Application of Foliar Nutrients to Increase Productivity in Sericulture

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ABSTRACT

It is a well acknowledged fact that foliar nutrients provide instant nourishment to the plants which not only enhance the growth rate of plants but also boost their productivity. Present review focuses on bringing in a nutshell, diverse information about different foliar formulations (natural, synthetic and commercially available) which can play a significant role in sustainable improvement of mulberry plants and silkworms, Bombyx mori L. (Lepidoptera: Bombycidae). Furthermore, it reveals that foliar sprays on mulberry plants help in disease management, enhance biochemical constituents in mulberry plants, silkworm growth as well as cocoon parameters. Thus, foliar sprays have a wider impact on sericulture productivity.

Key words: Mulberry, silkworm, foliar nutrients, quality, productivity, disease

INTRODUCTION

It is a well established fact that, synthetic chemicals, fertilizers, pesticides, herbicides, growth promoters and other inputs though enhance productivity but adversely affect the eco-system and increase prices of agricultural inputs (Fatil et al., 2006). Due to excessive use of insecticides and fungicides for improving productivity of mulberry cultivars, these chemicals pose a serious threat not only to mulberry crop but also the environment. So an alternative approach is necessary for the purpose of enhancing mulberry production without causing substantial damage to the ecosystem. Foliar spray in liquid form with plurality of strains is generally used as spray for augmentation of crop yield and leaf quality.

The main aim of applying foliar nutrients to mulberry plants is to enhance essential nutrients and biochemical content in a readily available form. These sprays are not only cost effective but also have a longer life as compared to solid biofertilizers and chemical fertilizers (Katiyar et al., 1995). It is easy to apply and has been found to be highly effective for the growth and development of mulberry crop. Due to presence of antioxidants, essential amino acids, macro and micronutrients in foliar spray, it directly influences the growth of mulberry and is also capable of enhancing the productivity of mulberry.

Biological organisms play very important role and can be used as constituents in foliar spray. Nitrogen fixing algae i.e., Nostoc and Anabaena have been used to evaluate different combinations of nutrients both in indoor and outdoor cultures used as foliar sprays for mulberry cultivation (Bongale, 1989). Plant growth promoting bacterium applied as foliar spray on Lycopersicon esculentum and Cucumis sativus increased biochemical contents and growth parameters of plants (Dursun et al., 2010).
Application of sodium chloride at one per cent concentration imposed through roots by irrigation during the growth period of mulberry (S-1 variety) decreased the leaf yield, photosynthetic rate and water use efficiency. Sodium chloride treatment drastically reduced the soluble protein content but the opposite trend was also noticed in the case of soluble sugar and proline content of mulberry. Foliar spray of kinetin (Lee, 1985) and spermidine with different concentrations increased the leaf yield and photosynthetic rate under normal condition (Das et al., 2000). Hosny et al. (1996) showed that 'ethrel' can be used as an effective foliar spray on Morus alba and Baladi trees. It was also seen that the quality and percentage of dropped leaves were found more in untreated plants. The total nitrogen content increased in dropped leaves while the sugar content decreased.

Gowda et al. (2000) studied the efficacy of foliar spray 'seriboost' on mulberry and its impact on cocoons production. Foliar spray on M-5 mulberry variety significantly increased the number of shoots, shoot height, number of leaves and total yield. In addition, to that increased N, P, K, Ca, Mg, S and level of soluble sugars, protein and total chlorophyll.

**IMPORTANT OF FOLIAR SPRAY**

Nutrients present in the soil are not well absorbed in deep rooted plants and translocation of nutrients to shoots is sluggish under adverse soil condition which favour soil fixation of nutrients. Mulberry (Morus spp) as a deep rooted high biomass producing foliage crop, responds well to foliar nutrition. Foliar application in right time increases level of absorption in specific nutrients to the leaf during growth and development (Narahari et al., 1997).

