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Management of Soil Fertility for Sustaining Quality Mulberry Leaf Production in North India

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Abstract- The silk industry in Jammu and Kashmir (J&K) state is of very ancient origin. Due to natural irrigation system and highly salubrious climatic conditions is very suitable for bivoltine sericulture. Soil fertility is only one of a number of factors that determine the magnitude of crop yield. Low fertility results in decreased crop development and yield. The fertility of the soil can be managed by fertilization or by application of appropriate management approach. Plants sequester nutrients from atmosphere via photosynthesis and absorption by roots from soil, proportion of which in turn is taken up by animals and returned back to soil. The soil microbial biomass is the living portion of organic content in soil, maintenance of which facilitates retention of soil organic pool and nutrient availability. Increasing organic carbon in soil improves soil health, reduces soil erosion and degradation, improves surface water quality, and increases soil productivity. Indiscriminate use of inorganic fertilizers may have deteriorated the soil characteristics and its micro-flora. In view of above reasons, the output yields of mulberry are low in the traditional sericulture zones. Application of green technologies will pave way for sustenance of soil fertility and quality leaf production.

Keywords- micronutrients, mulberry, nutrients, organic farming, soil health

I. INTRODUCTION

Jammu and Kashmir has an age old tradition of sericulture. Temperate climatic conditions of Kashmir are excellent for the bivoltine sericulture [1]. The sericulture in the region however, sustains on tree type of plants which is available on road side, bund side, river side and borders of agricultural fields etc [2]. Most of the traditional farmers in these areas have taken sericulture as secondary occupation. Other farmers with more land have taken up mulberry sericulture only as a subsidiary occupation in the major portion of their land. Thus as a result of financial constraints and ignorance on the part of majority of stake holders, mulberry is cultivated in nutrient deficient land. Due to the above constraints, the quality and yields of mulberry are low in the conventional areas [3]. Organized intensive plantation is not taken up at the commercial level in the region (Fig.1). In light of above, the leaf quality gets affected especially without application of any inputs. The average bivoltine silk production is 55.0 kg/100 DFLs whereas, in J&K it is around 35.0-40 kg /100 DFLs. So, attempts are required to be made to develop sustainable ways to improve leaf quality.

Fig.1: Mulberry plant growing around the edges of farm.

II. REQUIREMENT OF NUTRIENTS FOR PLANT GROWTH AND DEVELOPMENT

Plants require proper nutrients to grow. Nutrients are available in organic and inorganic forms. Plants require essential nutrients to sustain growth and development. Plants need macronutrients and micronutrients. Absorbed through the roots from the soil these nutrients mix with water and carbon dioxide to make food. If soil has an inability to produce sufficient amounts of any of these nutrients you can add fertilizers enriched in nutrients to give it a boost [4]. Seventeen elements are now days considered as important for plant's growth. These chemical elements are divided into two main groups: mineral and non-mineral.

Mineral Nutrients: The nutrients, are absorbed from the soil directly, are dissolved in water and absorbed through a plant's roots. These are not available always in ample quantity in the soil for a plant. Due to this reason, in most cases fertilizers are used to add the nutrients to the soil. The mineral nutrients are divided into two groups:

Macronutrients: Macronutrients are divided into two more groups: primary and secondary nutrients. The primary nutrient includes nitrogen (N), phosphorus (P) and potassium (K). The macronutrients are often lacking from the soil, because plants use large of their amounts for growth and survival. The secondary nutrients include calcium (Ca), magnesium (Mg) and sulphur (S). These nutrients are moreover present in soil so application of inputs is not needed frequently. Considerable quantum of Calcium and Magnesium are added when lime is applied to acidic soils. Sulphur is usually found in required amounts from the decomposition of soil organic contents.

Micronutrients: These elements are needed in minimal (micro) quantities. These are called minor elements or trace elements, These are boron (B), copper (Cu), iron (Fe), chloride (Cl), manganese (Mn), molybdenum (Mo), nickel (Ni) and zinc (Zn). Recycling of organic matter such as plant parts is an excellent way of enriching soil with micronutrients (as well as macronutrients).

Non-Mineral Nutrients: Non-Mineral Nutrients includes Carbon (C), Hydrogen (H) & Oxygen (O). These are found in ample amount like in air and water. In photosynthesis, plants use energy from the sun to convert carbon dioxide (CO_2- carbon and oxygen) and water (H_2O- hydrogen and oxygen) to sugars.

