

The authors are highly thankful to the Director of Central Tasar Research and Training Institute for providing the lab facility and the Head of University, Department of Botany, Ranchi University, Ranchi for constant support and guidance.

REFERENCES

Adhikari, R.C. (2009). Effect of NPK on vegetative growth and yield of desire and Kufri Sindhuri Potato. Nepal Agric. Res. J. 9: 67-75.

AOAC (1970). Official Methods of Analysis (Ed. Daniel Banes) Published by A.O.A.C., Washington, D.C. Banglore. 105.

Bambhaniya, K.C., Naik, N.M. and Ghetiya, L.V. (2017). Biology of tasar silkworm, *Antheraea mylitta* Drury under indoor conditions. Trends in Biosciences. 10(1): 126-131.

Borea, J.M. (1991). Vesicular-Arbuscular Mycorrhizae as Modifiers of Soil Fertility. In: Advances in Soil Science. Springer-veriag, New York. Vol. 15: pp. 2-31.

Chakraborty, B. (2018). Evaluation of the leaf productivity of *Terminalia arjuna* and its impact on commercial traits of Tropical Tasar Silkworm (*Antheraea mylitta* Drury) under organic based agro forestry system. Proceedings of ISER 125th International Conference, Malacea, Malaysia. pp: 6-8.

Chakraborty, B. and Kundu, M. (2015). Effect of biofertilizer in combination with organic manures on growth and foliar constituents of Mulberry under Rainfed lateritic soil condition. The International Journal of Engineering and Sciences. 4(3): 16-20.

Chaudhuri, P.S., Paul, T.K., Dey, A., Datta, M., Dey, S.K. (2016). Effects of rubber leaf litter vermicompost on earthworm population and yield of pineapple (*Ananas comosus*) in West Tripura. India Int. J. Recycle Org. Waste Agricult. 5: 93-103.

Chowdhury, P., Setua, G.C., Ghosh, A., Kar, R., Shivnath, S.K., Maity and Bajpai, A.K. (2009). Organic farming approach for sustainable quality leaf production in mulberry (*Morus alba* L.) var S-1635 under irrigated condition. Journal of Crop and Weed. 5(1): 38-43.

Das, P.K., Chowdhury, P.C., Ghosh, A., Mallikarjuna, B., Suryanarayana, N. and Sengupta, K. (1990). Effect of green manuring, dry weed and black polythene mulching on soil moisture conservation, growth and yield of mulberry and their economics under rainfed condition. Indian J. Seric. 29: 263-72.

Duxbury, J.M., Smith, M.S., Doran, J.M. (1989). Soil Organic Matter As a Source and a Sink of Plant Nutrients. In: Dynamics of Soil Organic Matter in Tropical Ecosystems. University of Hawaii, Honolulu, HI, USA. 2: 33-67.

Gomez, K.A. and Gomez, A.A. (1984). Statistical Procedures for Agricultural Research. John Willey and Sons. New York, USA.

Hodges, S.C. (1995). Soil Fertility Basics. North Carolina State University, Soil Science Extension. 2-75.

Islam, M.R., Trivedi, P., Palaniappan, P., Reddy, M.S., Sa, T. (2009). Evaluating the effect of fertilizer application on soil microbial community structure in rice based cropping system using fatty acid methyl esters (FAME) analysis. World J. Microbial Biotechnol. 25: 1115-1117.

Jackson, K.M. and Brown, M.E. (1966). Behaviour of *Azotobacter chroococcum* introduced into the plant Rhizosphere. Ann. Inst. Pasteur Paris. 111: 108-112.

Khan, S. and Pariari, A. (2012). Effect of N-fixing biofertilizers on growth, yield and Quality of Chilli. The Bioscan. 7(3): 481-482.

Kumar, A., A.S. and John, P.S. (1999). Integrated Nutrient Management for Sustainable Mulberry Production in Humid Tropic. In: Moriculture in Tropics Vol I. Proc Natl. Sem. in Tropical Seric. UAS. GKVK, Bangalore. 53-57.

Mallapa, B. (2015). Integrated nutrient management in mulberry (*Morus alba* L.). M.Sc. thesis. University of Agricultural Sciences. Bangaluru.

Mallappa, B., siddappa, V.S. and Biradar, S. (2016). Effect of Integrated Nutrient Management on growth and yield of mulberry (*Morus alba* L.). The Bioscan. 11(2): 1303-1305.

Nakpathom, M., Somboon, B., Narumol, N. (2009). Papain enzymatic degummimg of thai *Bombys mori* Silk fibers. J. Microscopy Society of Thailand. 23(1): 142-146.

Nambiar, K.M. and Abrol, I.P. (1992). Long term fertilizer experiments in India-An overview. Fertilizer News. 34: 11-26.

Patel, R. and Modasiya, M. (2011). Sericin: Pharmaceutical application. International Journal of Research in Pharmaceutical and Biomedical Sciences. 2(3): 913-917.

