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Effect of different levels of spacing and organic fertilizer on productivity of Safed Musli *var.* ASM1

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Abstract
Safed Musli *var*. ASM1 has been evaluated at three spacing and vermicompost fertilizer level to determine its yield potential at BAU, Ranchi. Average number of fleshy root per plant was found maximum (19.8) at 30 cm spacing and 15 q/ha vermicompost, while minimum (9.4) at 45 cm spacing and 10 q/ha vermicompost level. Average length of fleshy root was found maximum (11.9 cm) at 30 cm spacing level and 10 q/ha as well as 15 q/ha vermicompost level, however its minimum value (3.7 cm) was observed both at (15 cm & 10q/ha) as well as in (45 cm & 20 q/ha). Average diameter of fleshy roots was found maximum (0.9 cm) both at 30 cm & 45 cm spacing levels having 15q/ha vermicompost application. Similarly minimum value was observed both at 30 cm and 45 cm spacing levels and at 15 q/ha vermicompost application level. Average fresh weight of fleshy root per plant was found maximum (75.5 g) at 30 cm spacing and 15 q/ha vermicompost level and minimum (43.2 g) at 15 cm spacing and 10 q/ha. Similarly average productivity of fleshy roots (g/m^2) was calculated maximum (87.58) at 30 cm spacing & 15 q/ha and minimum (49.87) at 15 cm spacing & 10 q/ha fertilization level. Average fresh yield of fleshy roots was calculated maximum (9.83 q/ha) at 30 cm spacing & 15 q/ha and minimum (15.62 q/ha) at 15 cm spacing & 10 q/ha).

Keywords: Client Satisfaction Index, Extension gap, Frontline demonstration, Mustard, Technology gap, Technology index

Introduction
Levels of spacing & application of fertilizer doses have direct impact on productivity status of medicinal & aromatic plants. Standardization of spacing and fertilizer application is necessary for remunerative cultivation and one of the primary aims of scientific cultivation of medicinal & aromatic plants. Moreover economics is directly related to input and output of production system, so optimization of spacing and fertilizer doses becomes important aspect for productivity estimation research activities. Evaluation of quantitative characters of medicinal plants is necessary, before recommending it to farmers, as this factors depending upon local climatic and edaphic conditions. Keeping the above mentioned objectives in consideration, an experiment was conducted to know the impact of different levels of spacing and organic fertilizer (vermicompost) on fleshy roots productivity of *Chlorophytum borivilianum*.

Safed Musli (*Chlorophytum borivilianum)* is an eminent medicinal plant of India and considered as a 'white gold' or 'divyaaushad' in Indian systems of medicine. In Ayurveda, *Chlorophytum borivilianum* belongs to the group of "Vajikaran Rasayana" corroborated to its rejuvenating and aphrodisiac properties and effective in alleviating sexual disorders. It is largely used as ethnic medicine by local healers of indigenous communities of India. *Chlorophytum borivilianum* is now the most commercially exploited species due to its celebrated aphrodisiac as well as immune modulatory properties. To meet the increasing demand of Safed Musli, nowadays its farming has been successfully introduced in many parts of India. Only in India it has been utilized as a source of medicine and recently, its new found status as the herbal alternative to 'Viagra' raised its popularity even among western countries. Nowadays, USA and England are making chips/flakes with the tubers to use it as a nutritious meal. Of late, there has been tremendous increase in the demand of this plant in Indian and International drug markets, and it is a vital entity of more than hundred herbal drug formulations. Though the exact static demand in the international market is obscure, it is estimated to be much higher than the present production. This plant species has now become endangered due to depletion in the natural habitat because of extensive denudation of the forest floor, poor seed setting and germination (Suri *et al.*, 1998), high incidence of viral and bacterial diseases affecting rhizomes (Bhattacharjee, 1998).

