



Effect of Varieties and Spacing on Vegetative Growth and Root Yield of Safed Musli (*Chlorophytum borivillianum*)

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

The experiment entitled "Effect of varieties and spacing on vegetative growth and root yield of safed musli (*Chlorophytum borivillianum*)" was carried out to find out the suitable variety with optimum spacing 2018-19 and 2019-20 which was designed in factorial RBD with two varieties and three spacing levels. The trials were sown in two years *i.e.* on 02-07-2018 and 31-05-2019. The present investigation has been carried out at the main experiment station, Department of Horticulture at Medicinal and Aromatic Plant, Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya, Uttar Pradesh, India. The data has been recorded in the following parameters, like leaf length, leaf width, number of tillers/hill, length and diameter of fingers, number of fingers per plant, fresh root yield, and dry root yield. It is effective against male sexual disorders such as erectile dysfunction, premature ejaculation, and infertility and is used as a health tonic.

Keywords: Safed Musli; spacing; vegetative growth and root yield.

1. INTRODUCTION

Chlorophytum Borivillianum belongs to the family *Liliaceae*. It is the most eminent medicinal plant, which is commonly known as *Safed Musli* or *Dholi Musli*. [1]. It is partly an herb with sub-erect lanceolate leaves. This plant is used for medicinal purposes for about 4000 years as per the Hindu epic *Srimad Bhagwat*. [2]. There are about 256 species of *Chlorophytum* and 17 among them are found in India. It is mainly cultivated in the drier parts of Madhya Pradesh, Punjab, Rajasthan, and South India. In Madhya Pradesh, it is cultivated in about 4000 hectares area [3]. The major producers and importers of organic products are the European Union, the United States of America, and Japan. The plant is well known for its tuberous roots because of bioactive constituents like flavonoids, alkaloids, saponins, phenols, steroids, triterpenoids, vitamins, and tannins. [4]. *Safed Musli* (*Chlorophytum borivillianum*) is an eminent medicinal plant of India and is considered a 'white gold' or 'divyaaushad' in Indian systems of medicine. In Ayurveda, *Chlorophytum borivillianum* belongs to the group of "Vajikaran Rasayana" corroborated by its rejuvenating and aphrodisiac properties and effectiveness in alleviating sexual disorders. It is largely used as ethnic medicine by local healers of indigenous communities of India. This chemical constituent has a specific mode of action in the human body as the intake of this plant [5]. It also helps to cure rheumatoid arthritis, post-menopausal syndrome, [6] diabetes, and piles [7]. These root tubers are used in the traditional medicinal system of India since the 11th century to cure a variety of diseases. [8]. *Safed Musli* is medicinally used in various medicinal systems such as Ayurveda, *Unani*, allopathic, homeopathic, and *Siddha*. [9]. The description of this plant is mentioned in multiple ancient works of literature such as *Rasendra Sarsangrah*, *Bhavaprakash Nighantu*, and *Raja Ballabh Nighantu* as *Vajikaran* or a special type of immunomodulatory. [10]. It is effective against male sexual disorders such as erectile dysfunction, premature ejaculation, and infertility and is used as a health tonic [11]. Roots of this plant are used widely in the ayurvedic and *Unani* medicinal systems for therapeutic purposes [12,13]. It is also reported that *Safed Musli* is popular in western countries as this plant is considered an alternative to *Viagra* and effective in curing chronic leucorrhea, high BP, delayed menopause, arthritis, and diabetes [14]. In India, it was first described by *Santapau* and *Fernandes* in 1954. (TIE, 1999). The new drug

named "*Nai Chetna*" was launched by the Gujarat State Forest Development Corporation, India, a *Safed Musli*-based potency drug [14]. The tubers of this plant have a remarkable effect on the Central nervous system. It was also reported that fleshy roots contain the highest amount of saponin content. This plant is promoted and protected by the Medicinal Plant Board of India, as it is recognized as 26th among the top priority medicinal plant because of its high medicinal properties. The Indian government has started promoting its cultivation due to its high economic perspective [15,16]. This plant is also used as a culinary food in India [2]. The roots of *Chlorophytum borivillianum* are being used as an aphrodisiac, health-promoting, adaptogen, and antiaging agent. Besides this, it is also used in pharmaceutical industries to prepare shampoos, confectionery, soaps, soft drinks, beer, and other anti-hemorrhoidal ointments because of its high saponin constituents. The roots of *Safed Musli* contain saponins with considerable aphrodisiac qualities called stigmasterol and hachogenin [17,18]. 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 [19], and high incidence of viral and bacterial diseases affecting rhizomes [20]. Moreover, economics is directly related to the input and output of the production system, so optimization of spacing and fertilizer doses becomes an important aspect of productivity estimation research activities. Evaluation of quantitative characteristics of medicinal plants is necessary, before recommending it to farmers, as these factors depend upon local climatic and edaphic conditions [21-23]. Keeping the above-mentioned objectives in consideration, an experiment was conducted to know the impact of different levels of spacing and organic fertilizer on fleshy roots productivity of *safed musli*.

