Efficacy of biofoliar spray on plant nutrients of different mulberry varieties

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ABSTRACT

Biofoliar spray is a technique of feeding plants by applying nutrients directly on their leaves in a ready form. The objective of the current study was to investigate the interactive biofoliar formulation on their concentrations (15ppm, 30ppm and 45ppm) to enhance plant nutrients (N, P, K, OC, S, Ca, Mg, Zn, Fe, Mn, and Cu) of different mulberry varieties (S-1, S-146, S-1635, BR-2 and AR-14) without harming mulberry ecosystem. Mulberry leaves were collected after biofoliar application and analyzed by using Flame Photometer and Atomic Absorption Spectrophotometer and increase sign in the nutrient concentration of selected mulberry varieties. The investigation implies that, among five mulberry varieties, BR-2 with 45 ppm concentration performed well and enhanced plant nutrients significantly followed by S-146 and AR-14.

Key words: Biofoliar spray, macro-nutrients, micro-nutrients, mulberry.

INTRODUCTION

Biofoliar is an eco-friendly formulation applied for the growth and productivity of mulberry. The main aim is to enhance the essential plant nutrients and biochemical content in an immediate available form. However, for the first time biological based organisms were used for biofoliar spray on mulberry. These, foliar sprays are often used during critical periods *viz;* slow growth periods, flowering and heat stress or injured root systems. This is because the nutrients present in the foliar spray are absorbed directly into the leaf through the leaf cuticle, around the stomata (Handreck and Black, 1994). In mulberry, chemical fertilizers are usually applied to maintain and enhance the quality and productivity per unit area. However, frequent use of chemical fertilizers for a prolonged period of time not only deteriorates soil proportion but also affects the availability and uptake of nutrients in a plants (Subbaswamy *et al.,*1994) this inturn adversely affect the eco-system and increase in prices of agricultural inputs (Patil *et al.*, 2006). Foliar application is an admirable way to supplement instant nutrients to the plants for quick boost, or if it shows any symptoms of nutrient deficiency. Therefore, it is an effective method for correcting the soil deficiencies and to overcome soils inability to mobilize nutrients to the plants. It is found very effective in improving the leaf yield, quality and quantity of mulberry which is an important factor for optimum growth and development of silkworm, *Bombyx mori* (Bose *et al.*, 1994). Result of the similar studies revealed that, foliar application is 8 to 10 times more effective than soil application to 90 per cent of foliar nutrients found in the smallest root of mulberry within 60 minutes of application. Foliar application of essential nutrients has improved the quality, quantity and yields of muskmelon (Giskin *et al.*, 1984), maize (Barel and Black, 1979) and soybean (Giskin and Efron, 1986). The field experiment evaluates the effect of application of organic and inorganic matters and their combination on the leaf quality of mulberry (Jadhav *et al.*, 2000). The foliar spray proved best with ready availability of the material at the real site of action, i.e. the leaves which are to be fed to larvae compared with other application and assimilation efficiency and growth of the larvae fed on leaves treated with panchakavya, vermiwash and Seriboost increased over control (Samuthiravelu *et al.*, 2012). An attempt has been made to interrelate the supplementation of mulberry leaves with combination of secondary and micronutrients on the rearing performance of the silkworm (Vishwanath *et al.*, 1997). Mulberry leaves sprayed with magnesium sulphate, zinc sulphate, potassium chloride ferrous ammonium phosphate, copper sulphate and sodium sulphate fed to silkworm, *Bombyx mori* L., enhanced all growth parameters with application of minerals (Jayaprakash *et al.*, 1998). Application of 'seriboost' as foliar spray after pruning significantly increase in N, P, K, Ca, Mg and S contents of M-5 mulberry variety besides increase in the level of soluble sugars, protein and total chlorophyll (Gowda *et al.,* 2000).