Pilanee, V., Taweesiri, M. and Waraporn, A. (2008). Silk degumming solution as substrate for microbial protease production. Kasetsart J. (Nat. Sci.) 42: 543-551.

Prashar, P. and Shah, S. (2016). Impact of Fertilizers and Pesticides on Soil Microflora in Agriculture. In: Sustainable Agriculture Reviews. [E. Lichtfouse (ed.)], Springer International Publishing, Switzerland. 19: 331-361. DOI. 10.1007/978-3-319-26777-7-8.

Pushkarnath (1976). Potato in Sub-tropics. Orient Longman. 289p.

Ram, R.L., Chatterjee, S., Maji, C., Sharma, P.K. and Singh, Y.V. (2017). Integrated effect of FYM and potassium humate on mulberry leaves and bioassay of silkworm in acid soils of Kalimpong Hills. International Journal of Bio-Resource and Tree Management. 8(3): 405-412.

Rashmi, K., Shankar, M.A., Narayanaswamy, T.K., Sreeramulu, K.R. and Rajegowda (2006). Effect of Application of Organic Manures and Inorganic Fertilizers on Growth, Yield and Quality of S36 mulberry. National Conference on New Strategies in Research and Development of Sericulture. India Perspective, Bangalore University, Bangalore (India). pp: 36-37.

Sahay, A. and Kapila, M.L. (1993). Role of Nutrition in Synthesis of Tasar Silk. Indian Silk. 30(2): 8-11.

Sahay, A., Sahay, D.N. and Thangavelu, K. (2001). Disease management during tasar seed production. Workshop on Tasar seed production, planning and grainage. Central Tasar Research and Training Institute, Ranchi. 14-16. p: 32-45.

Sajan, K.M., Gowda, K.K., Kumar, S.N. and Sreramu, B.S. (2002). Effect of bio-fertilizers on growth and yield of chilli (*Capsicum annuum* L) cv. byadagi dabba at different levels of nitrogen and phosphorus. Journal of Spices and Aromatic Crops. 11(1): 58-61.

Setua, G.C., Setua, M., Ghosh, A., Debnath, S., Dutta, A.K., Benerjee, N.D. and Sarkar, A. (2007). Effect of integrated nutrient management on sustainable quality leaf production of mulberry *(Morus alba*) under irrigated alluvial soil conditions. Indian J. Agric. Sci. 77: 286-90.

Singh, M.K., Roy Chowdhuri, S. Naqvi, A.H., Ghosh, M.K. and Bindroo, B.B. (2012). Studies on integrated nutrient management on leaf yield and quality of silk of mulberry (*Morus alba* L.) grown under rainfed situation. Journal of Crop and Weed. 8(2): 80-82.

Sinha, A.K., Sinha, U.S.P., Banerjee, N.P., Prasad, J. and Brahamchari, B.N. (2002). Effect of foliar spray of micronutrients on leaf yield of *Terminalia arjuna* and quality cocoons produced on them. Plant Archives. 2(2): 151-155.

Subsashri, M. (2004). Vermiwash: An effective biopesticide. The Hindu. September 30, 2004.

Sudhakar, P., Gangawar, S.K., Satpathy, B., Sahu, P.K., Ghosh, J.K. and Saratchandra, B. (2000). Evaluation of some nitrogen fixing bacteria for control of foliar disease of mulberry (*Morus alba*). Indian J. Seric. 39: 9-11.

Sujathamma, P., Savithri, G., Vijaya Kumari, N., Asha Krishna, V., Vijaya, T., Sairam, K.V.S.S. and Sreerama, N., Reddy (2014). Effect of organic manures on quantitative and qualitative parameters of mulberry production. Hortflora Research Spectrum. 3(1): 14-20.

Suryanarayan, N., Kumar, R. and Gargi (2005). Monograph on Indian Tropical Tasar Silkworm Food Plants (*Terminalia spp.*) Central Tasar Research and Training Institute. CSB, India.

Takeda, S. (2009). Sericulture. In: Encyclopedia of Insects. [V. Resh and R. Carde (eds)], 2nd edition. Academic Press (chapters).

Taya, J.S., Mallik, Y.S., Pandita, M.L. and Khurana, S.C. (1994). Fertilizer management in potato based cropping system-1: Growth and yield of potato. J. Indian Potato Assoc. 21(3-4): 184-488.

Vigneswaran, C., Nivethinni, D.R., Shilpaa, K. and Dhanapal, S. (2015). Tussar Silk: Scope for Improving Quality by Enzyme Technology. JTATM. 9(3): 1-9.

Waleed F. Hassan and Iman Mohammad, Q. (2017). Effect of Bio-organic fertilization in some nutrients availability, Growth and yield of Cucumber (*Cucumis sativus* L.).IOSR Journal of Agriculture and Veterinary Science. 10(10, VerIV). pp: 13-17.

Zambare, V.P., Padul, M.V., Yadav, A.A. and Shete, T.B. (2008). Vermiwash: Biochemical and Microbiological approach as eco-friendly soil conditioner. ARPN Journal of Agricultural and Biological Science 3(4): 1-5.