Effects of foliar spray of urea (Goding and Davies, 1992; Readman et al., 1997) along with different doses of NPK fertilizers significantly increase leaf yield and nutrients like moisture content, protein, sugar, reducing sugar and starch in both tender and matured leaves (Quader et al., 1989). Commercially available foliar formulations namely Plantoflex, Microflex, Multizyme and Harith used on M-5 mulberry variety under irrigated condition increased yield, quality, total chlorophyll, sugar and protein contents of mulberry (Narahari et al., 2001).

Plant nutrients like magnesium, manganese, iron, zinc and boron are also used as foliar spray on mulberry crop for enhanced growth, yield, quality (Loknath and Shivasankar, 1986), cocoon weight and cocoon yield (Vishwanathan and Krishnamurthy, 1982). The influence of micronutrients was studied by assessing the quality of leaves offered to bivoltine race Kalimpong-A (Kasivishwanathan, 1986) on larval development and cocoon characters of silkworm (Bombyx mori L.).

Das et al. (2002) found that, foliar spray of kinetin based plant growth regulator (Biozyme) spray to mulberry plant before onset of water logging, showed that biozyme partially compensated the water logging effect and increased the leaf yield by 30% and improved the chlorophyll, sugar content and photosynthetic rate significantly. Foliar spray of Indol Acetic Acid (IAA) and Gibberellic Acid (also called Gibberellin A3, GA and GA3) as plant growth regulators significantly improved leaf lobation and sex expression of Kajli and Mysore Local cultivars of mulberry (Govinda and Basavaiah, 2006).

Previous studies have shown that, liquid fertilizers significantly improve crop productivity and it has also been reported that, foliar application of urea increased the protein content of wheat grain (Abod et al., 2004). The effects of foliar spray of CCC (2-Chloroethyl-trimethyl-ammonium chloride) on growth and metabolic activities of mulberry were calculated. Leaf area, fresh and dry weight of leaves and height of shoot was not found effective but it was effective in enhancing diameter of shoot and chlorophyll content (Lee, 1980). The activities of hydrolytic reducing sugar in mulberry leaves of infiltrated sucrose were lower than those of the control in all treated leaves
but the activities of synthetic non-reducing sugar in the mulberry leaves infiltrated glucose were higher. Growth regulators especially 'Cytokinin' modify morphological and physiological characteristics of plant and also induce better adaptation of the plant to environment which improves the growth and yield. Such compounds induce cell division and organogenesis in plant cell cultures and affect many other physiological and developmental processes in plants (Ibrahim et al., 2001). Different types of foliar spray (Table 1) can be used effectively to enhance nutritive quality of mulberry leaves and their use will help to reduce the extensive usage of chemicals and insecticides.