2. MATERIALS AND METHODS

The present investigation has been carried out at the main experiment station, Department of Horticulture at Medicinal and Aromatic Plant, Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya, Uttar Pradesh, India, during 2018-19 and 2019-20. Which is designed in factorial RBD with 2 varieties (MCB 412 and MCB 405) and 3 spacing levels (10, 15 and 20 cm). Geographically the experimental site is situated between the latitude of 24.47 and 26.75 North and longitude of 82.12

and 83.98 East at the elevation of 118 meters above mean sea level. The experimental site is located under humid subtropical climate conditions having three climate seasons *i.e.* summer, rainy, and winter. The data has been recorded in the following parameters, leaf length, leaf width, number of tillers/hill, length and diameter of fingers, number of fingers per plant, fresh root yield, and dry root yield. Data recorded on various parameters of growth and yield attributes were subjected to statistical analysis by following fisher's method of analysis of variance [24].

3. RESULTS AND DISCUSSION

3.1 Leaf Length

Data on leaf length (cm) showed in Table 1, indicated that non-significant varieties were obtained on leaf length due to varietal and spacing traits during both years. However, variety MCB 412 (32.58 and 27.96 cm) showed comparatively better during 2018-19 and 2019 season respectively spacing at 20 cm (32.36 cm) during 2018 season and 15 cm (28.65 cm) during 2019-20 gave better results. Table 1 indicated that the significant interaction effect due to varieties and various spacing levels were observed during 2019-20 only which varied from 26.48 to 29.53 cm.

3.2 Leaf Width

Observations concerning leaf width (cm) were recorded and depicted in Table 1, revealed that non-significant varieties due to varieties and spacing levels were recorded individually internationally during both the years, except in the following (2019) in case of spacing levels, significant results showed, which varied from 1.74 cm to 1.97 cm.

3.3 Number of Tillers/ Hill

Data presented in Table 5, indicated that variation due to variety and spacing was found non-significant during the first year (2018-19 season). But in the following year (2019-20 season), the number of tillers/ hill increased significantly due to variety and spacing. The higher number of the tiller (3.40) was recorded at 10 cm spacing during 2019-20. But in 2019-20 seasons, 15 cm spacing showed better results. The interaction between variety and spacing was found significant during both the year. The maximum number of tillers (4.10) was recorded

when variety MCB 412 was sown at 15 cm spacing level during 2018-19 season.

3.4 Length and Diameter of Fingers

Data pertaining to the above parameter were depicted in Table 6, length of finger non-significantly varied that was due to variety and spacing levels during both the years, except in the 2019-20 season, variety MCB 405 (13.20 cm) showed significantly higher finger length than variety MCB 412. Variety MCB 412 significantly increased the diameter of finger (0.71 cm) than MCB 405 (0.64 cm), while varieties due to spacing level showed non-significant effect during 2018-19 year. But in the second 2019-20 season, Variation was non-significantly found, that was due to the variety characteristic. Interestingly significant variations were observed due to various spacing levels during 2019-20. The maximum average diameter (0.71 cm) was related 10 cm spacing.

3.5 Number of Fingers per Plant

Data presented in Table 6, Showed that number of fingers/plants significantly varied that might due to variety and spacing levels during both the years. However, variety MCB 405 (17.33 and 16.56) gave a higher number of fingers than MCB 412 during 2018-19 and 2019-20 seasons respectively. The maximum average number of fingers (17.24) was recorded when sown at 20 cm spacing.

3.6 Interaction Effect on Length and Diameter of Fingers and Number of Fingers/ Plant

Table 7, Showed that significant interaction effect due to variety and spacing levels were observed on increasing length, diameter and number of fingers/ plant during 2019-20 season but in previous (2018-19 season), interaction effect has found non-significant. The maximum length of finger (13.71 cm) was found, when variety MCB 405 sown on 15 cm spacing level during 2019-20 year as for as diameter of finger is concerned, the highest diameter (0.73 cm) was noticed when MCB 412 interacted with 10 cm spacing level during 2019-20 season. When variety MCB 405 interacted 20 cm level which gave the highest number of fingers (18.53) during 2019-20 season.