Many nitrogen fixing bacteria such as *Azotobacter, Azospirillum* and *Beijerinckia* are used as foliar spray on mulberry *(Morus alba),* particularly the *Azotobacter* is used as foliar biofertilizer to increase mulberry leaf production (Sudhakar *et al.*, 2000). Nutrients such as calcium (essential part of plant cell wall structure, provides for normal transport and retention of other elements as well as strength in the plant), magnesium (plays vital role in photosynthesis and activate many plant enzymes which are needed for growth), iron (actively participate in transformation of carbohydrates and regulates consumption of sugars) are most important nutrients for mulberry. Micronutrients always play a major role in mulberry cultivation therefore; foliar sprays of micronutrients are known to influence the growth, quality and yield of mulberry crop (Chikkaswamy *et al.*, 2006).

Foliar spray of botanical-II as biocontrol agent reduced the powdery mildew disease caused by *Phyllactinia corylea.* Further, combination of neem oil with fish oil rosin soap as biocontrol agent could be used as an alternate to dichlorvos to manage jassid menace in mulberry as well as to conserve the natural enemies (Sakthivel *et al.*, 2012). The foliar spray of botanical and biocontrol agents are safe and environment friendly for management of major foliar diseases of mulberry (Maji *et al.,* 2006). The present investigation was carried out on efficacy of biofoliar spray of biological based organism on five different mulberry varieties namely S-1, S-146, S-1635, BR-2 and AR-14 for augmentation of plant nutrients in mulberry.

MATERIALS AND METHODS

Collection of samples

The biological based organism blue green algae (*spirulina*), vermiwash and soybeans were procured from the University of Allahabad, Allahabad, Extension Centre of Central Institute of Medicinal Aromatic and Plant Research, Lucknow and Seed Market, Lucknow respectively for preparation of biofoliar formulation.

Extraction of samples

Spirulina and soybean were air-dried in the laboratory and ground to powder using an electric mixer grinder. 450 g of the powdered material of each sample was macerated with 2800 mL of ethanol (90%) for 72 hrs. The extract was filtered and concentrated part dried by evaporation in a water bath at $40^{o}C$ to yield 16.94 g of the crude ethanol extract, which was used for the preparation of biofoliar. Vermiwash extracted from vermicompost containing earthworms (*Eudrilus eugeniae*). The watery yellowish black extract of vermicompost was drain out. The collected vermiwash was centrifuged at 1000 rpm and preserved into sterilized cane for further process.

Formulation of Biofoliar

After extraction, spirulina, soybean and vermiwash were mixed in 3:2:1 proportion to prepare biofoliar spray of different concentrations *viz.* 15ppm, 30ppm and 45ppm and sprayed on mulberry varieties after pruning of mulberry plants.

Digestion and sample preparation

After 60 days of biofoliar spray mulberry leaves of each variety were collected from experimental plots to analyze nutrients (nitrogen, phosphorus, potassium, calcium, magnesium, iron, zinc, manganese, sulphur, sodium, copper, chromium and organic carbon) percentage between treated and control plots present in different mulberry varieties with different concentrations.

Dried mulberry leaf powder 0.5 g was taken from each samples and transferred into a 100 mL conical flask. 10 mL of di-acid mixture (perchloric acid and nitric acid 1:3 ratios) was added in each digestion flasks and kept overnight until the vigorous reaction phase is over. After preliminary digestion, the flasks were placed on hot plate and temperature was raised up to 150°C for 1 hrs and increased gradually until all traces of nitric acid disappeared. After dense white fumes of perchloric acid was appeared in the flask and digestion was continued for 30 minutes. The flask was lifted out from the hot plate and allowed to cool for few minutes later few drops of distilled water was added through the funnel. The solutions were filtered through Whatmann filter paper and double distilled water was added to make up the volume upto 25 mL.

Analysis of plant nutrients

Plant nutrient analysis was done at Analytical Chemistry Division, Indian Institute of Toxicological Research, Lucknow, India. Digested leaves samples were taken for analysis from all treatments and control to know the efficacy of biofoliar spray on mulberry plant nutrients. Nitrogen content was analyzed by micro-kjeldahl method (Kjeldahl, 1983) and Sulphur by Jackson (1973). Plant nutrients such as P, K, Ca, Mg, Zn, Fe, Mn and Cu were analyzed by Atomic Absorption Spectrophotometer at different wave length 420 nm, 548 nm, 422.7 nm, 285.2 nm, 213.9 nm, 248.3 nm, 279.5 nm**,** 324.7 nm and respectively by Parker method using flame photometer and atomic absorption spectrophoto-meter.