Table 1: Commonly used foliar nutrients in mulberry production

<table>
<thead>
<tr>
<th>Foliar nutrients</th>
<th>Improvement in plant</th>
<th>Source of information</th>
<th>Natural</th>
<th>Synthetic</th>
<th>Commercially available product</th>
</tr>
</thead>
<tbody>
<tr>
<td>Botanicals</td>
<td>Chlorophyll-a, b, total chlorophyll, total soluble sugar, total soluble protein and total soluble phenol</td>
<td>CSR and TI, Berhampore, India.</td>
<td>+</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>B-nine</td>
<td>Leaf moisture and chlorophyll</td>
<td>RSRS, Dehradun, India.</td>
<td>+</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Phalda</td>
<td>Leaf yield</td>
<td>RTB, Bhandara, India.</td>
<td>+</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Tracele, Narasas, Mircon 329 Amruth, Parve, Plantovit</td>
<td>Growth, quality and yield of mulberry leaves</td>
<td>DOS, Bangalore University, India.</td>
<td>+</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Azotobacter chroococcum</td>
<td>Atmospheric nitrogen</td>
<td>CSR and TI, Mysore, India.</td>
<td>+</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Seri-Azo and Seri-Phos</td>
<td>Mulberry leaf yield and quality</td>
<td>DOS, IAS, Dharwad, India.</td>
<td>-</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>Di-ammonium phosphate</td>
<td>Total chlorophyll, crude protein, total carbohydrates, nitrogen phosphorus, potassium, calcium, magnesium and sulphur.</td>
<td>DOS, GKVE, Bangalore, India.</td>
<td>-</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>Doman</td>
<td>Amino acids, citric acid and humic acid, photosynthesis</td>
<td>DOS, GKVE, Bangalore, India.</td>
<td>+</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>Bione</td>
<td>Chlorophyll, sugar content and photosynthetic rate on water logging effect</td>
<td>CSR and TI, Berhampore, India.</td>
<td>+</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>VAM</td>
<td>Leaf quality and quantity</td>
<td>RSRS, Chamarajanagar, India.</td>
<td>+</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>Green Leaf</td>
<td>Shoot height, number of shoots, leaves per plant, fresh leaf yield, dry leaf yield, moisture content</td>
<td>DOS, Bangalore University, India.</td>
<td>+</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Sereboost</td>
<td>N, P and K constituents of the leaf</td>
<td>SDTC, Bangalore, India.</td>
<td>+</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>Sodium chloride</td>
<td>Soluble sugar and proline</td>
<td>CSR and TI, Berhampore, West Bengal, India.</td>
<td>-</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>Ethrel</td>
<td>Nitrogen content increased in dropped leaves</td>
<td>PPRI, DOS, Dokki-Giza, Egypt.</td>
<td>-</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Plantonik</td>
<td>Chlorophyll, proteins, sugar and amino acid</td>
<td>RSRS, Jorhat, Assam, India.</td>
<td>+</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Urea and NPK</td>
<td>Nitrogen in plants</td>
<td>BAAS, Dhaka, Bangladesh.</td>
<td>-</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>Plantoflex, Microflex</td>
<td>Growth, quality and yield of mulberry leaves</td>
<td>KSSF and DI, Bangalore, India.</td>
<td>+</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Multiye</td>
<td>Leaf moisture and chlorophyll</td>
<td>KSSR and DI, Bangalore, India.</td>
<td>+</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Nestoc, Anabasena</td>
<td>Leaf yield</td>
<td>KSSR and DI, Bangalore, India.</td>
<td>+</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>2-Chloroethyl-trimethylammonium chloride</td>
<td>Metabolic activities</td>
<td>CACNU, Kwangju, Korea Republic.</td>
<td>-</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Harith</td>
<td>Leaf yield and quantity</td>
<td>KSSR and DI, Bangalore, India.</td>
<td>+</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Tracele-2</td>
<td>Leaf spot disease</td>
<td>Rallis India Ltd., Bangalore.</td>
<td>-</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>PGPR</td>
<td>Leaf rust disease</td>
<td>RSRS, Chamarajanagar, India.</td>
<td>+</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

+: Yes, -: No
FOLIAR SPRAY AND PLANT RELATIONSHIP

The uptake of plant nutrients varies according to the plant species, variety and agro-climatic conditions which ultimately determine factors such as leaf morphology, structure and the rate of physiological processes. Several investigators have been reported on the penetrability of the lower epidermis vs. the upper epidermis which will be governed chiefly by stomatal and cuticular variations between the two leaf surfaces (Currier and Dybing, 1959; Wojick, 2004). The structure and composition of the cuticle as well as the morphology, distribution and sizes of the stomata and leaf hairs differ between plant species and influence foliar uptake processes. Variations in cuticular structure and composition resulted into differences in leaf wettability, retention and penetration of substances.

Selective permeability of the cuticular edges of guard cells has been reported (Eichert and Burkhardt, 2001; Schlegel et al., 2006; Schonherr, 2001). Tender and partially-expanded leaves are more penetrable than fully expanded leaves (Sargent and Blackman, 1962). The stomata present in old leaves may fail to open and penetrability of foliar spray suffers adversely (Turner and Begg, 1973).