III. SOIL HEALTH STATUS

Plants usually grow by absorbing nutrients from the soil for their normal growth and development. Soil usually contains some amalgamation of sand, silt, clay, and organic matter. The makeup of a soil (soil texture) and its acidity (pH) determine the extent to which nutrients are available to plants [5]. As water drains from soils, it often carries nutrients along with it. This condition is called leaching. When nutrients percolate into the soil through rains etc, they are not available for plants to use. Soil testing is undoubtedly a useful tool for making sound recommendations for fertilizer use. It has the potential to play a major role in facilitating balanced and hence efficient use of applied nutrients. Assessment of the extent and type of prominent soil problems like acidity, alkalinity and salinity etc. and advising for their profitable management are some of the in-built strengths, since bringing back these types of soils to normal cultivation can add tremendously to the quality improvement in mulberry. Research and development component provides better/suitable methodology for factual assessment of soil nutrient availability. Such methods after systematic evaluation and calibration may lead to meaningful recommendation. Management and application of standard package of practices under organized plantation leads to better plant growth and leaf yield (Fig.2).

Fig.2: Healthy plants under organized plantation.

Causes of Nutrient Deficiency in Mulberry

- Nutrient requirement and use varies from variety to variety.
- Nutrient depletion due to continuous cultivation.
- Inadequate quantity of macro and micro-nutrients present in soil.
- Deranged fertilizer application in field.
- Change in pH, loss of top soil due to runoff or soil levelling.
- Repeated application of single type input induces deficiency of others.
- Weeds in the field also utilize majority of nutrients making them unavailable to plant.

Soil Properties that Affect Plant Nutrition:
Soil is a composite mixture of non-living materials (minerals, organic matter, gases and liquids) and living organisms (bacteria, fungi, insects, worms, etc). These factors influence soil fertility either directly or indirectly. The affect of deficiency of certain nutrients can been seen morphologically which are termed as nutrient deficiency symptoms in plants (Fig.3). Soil consists of mineral elements, organic matter in various stages of decomposition and living organisms. Soil physical and chemical properties are to be analyzed systematically to get the current status of soil health [6].

Table 1: Status of soil pH and EC at different CSR&TI and nested units

SITE	pH (Spring)	EC (Spring) dS/m
REC TRAL	5.21 - 7.91	0.12 - 0.21
CSR&TI, PAMPORE	6.62 - 8.35	0.15 - 0.26
REC Y. K. PORA	6.43 - 6.92	0.12 - 0.23
REC BANDIPORA	6.01 -7.73	0.12 - 0.17
P4 MANASBAL	6.32 - 8.25	0.15 - 0.21

Table 2: Variation in macronutrients status at different CSR&TI units in spring season

SITE	AVAILABLE N kg/ha	AVAILABLE P kg/ha	AVAILABLE K kg/ha
CSR&TI, PAMPORE	323.63	32.3	225.45
REC TRAL	383.15	41.3	278.52
REC Y. K. PORA	262.15	28.4	164.42
REC BANDIPORA	233.45	32.05	244.18
P4 MANASBAL	361.63	42.14	237.24

It is a good to have soil analyzed, to know about the current status of micro and macro nutrient in the soil which intern depicts how much amendments and fertilizer the crop needs to get quality yield. In Kashmir valley, soil exhibits great variability in soil pH and macronutrients status. In different seasons of the year and at different locations of valley the status of soil nutrients vary. Lime is added to the soil to make it less acidic and also supplements calcium and magnesium for plants uptake. Lime raises the pH of soil to the optimum range of 6.2 to 6.8. If the pH is alkaline, appropriate amount of gypsum can be used for soil reclamation. In some places ammonium sulphate is used in place of urea, which also can be taken up for reclamation of alkaline soils. The imbalance of pH, builds up accumulation of toxic salts, which inhibit absorption of water. In optimum pH range of 6.2-6.8, nutrients are easily available to mulberry plants, and microbial activity in the soil also increases.

Fig.3: Plant showing nutrient deficiency symptoms.

Biochemical analysis of plant leaf samples helps in improving present information, perceptive on various seasonal biochemical changes and mounting ways to prevent abiotic and biotic stress in mulberry species [7].

IV. SUSTENANCE OF SOIL FERTILITY

Green and Organic Manure application:
Green manuring can be adopted for established plantation. The plants grown as intercrop with mulberry can fix atmospheric nitrogen in the soil by the action of root nodule bacteria (*Rhizobium)*. Green manuring is done by simultaneously growing short duration crops like Cow pea (*Vigna unguiculata*), pea (*Pisum sativum*) and masoora (*Phaseolus aureus*). Further, cut the plants into small pieces before onset of flowering and mulching into the soil by ploughing. It adds up organic matter and also provides additional nitrogen as well as improving soil structure and water holding capacity.

Organic manure is obtained from decomposing plant and animal part or produce. It plays a prime role in building up soil fertility, rising moisture holding capacity and enhanced growth of micro-organisms in the soil. It considerably improves micro-nutrient position and the physical condition of the soil. Hence, application of appropriate amount of organic manure to maintain the fertility status of the soil is very much essential. The most frequently used organic manure in mulberry farm is farmyard manure (FYM). The compost or vermicompost are helpful in escalating the nutrient availability to the plants. Under irrigated conditions, farmyard manure is applied at the rate of 20 tons per hectare per year, whereas, under rainfed conditions, 10 tones farmyard manure is applied per year hectare of mulberry plantation during November – December. The farmyard manure is to be fully decayed in a pit prior to its use and should be comprehensively assorted with the soil. As the availability of good farmyard manure is becoming difficult day by day, it is highly useful for the farmers to prepare compost or vermicompost using sericulture farm residues.