Table 1. Effect of variety and spacing on vegetative character of Safed Musali during 2018-2019 and 2019-20 season

Treatments	Leaf length (cm)		Leaf width (cm)	
	2018-19	2019-20	2018-19	2019-20
A. Varieties				
(V ₁) MCB 412	32.58	27.96	2.09	1.80
(V ₂) MCB 405	31.48	27.49	1.91	1.88
SEm±	0.50	0.48	0.09	0.04
CD at 5%	NS	NS	NS	NS
B. Spacing				
(S ₁) 10 cm	32.24	27.64	1.95	1.97
(S ₂) 15 cm	31.49	28.65	2.08	1.74
(S ₃) 20 cm	32.36	26.89	1.97	1.81
SEm±	0.62	0.59	0.11	0.05
CD at 5%	NS	NS	NS	0.14

Table 2. Effect of the interaction S X V of variety and spacing on Leaf length (cm) of Safed Musali during 2019-20 season

Spacing \ Variety	S ₁	S ₂	S ₃
V ₁	27.88	29.53	28.48
V ₂	27.40	27.78	27.30
SEm (S X V)	0.97		
C.D. at 5% (S X V)	2.92		

Table 3. Effect of variety and spacing on vegetative character of Safed Musali during 2018-19 season

Treatment	No. of tillers/hill		
	V ₁	V ₂	Mean
Spacing			
(S ₁) 10 cm	2.15	3.25	3.10
(S ₂) 25 cm	4.10	2.95	3.53
(S ₃) 20 cm	3.30	3.20	3.25
Mean	3.45	3.13	
SEm± A	0.14		
SEm± B	0.17		
SEm± A x B	0.24		
CD at 5% A	NS		
CD at 5% B	NS		
CD at 5% A x B	0.72		

*V₁ = MCB 412, V₂ = MCB 405

Table 4. Effect of variety and spacing on vegetative character of Safed Musali during 2018-19 and 2019-20 season

Treatments	Leaf length (cm)		Mean	Leaf width (cm)		Mean
	2018-19	2019-20		2018-19	2019-20	
A. Varieties						
(V ₁) MCB 412	32.58	27.96	30.3	2.09	1.80	1.95
(V ₂) MCB 405	31.48	27.49	29.5	1.91	1.88	1.90
SEm±	0.50	0.48		0.09	0.04	
CD at 5%	NS	NS		NS	NS	
B. Spacing						
(S ₁) 10 cm	32.24	27.64	29.9	1.95	1.97	1.96
(S ₂) 15 cm	31.49	28.65	30.1	2.08	1.74	1.91
(S ₃) 20 cm	32.36	26.89	29.6	1.97	1.81	1.89
SEm±	0.62	0.59		0.11	0.05	
CD at 5%	NS	NS		NS	0.14	

Table 5. Effect of variety and spacing on vegetative character of Safed Musali during 2018-19 and 2019-20 season

Treatment	No. of tillers/hill					
	2018-19			2019-20		
	V ₁	V ₂	Mean	V ₁	V ₂	Mean
Spacing						
(S ₁) 10 cm	2.15	3.25	2.70	2.83	3.98	3.40
(S ₂) 25 cm	4.10	2.95	3.53	2.55	3.18	2.86
(S ₃) 20 cm	3.30	3.20	3.25	3.13	3.05	3.09
Mean	3.45	3.13		2.83	3.40	
SEm± A	0.14			0.07		
SEm± B	0.17			0.09		
SEm± A x B	0.24			0.14		
CD at 5% A	NS			0.21		
CD at 5% B	NS			0.26		
CD at 5% A x B	0.72			0.43		

*V₁ = MCB 412, V₂ = MCB 405

Table 6. Effect of variety and spacing on reproductive characters of safed musali during 2018-19 and 2019-20 season

Treatments	2018-19			2019-20			of
	Finger length (cm)	Finger diameter (cm)	Number of fingers/plant	Finger length (cm)	Finger diameter (cm)	Number of fingers/plant	
A. Varieties							
(V ₁) MCB 412	13.36	0.71	15.47	11.93	0.69	14.33	
(V ₂) MCB 405	13.37	0.64	17.33	13.20	0.66	16.56	
SEm±	0.39	0.01	0.31	0.27	0.01	0.29	
CD at 5%	NS	0.04	0.95	0.82	NS	0.87	
B. Spacing							
(S ₁) 10 cm	13.79	0.69	14.90	12.59	0.72	14.60	
(S ₂) 15 cm	13.20	0.69	16.15	13.01	0.65	15.41	
(S ₃) 20 cm	13.11	0.66	18.15	12.09	0.64	16.33	
SEm±	0.48	0.02	0.39	0.33	0.02	0.35	
CD at 5%	NS	NS	1.16	NS	0.04	1.06	

Table 7. Interaction effect S X V of variety and spacing on reproduction characters of Safed Musli during 2019-20.

