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Optimum planting time, method, plant density, size of planting material, and photo synthetically active radiation for safed musli (*Chlorophytum borivilianum*)

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ABSTRACT

Safed musli *Chlorophytum borivilianum* (family Liliaceae) is a high value medicinal plant becoming rare because it is harvested from the wild. To encourage its adoption as a crop plant, propagation and other cultural methods were investigated under subtropical climatic conditions of the north Indian plains. Three separate field experiments were conducted during June–March for two growing seasons (June–March 2005–2006 and 2006–2007) at the Central Institute of Medicinal and Aromatic Plants, Lucknow, India for optimization of planting time, method, plant density, size of planting material, and photo synthetically active radiation (PAR) for safed musli. Planting of safed musli at the onset of monsoon on ridges or raised beds at 15 cm × 15 cm spacing by using 3–4 tubers with crown at 75% PAR produced maximum dry root yield.

1. Introduction

Safed musli (*Chlorophytum borivilianum* Santapau & Fernandes) is a small herbaceous plant of family Liliaceae with underground fleshy tubers milky white inside. It is found growing naturally in central India in Chattisgarh, M.P., Gujarat, Maharashtra, and Uttar Pradesh states in subtropical and tropical climates up to an altitude of 1500 m. Dried roots of the plant are considered as one of the most important drugs in Indian system of medicine (Ayurvedic, Unani, and Siddha) due to its aphrodisiac properties, great therapeutic importance, safed musli tubers are the major constituents of more than 100 Ayurvedic preparations (Oudhia, 2000a). Wild growing plants have been the major source of supply to drug industries in the country (Bordia and Simlot, 1995). In its natural habitat it is found growing under partial shade and considered as potential inter crop under different agro-forestry systems (Chadhar and Sharma, 1996; Singh et al., 2011).

However, the continued exploitation of natural resources has resulted in the fast depletion in Indian forests (Oudhia, 2000b). The demand of safed musli roots in India is estimated to be about 3500 tonnes against supply of 500–600 tonnes per annum (Kothari and Singh, 2001). Thus to meet the demand of internal consumption and export, it is important to increase the production through improved cultivation practices. The commercial cultivation of the crop at farmers' fields has been started recently. It is generally propagated by using under ground fleshy roots (tubers) with some portion of crown obtained from the previous year crop. There is very meager scientific information available on production techniques of safed musli. In view of the above, experiments were conducted to optimize the planting time, method, plant density, size of planting material, and photo synthetically active radiation for safed musli in subtropical plains of north India.

2. Materials and methods

2.1. Experimental site

A field experiment was conducted for two years, 2005–2006 and 2006–2007 during June–March at the research farm of the Central Institute of Medicinal and Aromatic Plants, Lucknow, India situated at 26°5′N latitude, 80°5′E longitudes with an elevation of about 120 m above mean sea level. The experimental site is classified as semi-arid sub-tropical with severe hot summers and fairly cool winters. In this region monsoon normally sets from last week of June and continues until the end of September with an average annual precipitation of 700 mm. About 80% of the monsoon rains are received in July and August. Winter also experience some rains due to cyclonic disturbances in the Arabic sea. Mean maximum temperature fluctuated from 26.1 to 44.5 °C; where as mean minimum temperature varied from 7.8 to 29.5 °C. The temperature was lowest during mid-December to end of the January and an increasing trend in mean temperature was noticed from the first week of February and reached to highest in mid-May

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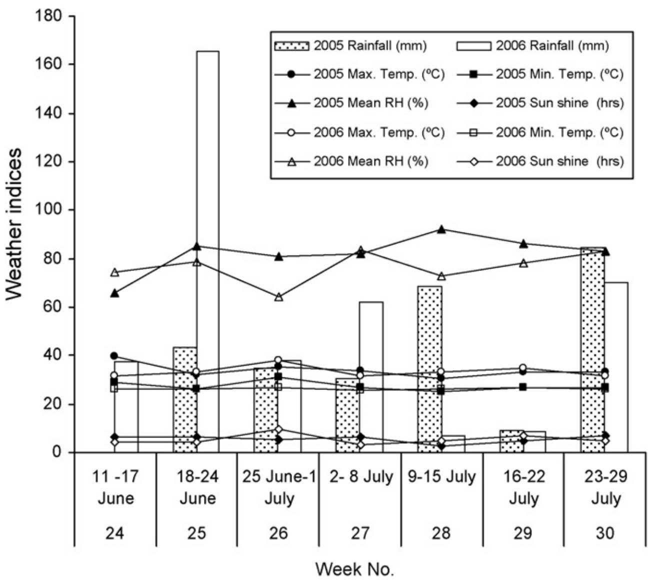

Fig. 1. Weather parameters during planting period.

and it declines only after the onset of the monsoons in the last week of July. Weekly weather parameters during the planting periods are given in Fig. 1. The soil (pH 7.9) of the experimental field was a sandy loam (Typic Ustifluvent) having organic carbon 0.3%, available N (alkaline $KMnO_4$ extractable N) 140 kg ha^{-1}, available P (0.5 M Na HCO_3 extractable) 14.0 kg ha^{-1} and available K (1 M NH_4OAc extractable) 150 kg ha^{-1}.