Statistical analysis

Data were analyzed by ANOVA to test the significance effect of biofoliar formulation among mulberry varieties. Results were considered significant at $P<0.01$.

RESULTS AND DISCUSSION

The availability of plant nutrients in selected mulberry verities with various concentrations of biofoliar formulation showed distinctive results. Out of 11 plant nutrients analyzed, 10 nutrients were found highly significant ($P<0.01$) in BR-2 mulberry variety with 45 ppm concentration followed by S-146 and AR-14. Nitrogen content was highly significant at $P<0.01$ level and it was highest in S-1 variety with 45 ppm followed by BR-2, S-1635 and S-146. The phosphorus content was enhanced significantly at $P<0.01$ level due to biofoliar spray in BR-2 variety with 45 ppm followed with S-1635, S-146, S-1 and AR-14 variety over control. Potassium content were shown highly significant at $P<0.01$ level value in BR-2 when compared to other mulberry varieties over control. 30 ppm and 45 ppm concentrations enhanced Sulphur content in all five mulberry varieties. However, it was highly significant at $P<0.01$level in BR-2 and S-146 varieties when compared to control. Organic carbon showed highly significant values at $P<0.01$level in leaves of BR-2 variety followed by S-146, S-1 and S-1635 over control (Table 1).

Biofoliar spray was able to enhance plant nutrients in different mulberry varieties. Therefore, Zinc content was noticed highly significant at $P<0.01$level with 30 ppm and 45 ppm in S-1 and AR-14 varieties over control. Magnesium was observed highly significant at $P<0.01$level in BR-2 at 30 ppm and 45 ppm in compared to other varieties and control. Iron was found highly significant at $P<0.01$ and it was highest in S-146 followed by BR-2, AR-14 and S-1635 over control range. The highest value of Manganese content was recorded in BR-2 with 45 ppm concentration and found highly significant. Copper was increased significantly at $P<0.01$level in all mulberry varieties with 45 ppm concentration. However, highest value of Copper was recorded in S-146 and S-1. Calcium content was significantly increased at $P<0.01$ in BR-2 and S-146 whereas less in S-1 (Table 2).

Application of biofoliar spray on different mulberry varieties increased the nutrient availability in mulberry plants, confirming the findings from earlier studies that foliar application on mulberry increased micronutrients content (Bose *et al.*, 1995). The study is also supported by several workers; that beneficial effect of foliar nutrition on leaf yield and plant nutrients of mulberry (Fotedar and Chakraborty, 1985; Quadder *et al.*, 1990). The current results are also supported by Mishra *et al.* (1993) who reported that,

Table1. Impact of bio-foliar spray on macro nutrients of different mulberry varieties

