Article

Agronomic practices for the production of Safed musli (*Chlorophytum borivilianum* Santapau & Fernandes) in India

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Introduction

Dried roots of ***Chlorophytum borivilianum*** **Santapau & Fernandes** (Family-*Liliaceae*), popularly known as safed musli in trade in India, is considered as wonder drug in Indian systems of medicine (Ayurveda, Unani and Siddha) due to its aphrodisiac and sex tonic properties. Because of great therapeutic importance, safed musli roots are the major constituents of more than 100 Ayurvedic formulations (Oudhia, 2000). Since a long time wildly growing plants have been the major source of supply of the drug to herbal drug industries. However, over exploitation of natural resources has dwindled the population of safed musli in its natural habitats. Accordingly, the availability of roots from forest resources has gone down rapidly. Now it is widely realized that if immediate steps for the conservation of safed musli are not taken, Indian forests will soon loose this valuable plant.

The current annual demand of safed musli roots in India is estimated to be 3500 tonnes as against the supply of 500-600 tonnes (Kothari & Singh, 2001). Thus, the poor availability of the drug in market at one hand and the increased demand of roots for internal consumption and export on the other, has created spurt in prices of safed musli. Until middle of last decade of 20th century there has been no serious attempt for the domestication and systemic cultivation of safed musli in the country (Bordia *et al*, 1995). However, the unprecedented increase in the prices of roots in the last few years has attracted the attention of growers and researchers all over the country. Realizing the therapeutic importance of safed musli, its demand in national and international markets and high economic returns from cultivation, large number of farmers took up trial cultivation in several states in the country. However, it has been found that safed musli growers are facing a number of problems. These include: the lack of information on the package of cultivation practices, high cost of seed material and non availability of an efficient and cost effective technology for the peeling of roots. Therefore, a need to collate the published information on various aspects of safed musli cultivation is felt necessary. In present communication, the package of cultivation practices, based on the research work carried out at the Central Institute of Medicinal and Aromatic Plants (CIMAP), Lucknow and at other research centers in the country, are described.

Cultivation practices

Climate and soil

Safed musli requires warm and humid climate for optimum plant growth and fleshy root development. Areas receiving 50-150 cm annual rainfall, the major part of which is received during July-October, may be considered suitable for its cultivation. Too high day temperature (35°C and above) does not favour plant growth. Considering above conditions, several areas in Uttar Pradesh, Andhra Pradesh, Madhya Pradesh, Chhattisgarh, Gujarat, Rajasthan, Jharkhand, Haryana, Maharastra and Bihar states are considered suitable for safed musli cultivation.

Well-drained sandy loam and loam soils rich in organic matter are most suited. Porous soils with high organic matter content help in the fleshy root development. The plants are highly susceptible to water logging, and water stagnation for a period of 1-2 days may cause heavy damage to the plantation. Soils with high calcium carbonate content, and high pH (pH 8.0 and above) should be discarded as the availability of several major and micro nutrients, especially iron, becomes a limiting factor in such soils, to which *Chlorophytum* is highly susceptible (Bordia *et al*, 1995; Singh *et al*, 2001). Safed musli showed severe iron deficiency symptoms when grown in sandy loam soils at Lucknow in Uttar Pradesh.

Land preparation

Land selected for safed musli cultivation should be thoroughly prepared by several deep ploughing, disking and harrowing. Thorough land preparation is essential on two accounts: (i) to eradicate perennial weeds and minimize seasonal weed population and (ii) to make soil porous to facilitate fleshy root development. Depending upon the slope, soil texture and amount of rainfall, suitably sized beds are prepared. In high rainfall areas, planting on raised beds (10-15 cm high) is suggested for a quick drain of excess water. In seedbed, provision of both irrigation and drainage channels should be made.

Propagation

Chlorophytum can be propagated by seeds as well as by vegetative means from fleshy roots containing some portion of disc where buds are located. *In vitro* micro-propagation using stem disc has also been attempted and found successful. Micro-propagation would also help in ensuring the production of uniform plants, thereby restricting the variation in commercial population and quality of roots, which, at present, is a major problem encountered with seed and root propagated materials (Kothari & Singh, 2001; Singh *et al*, 2001). The production of uniform (homogenous) plants still become more important, in the absence of any improved variety available for cultivation.