MICRO ORGANISMS AS FOLIAR SPRAY

Continuous use of chemicals, insecticides, fungicides and antibiotics lead to evolution of resistant pathogen strains, a major constraint in enhancing productivity. Various investigators determined that Plant Growth Promoting Rhizobacteria (PGPR) can stimulate growth and increase yield in sugar beet (Cakmak et al., 2006), in spring barley (Salantur et al., 2005), in apricot (Esitken et al., 2003; Altindag et al., 2006), in raspberry (Orhan et al., 2006) and in apple (Aslantas et al., 2007). Maximum grain yield were produced from inoculation of blue green algae alone or in combination with Azospirillum in different seasons (Sharief et al., 2006). Arbuscular Mycorrhizal Fungi (AMF) also well known for phosphorus solubilization, increased plant nutrients uptake and in control of root diseases in mulberry (Bharadwaj and Satyawati, 2006).

Several studies have also shown that, liquid biofertilizer formulations i.e., Azotobacter, phosphate solubilizing microorganisms and potash mobilizing bacteria, carrier based biofertilizers formulation (Seri-Azo, Seri-Phos and Potash Mobilizing Bacteria) and foliar application in rhizosphere have significantly enhanced leaf yield of mulberry, quality and soil health under irrigated condition. However, the role of potash mobilizing bacteria Fratureia aurentia belonging to the family Pseudomonaceae in liquid or carrier based forms was found to be quite promising when applied in the rhizosphere of mulberry (Saha et al., 2003). Application of Vesicular Arbuscular Mycorrhiza (VAM) and Azotobacter has shown a way of saving on expensive fertilizers like Nitrogen and Phosphorus thereby improving leaf yield and quality. Unlike chemical fertilizers, VAM and Biofertilizer enrich the soil fertility and are eco-friendly (Srikantasmwamy et al., 2001). Kumar et al. (2009) studied the efficacy of blue green algae (Spirulina) as a foliar spray drastically enhanced pupal weight, cocoon weight, shell weight and silk filament length.

EFFICACY OF FOLIAR NUTRIENTS IN ENHANCING BIOCHEMICAL CONSTITUENTS IN MULBERRY

Biochemical analysis revealed that, foliar spray of botanicals increased Chlorophyll-a, b, total chlorophyll, total soluble sugar, total soluble protein and total soluble phenolic content. Kumar et al. (2010a, b) evaluated the best mulberry variety from the locally available for silkworm feeding based on the nutritional composition, physiological and biochemical parameters.
The effect of B-nine on growth modification of mulberry viz. moisture and chlorophyll contents in the leaf as major component and also produced thicker and darker leaves with high nutritive values (Mohan et al., 2006). ‘Navaras’ a proprietary commercial nutrient used as foliar spray on Kanva-2 mulberry variety significantly increased the growth and number of leaves per plant along with other biochemical parameter (Chikkaswamy et al., 2006). He also reported that, effect of ‘Vipul’ as foliar spray on mulberry under irrigated conditions increased leaf yield, leaf moisture, number of shoots and number of leaves. Plant growth promoter ‘Phalsa’ is used as foliar spray which increases the growth and leaf yield of mulberry and its application produced variety specific results.

Response of mulberry varieties like K-2, S-13 and S-34 was positive on growth parameters, except plant height, leaf yield and biomass production (Singhvi et al., 2006). Daman Penshibao is a multifunctional organic acids (amino acids, citric acid and humic acid) with the necessary major nutrients, micro elements and vitamins (Jyothi et al., 2002). It is known to promote the uptake of nutrients, stimulate photosynthesis, protein synthesis and activate enzyme action. Foliar application of Daman Penshibao has significantly increased the chlorophyll-a, chlorophyll-b, total chlorophyll and soluble protein while crude protein was higher. Plantonik a micronutrient formulation was found to be effective for improvement in leaf yield of mulberry over control through foliar spray. The leaf biomass was also improved significantly in ‘Plantonik’ sprayed plants (Phukan et al., 1995).

Raj et al. (2003) investigated the effect of different doses/forms of phosphatic fertilizer and methods of application on improving the quality of mulberry leaf of M-5 variety and elemental composition under irrigated condition. Foliar application of phosphorus through Single Super Phosphate (SSP) and Di-ammonium Phosphate (DAP) recorded significantly results. It enhance leaf moisture percentage, total chlorophyll, crude protein, total carbohydrates and plant nutrients such as nitrogen, phosphorus, potassium, calcium, magnesium and sulphur content (Trivedy et al., 2003). Foliar treatment with different concentrations of potassium chloride (KCl) to mulberry plants resulted in higher level of total chlorophyll, total sugars and soluble protein (Das et al., 2003). Biochemical factors such as sugar, protein, moisture content and leaf yield significantly increased by application of ‘green leaf’ as foliar spray (Chikkaswamy et al., 2001).