Treatments	Spacing	Finger length (cm)			Finger diameter (cm)			No. of finger per plant		
		S ₁	S ₂	S ₃	S ₁	S ₂	S ₃	S ₁	S ₂	S ₃
Variety										
V ₁		11.78	12.31	11.70	0.73	0.68	0.64	14.60	14.28	14.13
V ₂		13.41	13.71	12.47	0.71	0.63	0.64	14.60	16.55	18.53
SEm ± (S X V)		0.54	-	-	0.02			0.58		
CD at 5% (S X V)		1.63	-	-	0.07			1.74		

Table 8. Effect of variety and spacing on yield of Safed Musali during 2018-19

Treatment	2018-19		2019-20					2018-19		2019-20					
	V ₁	V ₂	Fresh root yield (q/ha)					Pooled mean	V ₁	V ₂	Dry root yield (q/ha)				
			Mean	V ₁	V ₂	Mean	V ₁				V ₂	Mean	V ₁	V ₂	Mean
Spacing															
(S ₁) 10 cm	75.34	79.52	77.43	33.37	28.56	23.97	54.20	14.31	15.90	15.11	6.34	5.41	5.87	10.49	
(S ₂) 25 cm	65.97	63.51	64.74	19.67	36.68	28.17	45.84	12.53	12.70	12.61	3.73	5.48	4.61	8.61	
(S ₃) 20 cm	40.62	56.66	48.64	29.76	24.21	26.98	37.81	7.71	10.83	9.27	5.95	4.84	5.39	7.33	
Mean	60.64	66.57		27.60	29.82			11.52	13.14		5.34	5.24			
Pooled mean				44.12	48.91						8.43	9.19			
SEm± A	1.34			0.55				0.18			0.16				
SEm± B	1.64			0.618				0.22			0.20				
SEm± A x B	2.32			1.10				0.31			0.32				
CD at 5% A	4.04			1.66				0.54			NS				
CD at 5% B	4.95			2.04				0.66			0.59				
CD at 5% A x B	6.70			3.32				0.94			0.96				

*V₁ = MCB 412, V₂ = MCB 405

Treatment MCB 412 and MCB 405, Spacing (S₁) 10 cm (S₂)25 (S₃)20 cm

3.7 Fresh Root Yield

Observations concerning fresh root yield were recorded and presented in Table 8, perusal of data revealed that maximum fresh root yield (66.57 q ha⁻¹ and 29.82 q ha⁻¹) was obtained by the variety MCB 405 which was found significantly higher than MCB 412 (60.64 q ha⁻¹ and 27.60 q ha⁻¹) during the 2018-19 and 2019-20 season, respectively. The closer spacing (10 cm- 77.43 q ha⁻¹ and 30.97 q ha⁻¹) proved better to enhance fresh root yield which was found significantly superior to other spacing levels. The minimum root yield (48.64 q ha⁻¹ and 26.98 q ha⁻¹) was observed with higher spacing (20 cm). The maximum average fresh root yield 54.20 q ha⁻¹ was also recorded due to the same treatment (10 cm) spacing. The interaction effect due to variety and spacing was found significant. The maximum fresh root yield (79.52 q ha⁻¹) was obtained by the variety MCB 405 sown at relatively closure spacing (10 cm) during the previous year 2018-19 season. But in the following 2019-20 season, when same variety interacted at relatively less closure spacing (15 cm), which showed the highest root yield (36.68 q ha⁻¹).

3.8 Dry Root Yield

Data presented in Table 8, showed that there was an almost similar trend as for as dry root yield is concerned significant variations were observed due to variety and spacing levels individually and internationally during both the 2018-19 except in the second year (2019-20 season) variation due to variety showed non-significant results. However, the same variety MCB 405 (13.14 q ha⁻¹) performed a higher dry root yield than MCB 412 (11.52 q ha⁻¹) during 2018-19 seasons. The closure spacing (10 cm- 15.11 g ha⁻¹ and 5.87 q ha⁻¹) also proved to be beneficial in terms of dry root yield. During 2018-19 and 2019-20 season, respectively. The maximum average dry root yield (10.49 q ha⁻¹) was also obtained at closer spacing (10 cm) significant interaction effect was noticed due to variety and spacing levels during both years. In the second (2019-20 season), root yield and other parameters were recorded which were found comparatively lower than the previous year (2018-19 season) due to poor germination percentage and other factors.

4. CONCLUSION

The present study highlighted the impact of different levels of spacing and organic fertilizer

on fleshy roots productivity of safed musli. It is used as a health tonic and is effective against male sexual disorders such as erectile dysfunction, premature ejaculation, and infertility. Local healers of India's indigenous communities primarily use it as ethnic medicine.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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