By seeds

Generally, one plant produces only one inflorescence. However, depending upon age, disc size and number of buds on disc, a mature and well-developed *Chlorophytum* plant bears on an average 2-5 inflorescences. Well mature seeds, which are small and turn black in colour at maturity, are collected from previous year's plantation. Each inflorescence contains 10-25 flowers. The seeds are small and enclosed in the boles. In one bole there are 10-12 seeds (Paturde *et al*, 2000). The seeds are light and 1000 seeds weigh 3.0-3.5g. Musli seeds have a dormancy period of about 10 months (Trivedi & Yadav, 1989). Therefore, sowing of seed is possible only after the dormancy period is over. Normally the seeds are sown just before or after the onset of rains in raised nursery beds in May-June. Seeds have very low germination. Experiments conducted at different places recorded 11-62% germination (Dalal *et al*, 1987; Trivedi & Yadav, 1989; Jat & Bordia, 1990). Seedlings are allowed to grow in nursery in the first year. During this period, each seedling produces 2-3 small fleshy roots weighing 2.5-3 g. These are used for commercial production of roots in next growing season. The method of planting fleshy roots produced from seed is the same as for the planting material prepared from fleshy roots. Each sprouted seed produces only one unit of planting material, as the disc size remains so small that it is not advisable to split the disc. Planting material generated from seeds has comparatively higher sprouting percentage (95-100%) than those prepared by splitting the disc (80-90%), as these become more prone to fungal and bacterial attack due to exposure of cut portion to micro-organism in the soil.

By vegetative means

Vegetative propagation is done through fleshy roots produced and stored from previous year's crop. Depending upon the planting material requirement, whole or a

portion of bunches of fleshy roots, after digging of roots in March-April, are stored. If the requirement of planting material is high, the root bunches are stored as such (without removal of roots) at a cool and humid place where day temperatures remain in the range of 25±2°C. These root bunches remain in store till they start sprouting in the month of May-June. Sometimes sprouting starts as early as ending April, if the humidity in the store increases beyond 60-65%. When the planting material is required in limited quantity, lengthy and thick roots are removed from the disc with the help of sharp knife, and small fingers are left to remain with disk. Before planting, bunches are taken out from store, kept for few days at root temperature to allow the buds on the disc to sprout. Fingers containing bud(s) and some portion of disc are separated with the help of sharp blade/knife. Splitting of disc is done in such a way that each disc or sprout contains 1-3 fleshy roots and weigh c. 5 g.

Planting

Planting of safed musli is one of the most important operations, which greatly affects the size of harvest of the crop. Because of this, time and method of planting, plant population, and weight of planting material are of vital significance. Planting is done during the months of June-July, depending upon the onset of rains. Planting should be done just before or after the onset of rains. Therefore, optimum time of planting will vary from place to place. For example, first and second week of June may be ideal for planting in Gujarat, Madhya Pradesh and Chhattisgarh states, while last week of June to first week of July may be considered optimum for northern states. In absence of experimental data, there is need to workout the planting time for various places considered suitable for safed musli cultivation. Planting is done either in flat beds or on ridges or on raised beds, depending upon the texture of soil and the amount of rainfall. In high rainfall areas and in heavy textured soils, planting should preferably be done on ridges or on raised beds, while in low rainfall areas and in light textured soils planting in flat beds or on ridges is advisable. A planting distance of 30cm × 15cm is maintained. At an average weight of 4 -5 g each planting material, 600-700 kg fleshy roots will be needed for one hectare planting. Some workers (Bordia *et al*, 1995; Paturde *et al*, 2000) have estimated the planting material requirement of 250-350 kg/ha of fleshing roots.