Mulberry Variety	Conc. (ppm)	N (%)			P (%)			K (%)			S (%)			OC (%)		
		Mean	SD	CV %	Mean	SD	CV %	Mean	SD	CV %	Mean	SD	CV %	Mean	SD	CV %
S-1635	15	3.89	0.03	0.78	0.32	0.02	0.63	2.35	0.04	1.70	0.17	0.01	1.81	13.99	0.03	0.18
	30	4.10	0.04	1.01	0.33	0.01	0.62	2.46	0.02	0.62	0.19	0.01	2.48	14.04	0.01	0.08
	45	4.15	0.05	1.24	0.37	0.02	5.27	2.63	0.04	1.34	0.24	0.01	3.84	14.1	0.02	0.14
	C	3.62	0.06	1.67	0.30	0.01	1.41	2.10	0.00	1.30	0.11	0.03	1.50	13.83	0.06	0.18
S-146	15	3.50	0.06	1.72	0.32	0.01	1.26	2.30	0.02	0.67	0.24	0.01	1.098	14.52	0.04	0.28
	30	3.77	0.05	1.36	0.35	0.01	0.58	2.33	0.02	0.74	0.25	0.01	1.39	14.59	0.03	0.17
	45	4.00	0.04	1.01	0.37	0.01	0.83	2.55	0.04	1.41	0.26	0.01	1.72	14.67	0.05	0.31
	C	3.45	0.05	1.49	0.27	0.01	2.46	2.25	0.03	1.36	0.22	0.01	2.55	14.44	0.03	0.17
BR-2	15	3.83	0.08	1.97	0.35	0.01	3.25	3.82	0.07	1.72	0.29	0.01	2.03	14.65	0.02	0.14
	30	4.13	0.11	2.61	0.37	0.01	1.52	3.90	0.04	1.15	0.31	0.00	0.79	14.70	0.01	0.06
	45	4.26	0.04	1.02	0.38	0.00	1.43	4.18	0.04	0.96	0.36	0.01	1.24	14.73	0.01	0.10
	C	3.62	0.07	1.96	0.28	0.00	1.48	3.71	0.04	1.08	0.21	0.05	25.5	14.53	0.03	0.17
AR-14	15	3.54	0.03	0.99	0.30	0.01	1.75	2.19	0.03	1.37	0.18	0.00	2.31	14.28	0.01	0.10
	30	3.72	0.03	0.71	0.32	0.01	1.15	2.29	0.03	1.31	0.19	0.01	2.19	14.33	0.02	0.17
	45	3.87	0.07	1.69	0.34	0.01	2.33	2.40	0.06	2.54	0.22	0.00	1.351	14.39	0.03	0.18
	C	3.52	0.08	2.15	0.25	0.00	1.22	2.13	0.03	1.10	0.18	0.003	1.82	14.23	0.03	0.18
S-1	15	3.84	0.09	2.48	0.31	0.01	1.30	2.31	0.02	0.87	0.17	0.01	2.60	14.43	0.01	0.22
	30	4.21	0.02	0.36	0.32	0.00	0.96	2.34	0.04	1.93	0.18	0.00	1.47	14.46	0.05	0.23
	45	4.30	0.03	0.71	0.37	0.01	2.95	2.41	0.03	1.04	0.19	0.00	1.33	14.52	0.01	0.07
	C	3.59	0.05	1.26	0.26	0.01	1.76	2.22	0.05	2.03	0.17	0.01	4.56	14.33	0.02	0.11

increased nitrogen content in mulberry leaves due to foliar application of triacontanol. Similarly, El-Tayeb (2005) in barely, Gunes *et al.* (2007) in maize, Szepsi *et al.* (2005) in tomato, Yildirim *et al.* (2008) in cucumber, Sarangthem and Singh (2003) in bean stimulated nitrogen uptake by foliar application of salicylic acid. Jain and Srivastava (1981) indicated that regulatory effect of salicylic acid induced promontory effect in mulberry leaf yield. The present study also reported that, potassium, magnesium and calcium content were enhanced by application biofoliar spray in different mulberry varieties. Similar results were observed by Ohnishi and Aoki (1966a, 1966b); potassium content in mulberry leaves increased. However, applying foliar spray did not enhance magnesium and calcium content of different varieties mulberry. The increased potassium content of mulberry leaf in the present study may be due to the availability of adequate potassium in biofoliar and also owing to increased nitrogen content in leaves. An early study of Shankar *et al.* (1994) opined that potassium content increased due to nitrogen has synergistic effect with potassium content of leaves. Similar results were also observed in the present study because Nitrogen content was enhanced by the application of biofoliar spray. The improvement in the plant nutrients (Zn, Mn, Fe and Cu) and thereby quality of mulberry leaves by application of seriboost may be attributed to its micronutrient content and to the fact that each micronutrients plays significant role in specific physiological and biochemical processes of mulberry Gowda *et al.* (2000). Therefore, presence of micronutrients content with vermiwash (Kale, 1998; Ismail, 2005) in biofoliar formulation enhanced micronutrients of different mulberry varieties.