2.2. Treatment and experimental design

2.2.1. Experiment (i) studies on optimum time of planting and spacing

Experiment with four dates of planting (15 June, 25 June, 5 July, and 15 July) in 2005–2006 and five (15 and 25 June and 5, 15, and 25 July, 2006) in 2006–2007 and four plant spacing (30 cm × 15 cm, 30 cm × 10 cm, 20 cm × 15 cm, and 15 cm × 15 cm) was conducted in split-plot design with three replications, having date of planting in main plots and spacing in the sub-plots.

2.2.2. Experiment (ii) studies on planting methods and size of planting material

A field experiment was conducted for two years during 2005–2006 and 2006–2007 in split plot design with three methods of planting (flat, raised beds, and ridge) in main plots and thee size of planting materials (1 tuber, 2 tuber, 3–4 tubers with crown) in sub plots with three replications.

2.2.3. Experiment (iii) studies on photo synthetically active radiation (PAR) and plant density

A field experiment was conducted for two years during 2005–2006 and 2006–2007 in split plot design with four PAR levels (100, 75, 50, and 25%) in main plots and four population densities (25, 18, 12, and 9 plant m^{-2}) in sub plots with three replications. Calibrated nylon shading nets of 25, 50, and 75% photosynthetically active radiation transmission were used for providing the required radiation.

2.3. Raising of crops

Healthy planting material of fresh musli having 3–4 tubers with crown (weighing 5–7 g) of var CIM-Oj were prepared and planted as per treatment on raised beds except in experiment-ii during first fort night of July in 2005 and 2006, where as in experiment-i safed musli was planted on 15 June, 25 June, 5 July, and 15 July, 2005 in 2005–2006 and 15 and 25 June and 5, 15, and 25 July, 2006 in 2006–2007. At the time of last ploughing well decomposed farm yard manure (FYM) containing 0.5% N, 0.25% P, and 0.30% K @ 5 tonnes ha^{-1} and a uniform basal dose of 25 kg N, 30 kg each of P_2O_5 and K_2O ha^{-1} were applied through urea, single super phosphate and mutate of potash, respectively. Nitrogen @ 25 kg ha^{-1} through urea was top dressed at 30 days after planting. To ensure proper sprouting and growth a light irrigation was applied immediately after planting and two more irrigations each of 40 mm depth were applied in September and October. All the plots were kept weed free through two manual weedings at 20 and 50 days after planting.

2.4. Plant sampling and biometric observations

Observation on sprouting was taken 20 days after planting. Data on mortality and number of leaves plant^{-1} were recorded at 90 DAP. At the time of harvesting in last week of March, five plants were randomly selected from each plot for recording observations on number and length of roots and root weight plant^{-1}. Two hundred gram fresh roots from each plot were washed in water, peeled off, and dried in shade to obtain dry matter content. To determine dry root yield, fresh root yield was multiplied by dry matter content as percentage of fresh weight as follows:

$$\text{Dry root yield} = \frac{\text{Fresh root yield} \times \text{dry matter content (\%)}}{100} \qquad (1)$$

2.5. Statistical analysis

The analysis of variance was done in split plot design for various observations recorded during experimentation as described by Panse and Sukhatme (1985). The treatment means were compared by critical difference (CD) values at 5% level of significance.

3. Results and discussion

3.1. Optimum time of planting and spacing

In general, musli yield was higher in the second year than in the first year (Table 1). There was some infection by root knot nematode which had visible effects on number and length of roots and root yield. Also, the weather conditions particularly on early dates of planting in 2005–2006 were not favorable to musli growth. These were the possible reasons for lower yields in the first year.

Date of planting and spacing had no effect on number and length of roots. However, there was significant variation in per plant and total root production due to time of planting and spacing. In the first year, the crop planted on 15 July followed by 5 July produced significantly higher per plant and total root than earlier dates. Crop planted on 15 June had the lowest root yield. In second year, the trend was reverse and crop planted on 15 and 25 June produced the maximum per plant and per hectare root yield than rest of the dates. It was noted that during second year, in general, root yield decreased with delay in planting. However, this trend was not visible throughout the planting span. Crop planted on 15 July produced higher root than planted on 5 July. The study of weather parameters (Fig. 1) during the course of planting period clearly indicates that whenever rains, low temperature, high atmospheric humidity, and low sun shine hours coincided with planting dates or remained for a few days after planting, yields were better. During 2005–2006, there was high temperature, low humidity,