Manures and fertilizers

So far, no systematic studies on nutritional requirement of safed musli have been carried out. Farmers normally use 10-25 tonnes/ha FYM (Bordia *et al*, 1995). Recent studies at the Central Institute of Medicinal and Aromatic Plants (CIMAP), Lucknow indicated a low nitrogen, phosphorus and potassium requirement of crop. Nitrogen (N), phosphorus (P_2O_5) and potash (K_2O) in the ratio of 60: 65: 20 kg/ha was found to be optimum. Further increase in the fertilizer dose proved deleterious to root development. Studies at CIMAP also indicated that application of 25 tonnes FYM or 25 kg micronutrient or one tonne of vermicompost/ha, over and above the N, P and K fertilizers, proved highly effective in improving the root production. Responsiveness of *Chlorophytum* to FYM, vermicompost or micronutrient in studies at CIMAP indicated the susceptibility of safed musli to micronutrients, particularly to iron. Iron deficiency symptoms have been reported from other places in the country (Bordia *et al*, 1995). Green manuring with cowpea during

Safed musli plants showing iron deficiency symptoms

summer may help in minimizing iron deficiency and improving crop productivity.

Cropping system

Crops preceding with musli may greatly influence growth and fleshy root production. Crop species, which maintain sufficient residual fertility in soil, may prove ideal for safed musli. Therefore, potato, pigeon pea, pea, and winter season vegetables such as radish, cabbage, cauliflower and tomato are considered ideal in rotation with safed musli. *Chlorophytum* plants are of short stature and found growing in open as well as in partial shade in natural habitat, indicating the ability of safed musli to tolerate certain degree of shade. Therefore, there can be good possibilities of intercropping safed musli with rainy season crops, such as pigeon pea, cowpea, greengram and blackgram, etc. which do not offer much competition to other plant species growing in association. Musli remains dormant from mid-October until harvest in March-April. Therefore, winter season crops such as tomato, mustard, pea, lentil, *Aswagandha* and Psyllium, which have low water requirement, may prove compatible to safed musli. Studies on intercropping in safed musli need to be taken up on priority so as to improve the land use efficiency and economics of cultivation. Improvement in land utilization efficiency and economic returns from intercropping of blackgram and mustard during rainy and winter seasons, respectively, has been reported from Udaipur (Rajasthan) (Chouhan & Joshi, 2000).

Irrigation

Usually safed musli does not require any supplemental irrigation during active growing period (July-September), if there are regular rains. However, there may be occasions when there are long dry spells or rain free periods. In such a situation when rain free period exceeds 10-12 days or available soil moisture reaches around 65-70%, irrigation should be applied. During winter season, unless there is intercrop, no irrigation to sole safed musli crop is needed.

Fully developed bunch of fleshy roots

Varying size of roots with some portion of disc under sprouting

Inter culture

Plant canopy of safed musli consists of mainly leaves, which normally lie on ground or grow parallel close to soil surface. Since, sufficient soil surface remains vacant throughout the growth span, luxuriant weed growth is witnessed, if not controlled in the early stages of planting. Weeds have been found to reduce the root production by about 55%. Studies at CIMAP, Lucknow indicated that three manual weedings are sufficient to keep the weed growth under check. The first, second and third weedings should be done during 15 to 20, 25 to 30 and 50 to 55 days after planting, respectively. At first weeding, pulling out weeds manually, instead of using mechanical tools (*Khurpi*) is desirable to avoid damage to root system. Delay in first weeding leads to increased cost of weeding and poor root development. Weed problem during dormancy period (October-March) is normally less encountered. However, in areas where Parthenium **(*Parthenium hysterophorus* Linn.)**, *Satyanasi* **(*Argemone maxicana* Linn.)** and *Nagarmotha* **(*Cyperus scariosus* R. Br.)** weeds are problematic, extra weeding is required to minimize the

weed seed bank and economizing the cost of digging of roots.