Biofertilizer application:

Biofertilizers are live compositions, containing nitrogen fixing or phosphate solublizing micro-organisms used as field inputs to improve soil fertility, plant growth, crop production and protection [8]. This is a cost effective approach and also environment friendly, use of biofertilizers is gaining popularity in mulberry gardens. Research at C.S.R.&T.I. Pampore have revealed that the use of biofertilizers (*Azotobacter chrocosum* and *G. mosseae*) can improve the saplings survivability and better nutrient uptake and solubilization from soil and also minimizing transplantation shock during transplantation of saplings [9]. Use of these biofertilizers reduces the usage of chemical fertilizers, nitrogen and phosphorus up to the extent of 50%, thereby reducing the environmental pollution, besides being cost effective.

The two biofertilizers can be handled very easily. Bacterial preparation of live *Azotobacter chrocosum* cells are blended with peat soil/ charcoal/ FYM in powdered form as carrier containing 10^{8-9} cells per gram applied in soil as a fractional alternate to nitrogenous fertilizer [10]. Arbuscular Mycorrhizal Fungi (AMF), *G. mosseae* biofertilizer is of fungal origin, symbiotic in nature, containing mycelia and spores of AMF in rhizosphere soil which enhances mobilization, diffusion, absorption and uptake by plants especially in phosphate deficient soils [11].

Nano-fertilizers:

Nanotechnology has the potential to revolutionize the agricultural and food industry with new tools for the molecular treatment of diseases, rapid disease detection, enhancing the ability of plants to absorb nutrients etc. Nitrogen is the most important element in fertilizers and a key nutrient source for food, fibre and biomass production in mulberry. Nitrogen applied using conventional fertilizers with particle size dimensions greater than 1000nm, is lost to the soil due to leaching, leading to decrease of Nitrogen utilization efficiency (NUE) by plants. Hence to increase the NUE in conventional formulations have far resulted in little success. On other hand, the emerging nanostrategies indicate that, due to the high surface area to volume ratio, nanofertilizers are expected to be far more effective.

Nanoparticles are rated as one of the well-known candidates in agricultural application. Studies carried out on slow – release of urea-modified hydroxypartite- nanoparticle had shown more efficient utilization of nitrogen compared with commercial fertilizer. It is revealed that nanofertilizers showed an initial and a subsequent slow release even on day 60 where as commercial fertilizer release heavily early followed by release of low non uniform quantities around day 30. Nanofertilizers may maximize the NUE (Nutrient Use Efficency) while minimizing the adverse effects to the environment due to use of large quantities of fertilizers in agriculture [12]. In the coming years technologies like nanotechnology, precession agriculture and molecular farming will be common and will certainly impact the production status in conventional agriculture systems.

Non conventional approaches to improve nutrient absorption:

Mulberry leaf is harvested repeatedly from the plant leading to continuous loss of nutrients in the soil. It has been reported that production of 20,000 kg Mulberry-leaf (dry weight) removes 200-230 kg nitrogen, 40-45 kg phosphorus and 200-211 kg potash. Besides, stems and older leaves also lock about 226 kg nitrogen, 50kg phosphorus and 204 kg potash**.** Sericulture in J&K sustains on tree type of plantation which is grown on road sides as avenue tree, bund side, river side etc, with no inputs leading to nutrient deficient systems. The study of nutrient uptake by plant roots has been a fascinating subject, both from the academic view point and also its application in crop productivity [13, 14]. Since studies have revealed that plant absorbs nutrient by extending enzymes organic acids through root exudates which varies according to the species and the soil conditions and the nutrient status of the plant [15]. With the advancement of molecular studies it is been now identified genes involved in nutrient solubilization and their role in nutrient uptake [16, 17]. Hence a significant potential for the genetic enhancement of nutrient uptake from soil could be attempted for better nutrient uptake and solublization. Conservation of elite gene pool will also aid in gene prospecting [18].

V. CONCLUSION

Soil is an important factor which has to be analyzed before the rearing as the nutrient status of the soil will determine the quality of leaf produced as leaves of mulberry plants provide all the nutritional requirements for the growing silkworms. Thereby affecting the production of required amount of mulberry raw silk. Even though mulberry has not picked up as intensive farming system in north Indian states but mulberry gardens are necessarily required to be raised for the successful commercial crop as it purely depends on good quality mulberry. More so, mulberry farming can also come up as in corporate sector when package in soil health diagnosis and recommendations are there. The departmental farms both under centre as well as state government serves as nucleus gardens for leaf production, production of cutting material, chawkie garden etc. the health of such plants thus become important. By adopting appropriate nutrient management system we can easily sustain the productivity and sericulture in Kashmir regions.

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