ROLE OF FOLIAR SPRAYS ON MULBERRY DISEASE MANAGEMENT

Many diseases of mulberry affect the leaf yield and nutritive quality. Therefore, Maji et al. (2003) developed eco-friendly control of different mulberry diseases using two botanicals viz., botanical-I and botanical-II and one biocontrol agent. Botanical-II and biocontrol agent reduced powdery mildew disease which is caused by Phyllactinia moriela. The findings indicated that foliar spray of botanicals is safe and eco-friendly for management of major foliar diseases of mulberry. Further, foliar spray of medicinal plant extract of neem, parthenium and bulb extract of garlic were tested to assess their effect on conidial germination of Phyllactinia moriela and powdery mildew disease development on mulberry leaves and these were found to drastically reduce the Percent Disease Index (PDI) (Vidyasagar and Rajasab, 2001).

Leaf spot disease of mulberry is very common, causes substantial yield loss caused by Cercospora moriela which is controlled by Tractol, Navaras, Mireon ‘820’ Amruth, Paras, Plantovit, Micromixture (Chikkaswamy, 2006) and Tractol-2 (Tectia et al., 1994). As a result, disease resistant mulberry varieties viz. BM-4 and BM-5 (Ghosh et al., 2003) were evaluated to decrease the substantial crop loss. Srikantaswamy and Subramaniam (2005) have reported Azotobacter
**FOLIAR SPRAYS AS SILKWORM GROWTH ENHANCER**

Ito and Numinura (1966) and Horie et al. (1967) suggested that potassium, magnesium, iron, manganese and cobalt are essential for the growth of silkworm. Therefore, mulberry leaves sprayed over with macro and micronutrients were fed to the *Bombyx mori* L. and observed that all silkworm growth parameters were found to be improved (Vishwanath et al., 1997; Jayaprakshrao et al., 1998; Basit and Ashfaq, 1999). Foliar application of ‘seriboost’ significantly improved larval weight of silkworms (Singhvi et al., 2002). Further, Bose et al. (1994) also observed the enhanced total larval duration and larval weight. Ankalgi and Ansari (1992) developed foliar spray of triacontal and fasal which is effectively used in silkworm disease management. Islam et al. (2004) resulted that nickel chloride can be used at low concentrations for enhancing the economic character of silkworm, *Bombyx mori* L.

The nutritional supplement of soluble protein aqueous extracts from waste pupae on larval instars of *Antheraea assama* in different concentrations has an impact on the larval growth and cocoon parameters. The increased rate of food absorption in silkworms is evident with the enrichment of mulberry leaves by leaf extracts of *Coffea arabica* (Jeyapaul et al., 2003). The protein extract of muga pupa can be utilized as a supplement on the muga food plant as a growth stimulator in silkworm (Saikia and Das, 2005).

Effects of *Tridax procumbens*, *Tribulus terrestris* and *Parthenium hysterophorus* recorded significantly higher mature larval weight and found to be superior over controls and bringing down the larval mortality (Murugesh and Bhaskar, 2007). The silkworms fed with foliar spray of Green Leaf have improved cocoon weight, shell weight, pupal weight and filament length significantly enhanced when cocoons spun by worms fed with foliar treated leaves (Chikkaswamy et al., 2001).