Materials and Methods
The field experiment was conducted at Technology Park & Ranchi Veterinary College

campus, Birsa Agricultural University Ranchi Jharkhand, India which lies at $23^0$26"N latitude and $85^0$18"E longitude in Chotanagpur plateau. The altitude of site is about 622m above mean sea level. Climate of the area is sub-humid with mean daily temperature of about 24.2^0C and mean relative humidity is about 70.88%. Variety selected of Safed Musli for the experiment was ASM 1. Three spacing levels had been selected viz. 15cm x 15cm, 30cm x 30cm & 45cm x 45cm and vermicompost had been chosen as organic fertilizer with three levels of doses viz. 10, 15 & 20 q/ha. Fasiculated roots of Safed Musli were planted in the month of August. Uniform cultivation practices were followed during the growth period of crop. Parameters studied were viz. average number of fleshy roots per plant, average maximum length (cm) of fleshy roots, Avg. minimum length (cm) of fleshy root, average maximum diameter (cm) of fleshy roots, average minimum diameter (cm) of fleshy roots, average fresh weight (g) of fleshy roots per plant, average productivity (g/m^2) of fleshy roots and average fresh yield (q/ha) of fleshy roots. Five plants have been selected from each spacing and fertilization levels for collection of data from both the sites.

Results and Discussion:

Data related to fleshy roots productivity of Safed Musli is presented below. Average maximum number of fleshy roots per plant was observed under the trial of 15 q/ha fertilizer application with 30cm x 30cm spacing level (19.8), followed by 20 q/ha with 30cm x 30 cm (17.4), while the minimum value was recorded in the treatment 10 q/ha with 45cm x 45cm spacing (9.4), followed by 10 q/ha with 15cm x 15cm (19.6).

Table 1: Avg. no. of fleshy roots per plant at different spacing and fertilization levels

	Fertilization levels		
Spacing levels	10 Q / Ha	15 Q / Ha	20 Q / Ha
15 cm × 15 cm	9.6	13.0	12.2
30 cm × 30 cm	12.4	19.8	17.4
45 cm × 45 cm	9.4	13.0	13.6

As regards to average length of fleshy root tubers, maximum value was found same (11.9) under two treatments namely (15 q/ha with 30cm x 30cm spacing) and (10 q/ha with 30cm x 30cm spacing). Similarly minimum value (3.7) was observed same in two treatments namely (20 q/ha with 45cm x 45cm spacing) and (10q/ha with 15cm x 15cm spacing).

Table 2: Avg. length (cm) of fleshy roots at different spacing and fertilization levels

Fertilization levels	**10 Q / Ha**		**15 Q / Ha**		**20 Q / Ha**	
Spacing levels	Max^x value	Min^n value	Max^x value	Min^n value	Max^x value	Min^n value
15 cm × 15 cm	9.7	3.7	11.5	4.5	9.8	4.2
30 cm × 30 cm	11.9	4.2	11.9	4.6	9.8	4.3
45 cm × 45 cm	9.8	4.6	10.1	4.5	9.7	3.7

Average maximum diameter (cm) of root-tubers was observed same (0.9) in two treatments namely (15 q/ha with 30cm x 30cm spacing) and (15 q/ha with 45cm x 45cm spacing), while its least value (0.2) was observed under 10 q/ha with 15cm x 15cm spacing level.

Table 3: Avg. diameter (cm) of fleshy root at different spacing and fertilization levels

Fertilization levels	**10 Q / Ha**		**15 Q / Ha**		**20 Q / Ha**	
Spacing levels	Max^x value	Min^n value	Max^x value	Min^n value	Max^x value	Min^n value
15 cm × 15 cm	0.3	0.2	0.8	0.5	0.6	0.4
30 cm × 30 cm	0.5	0.3	0.9	0.7	0.7	0.6
45 cm × 45 cm	0.4	0.3	0.9	0.6	0.7	0.6

Average maximum fresh weight (gm) of root-tubers (75.5) was observed in 15 q/ha with 30cm x 30cm spacing treatment followed by 10 q/ha with 30cm x 30cm spacing (62.4) while the average least fresh weight was recorded (43.2) under 10 q/ha with 15cm x 15cm spacing level.