Table 2. Impact of bio-foliar spray on Zn, Mg, Fe, Mn, Cu and Ca (mg/100gm) of different mulberry varieties

Mulberry Variety	Conc. (ppm)	Zn (mg/100gm)			Mg(mg/100gm)			Fe(mg/100gm)			Mn(mg/100gm)			Cu(mg/100gm)			Ca(mg/100gm)		
		Mean	**SD**	**CV%**	**Mean**	**SD**	**CV%**	**Mean**	**SD**	**CV%**	**Mean**	**SD**	**CV%**	**Mean**	**SD**	**CV%**	**Mean**	**SD**	**CV%**
S-1635	**15**	2.06	0.01	0.49	3.65	0.08	2.24	33.7	0.11	0.32	3.08	0.04	1.30	0.43	0.02	4.65	88.00	2.00	2.27
	30	2.08	0.01	0.48	4.56	0.12	2.64	34.8	0.18	0.51	3.34	0.05	1.51	0.51	0.03	4.90	90.33	2.52	2.77
	45	2.14	0.02	0.72	5.32	0.16	2.92	36.2	0.62	1.71	3.80	0.00	1.10	0.53	0.03	4.72	139.0	3.61	2.59
S-146	**15**	2.34	0.04	1.71	4.47	0.09	2.05	35.4	0.08	0.22	4.98	0.09	1.73	0.43	0.02	4.65	94.67	2.52	2.66
	30	2.42	0.02	0.63	4.84	0.05	1.06	35.6	0.09	0.25	6.20	0.07	1.15	0.56	0.04	6.19	119.7	1.53	1.28
	45	2.56	0.03	1.19	5.15	0.04	0.68	48.2	0.12	0.26	6.92	0.05	0.65	1.48	0.02	1.35	122.3	2.52	2.06
BR-2	**15**	2.12	0.01	0.55	6.07	0.06	0.94	35.2	0.06	0.17	6.88	0.07	0.94	0.35	0.02	5.71	143.3	4.51	3.15
	30	2.19	0.02	0.70	6.16	0.13	2.09	43.2	0.05	0.12	9.08	0.09	1.01	0.38	0.03	6.57	159.7	4.51	2.83
	45	2.36	0.07	2.97	6.44	0.06	0.87	44.3	0.02	0.05	9.23	0.06	0.60	0.55	0.05	8.33	168.3	4.16	2.47
AR-14	**15**	2.51	0.05	1.79	5.07	0.07	1.42	32.8	0.06	0.19	5.13	0.05	0.89	0.42	0.01	2.38	111.0	2.00	1.80
	30	2.74	0.07	2.56	5.32	0.08	1.42	42.5	0.05	0.12	5.22	0.04	0.78	0.45	0.02	4.44	112.0	3.61	3.22
	45	2.94	0.06	1.94	5.34	0.05	0.94	44.3	0.07	0.16	6.14	0.02	0.33	0.77	0.05	5.88	114.3	2.52	2.20
S-1	**15**	2.69	0.07	2.60	3.53	0.09	2.44	26.52	0.07	0.25	5.3	0.05	0.88	0.29	0.02	5.33	93.00	2.00	2.15
	30	2.79	0.02	0.55	4.12	0.03	0.73	31.91	0.06	0.19	5.99	0.10	1.74	0.44	0.02	3.45	93.67	1.53	1.63
	45	3.07	0.04	1.30	4.36	0.08	1.84	33.33	0.06	0.18	6.06	0.05	0.83	1.44	0.06	4.48	96.67	1.53	1.58
S-1635	**Control**	2.05	0.01	0.49	3.29	0.18	5.40	32.61	0.13	0.38	2.42	0.06	2.52	0.388	0.03	8.11	71.67	3.51	4.90
S-146	**Control**	2.27	0.02	0.92	4.21	0.06	1.31	31.65	0.26	0.83	4.50	0.06	1.34	0.39	0.02	5.13	77.33	3.06	3.95
BR-2	**Control**	2.09	0.01	0.73	5.57	0.12	2.16	35.04	0.03	0.07	5.25	0.10	1.96	0.34	0.01	2.94	82.00	4.00	4.88
AR-14	**Control**	2.41	0.02	0.83	4.97	0.09	1.74	29.97	0.14	0.46	4.99	0.06	1.22	0.31	0.02	6.64	97.67	1.53	1.56
S-1	**Control**	2.62	0.03	1.17	3.39	0.06	1.77	25.69	0.07	0.26	5.22	0.05	0.88	0.29	0.02	6.90	66.67	2.52	3.78

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