**ROLE OF FOLIAR SPRAYS ON SILKWORM DISEASE MANAGEMENT**

The most commonly used methods of preventing diseases in silkworm are through application of chemicals. In nature, a number of plants have been found to harbor antiviral substances. Srivastava and Kumar (2009) studied the effect of antibiotics on reduction of mortality rate in mulberry silkworm (*Bombyx mori* L.). Phytochemicals like flavanoids has anti-microbial activity (Bernabas and Nagarajan, 1988) and their possible role in defense mechanism of silkworms (Chandrakala et al., 2007). Administration of seed extract of *Plectranthes corylifolia* and leaf extract of *P. ambonicus* to third instar silkworms resulted into reduction in mortality due to grasserie disease (Manimegalai and Chandramohan, 2006; Ranganatha et al., 2004). It is also noticed that higher doses of vitamin C, lowered the silk yield and caused decline in growth of silkworm larvae (Hussain and Javed, 2002). Some fungicides and chemicals were evaluated to control Muscardine disease in the silkworm *Bombyx mori* L. (Chikkaswamy et al., 2007).

Antifungal activity of certain botanicals in which the highest growth inhibition and lowest sporulation of *Beauveria bassiana* were observed with *Phyllanthus niruri* (Savitha and Bhaskar, 2005). Extract of algae (*Turbinaria conoides*) were found effective against *Beauveria bassiana* infected silkworm larvae for antifungal activity (Kumari et al., 2011). According to Shuba and Bhaskar (2006), the leaf extracts of *Adhatoda vasica*, *P. niruri*, *P. corylifolia*, *Tribulus*
terrestris and Willania sonniferum when supplemented through mulberry leaf to BmNPV infected larvae, were able to inhibit multiplication of BmNPV.

**EFFECT OF FOLIAR SPRAYS ON COCONO PARAMETER**

Silk protein synthesis starts in fourth and fifth instar of silkworm, there is a huge demand for protein rich food in late instars. Dietary supplementation of the leaf, flower and pod extract of *Moringa oleifera* elicited varied responses in the final instar larvae of the mulberry silkworm, *Bombyx mori* L. (Rajeswari and Isaiaresu, 2004). Various minerals viz. N, P, K, Ca, Mg and Cu, respectively in various combinations were enhanced silk production of *Bombyx mori* L. (Ashfaq et al., 2000).

*Amaranthus* grain powder is very rich in carbohydrates, protein, iron and a-carotene and it is found to be effective in increasing silk yield coupled with increased cocoon and shell weights (Gururaja and Patil, 1997). The application of leaf extract of *Acacia indica* and *Vitex negundo* at different concentrations on silkworm has significantly improved the shell weight and silk filament length (Sujatha and Rao, 2004). *Parthenium* root extract induced silkworms to feed more resulting in higher cocoon and pupal weight and better survival (Patil et al., 2005). The conversion of ingested dry matter into shell was increased by 20% in silkworms due to the application of *Spirulina* solution (Kamalakannani et al., 2005).

**FUTURE PERSPECTIVE OF FOLIAR SPRAY**

Foliar sprays influence the performance of mulberry varieties in terms of physiological parameters of plants viz., protein, carbohydrate, chlorophyll, carotenoids etc. Further research is needed to know the potential interactions between formulation components using modern analytical techniques. Efforts are to be made to understand the relevance of the biochemical properties of biofoliar sprays of blue green algae, medicinal plants and vermiwash extracts containing formulations and its significance in the changes of leaf surface in relation to the foliar uptake of nutrients. The process of penetration of biological organism containing solutions is increasing growth, quality and quantity of mulberry. The role of physiological processes and environmental factors in foliar uptake and distribution are required to be investigated further using intact leaves. In a nutshell, more information relating to biological organism based foliar spray and plants relationship. Eco-friendly and holistic approach is required to develop effective foliar spray formulations to correct widespread deficiency of mulberry and to sustain sericulture.

**CONCLUSION**

Foliar feeding is a technique of feeding plants by applying nutrients directly to their leaves. Foliar spray has been used as supplemental doses of minor and major nutrients, plant hormones, botanicals, stimulants and other beneficial substances. It has been known for many years that plants are able to absorb essential nutrients through their leaves and develop defense mechanisms to resist several mulberry and silkworm diseases. Study concluded that foliar nutrients improved drought tolerance, increases crop quality and yield of mulberry, enhanced silkworm growth and cocoon productivity without harming flora and fauna.

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