Table 4: Avg. fresh weight (g) of fleshy roots per plant at different spacing and fertilization levels

	Fertilization levels		
Spacing levels	10 Q / Ha	15 Q / Ha	20 Q / Ha
15 cm × 15 cm	43.2	58.8	49.7
30 cm × 30 cm	62.4	75.5	57.2
45 cm × 45 cm	48.3	61.6	54.6

As regards to average productivity (gm/m^2) of root-tubers is concerned, maximum value (87.58) was recorded in treatment 15 q/ha with 30cm x 30cm spacing and minimum value (49.87) was recorded under 10 q/ha with 15cm x 15cm spacing level. Vermicompost promote humification, increased microbial activity and enzyme production, which, in turn, increases the aggregate stability of soil particles, resulting in better aeration. Medium spacing (30cm x 30cm) proved significantly better than closer spacing (15cm x 15cm) and wider spacing (45cm x 45cm). Dahatonde *et al.*, (1983) found increased root yield of Ashwagandha from 625 to 681 kg per ha with an increase in N levels from 0 to 30 kg per ha. Nigam *et al.*, (1984) reported that application of 30:30 kg N and P_2O_5 per ha produce significantly higher root yield of Ashwagandha (632 kg/ha) compared to 15:15 kg N and P_2O_5 per ha (570 kg/ha). Anon., (1998) reported higher root yield

of Ashwagandha with the application of 50 kg N per ha over no nitrogen and 100 kg N per ha. Singh and Misra (1997) observed increased root yield of Ashwagandha with the application of 15 kg N and 40 kg P_2O_5 per ha over no fertilizer treatment

Table 5: Avg. productivity (g/m^2) of fleshy root at different spacing and fertilization levels

	Fertilization levels		
Spacing levels	10 Q / Ha	15 Q / Ha	20 Q / Ha
15 cm × 15 cm	49.87	68.07	57.75
30 cm × 30 cm	71.75	87.58	66.50
45 cm × 45 cm	56.18	70.43	63.28

Average maximum fresh yield (q/ha) of root-tubers (9.83 q/ha) was recorded in the treatment 15 q/ha with 30cm x 30cm spacing levels and the average minimum value (5.62 q/ha) was recorded under 10 q/ha with 15cm x 15cm spacing level. Earthworms greatly influence soil properties and cast production, which results in the continuous turnover of the soil and mixing of minerals and organic constituents thus resulted in higher economical produce. Maheshwari *et al.*,(2000) found highest dry root yield of Ashwagandha (881 kg ha-1) with the application of 2.5 t FYM + 12.5 kg N + 25 kg P_2O_5 per ha over other fertilizer levels. Ramesh (1996) observed that dry root weight per plant of Ashwagandha increased with increase in N levels from control to 90 kg N per ha. Maheshwari and Yadav (1981) reported highest root yield of Ashwagandha with the application of 20:40 kg N and P_2O_5 per ha over control. Dahatonde *et al.*, (1983) observed an increase in dry root yield of Ashwagandha from 625 to 681 kg per ha with an increase in N levels from 0 to 30 kg per ha. Singh and Misra (1997) indicated that the root yield of Ashwagandha increased with the application of 15 kg N and 40 kg P_2O_5 per ha over no fertilizer treatment.

Table 6: Avg. fresh yield (q/ha) of fleshy root at different spacing and fertilization levels

	Fertilization levels		
Spacing levels	10 Q / Ha	15 Q / Ha	20 Q / Ha
15 cm × 15 cm	5.62	7.64	6.46
30 cm × 30 cm	8.11	9.83	7.44
45 cm × 45 cm	6.28	8.08	7.10

Conclusion

On the basis of observation the data obtained and interpretation of results, it can be recommended that to obtain maximum productivity of *Chlorophytum borivilianum*, the optimum organic fertilizer dose level is 15 q/ha of vermicompost with spacing level 30cm x 30cm.

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