Harvesting and Yield

Safed musli takes 80-90 days to reach maturity. When plant approaches maturity, leaves start loosing green colour and turn yellow. Within few days, leaves dry up and fall down. Plants can be harvested at this stage if the planting material is not required for planting in next cropping season. Otherwise, harvesting is done in March-April. Each plant is carefully dug, separated of soils and washed with clean water. From October harvested crop, all fleshy roots are cut and peeled off as early as possible. Peeled roots are dried in shade. From March-April harvested crop, depending upon planting material requirement, 50-70% of lengthy and thick roots are removed from disc, and the remaining small and thin roots (fingers) along with disc are stored for planting in next cropping season. Peeling of roots is most laborious operation and may even involve more then 1000 man/day input/ha. Depending upon soil, climatic conditions and management practices, yield of fleshy roots may vary from 40-50qt/ha, which on drying remains 500-600 kg.

Storage of planting material

Crown disc along with fingers are kept in shade for about a week so that root bunches loose excess of moisture. After this, roots are stored in cool and dry place. Two methods are in vogue for the storage of roots. In first method roots mixed with dry sand are kept in pits 15-20 cm deep in soil under shade. In second method, roots are mixed with equal portion of dry sand and packed in 2-5 kg capacity perforated plastic bags. The bags are kept on rack in room where day temperature remains around 25°C and humidity at 60-65%. When storage temperature increases beyond 25°C and humidity falls down during peak summer months (May-June), humidity and temperature up to some extent can be kept within desired limit with the help of desert coolers.

Economics

Gross and net returns from safed musli cultivation are highly variable. Several factors, such as cost of planting material, level of yield achieved, the percentage of total roots processed for sale, labour wages and selling price of processed roots, affect the economics of production. However, the cost of planting material and the peeling off cost of roots are most important and greatly affect the economics of cultivation. Net returns of Rs. 60,000-Rs. 70,000 (Paturde *et al*, 2000) and Rs. 6.25 lakhs/ha (Jariyal, 1998) are reported. However, at an average input cost, root yield (500-600 kg/ha) and root selling price (Rs. 1000/kg), a gross and net returns of Rs. 5.0 to Rs. 6.0 lakhs and Rs. 2.5 to Rs.3.0 lakhs/ha, respectively, may be obtained.

Conclusion

Dried tubers of safed musli are of great pharmaceutical due to its aphrodisiac and sex tonic properties. In view of its increasing demand and depleting wild resources, there is a need to take up systematic cultivation of safed musli. Cultivation of safed musli can be done in warm and humid areas that receive 50-150 cm annual precipitation. Well drained upland soils that are rich in organic matter with pH below 8.0 should be preferred for cultivation. Planting of musli should be done on raised beds during June-July, using 600-700 kg/ha planting material. Application of 25 tonnes FYM and 25 kg each of N, P_2O_5 and K_2O and 25kg/ha micronutrient is recommended before planting. For maximizing land use efficiency and productivity, intercropping of rainy season crops such as pigeon pea, cowpea, green gram and black gram and winter season crops such as tomato, mustard, pea, lentil and aswagandha may be done. Safed musli does not require irrigation if there are regular rains. March and April months are ideal for harvesting. About 50-70% lengthy and thick tubers are removed for peeling and drying and remaining tubers along with disc are stored for planting new crop. Depending upon soil, climatic conditions and management

practices, 40-50qt/ha fresh tubers may be obtained for processing, which on peeling and drying remain 500-600 kg. At an average input cost, tuber yield and selling price, gross and net returns of Rs. 5.0 to 6.0 and Rs. 2.5 to 3.0 lakhs/ha, respectively, may be obtained. Integrated nutrient and iron management and intercropping studies should deserve priority in future agronomic researches.

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Planting *Chlorophytum* sp. as air purifier and ornamental plant

Cultivation of medicinal plants as ornamental herb in home gardens is taken up by rural people. The cultivar 'vittatum' of ***Chlorophytum comosum*** **(Thunb.) Jacq** (Spider -ivy or Spider plant) is commonly grown in pots in rooms and gardens. As it is spineless herb and free from latex, the people have no problem to adopt it. On the basis of numbers of flowers and floral arrangements it looks beautiful. Studies have shown that if planted as indoor plant it helps in purification of air. In Africa an infusion of tubers is given as a purgative to children and to women after childbirth (Wealth of India -A Dictionary of Indian Raw Materials, Rev. Ser. 1992, Vol. **3**, p.482).