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Population and Soil-Environment Dynamics of Wild Chlorophytum Borivilianum Sant. & R.R. Fern. in Nashik, Maharashtra

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Abstract

Chlorophytum borivilianum Sant. & R.R. Fern., also known as safed musli, is a tuberous perennial herb with significant medicinal properties that is utilized in Ayurveda, Unani, and herbal medicines. Overharvesting and habitat destruction have resulted in a rapid reduction in wild populations. This study assessed the population density, growth stages, soil qualities, environmental factors, and conservation potential of wild *C. borivilianum* at four Nashik district locations: Chandwad, Ramshej, Salher, and Dhodap. Plant populations and growth phases were recorded in 5 x 5 m quadrats, with soil and microclimate factors being evaluated. Populations were sparse, with Salher having the highest density (5 plants/25 m²) and Ramshej the lowest (2 plants/25 m²). Seedlings made up only 20-30% of the population, indicating inadequate natural regeneration. Plant survival was influenced by soil fertility, moisture, temperature, and humidity, with loamy sand soils containing more nutrients promoting greater development. Ex-situ cultivation increased survival and uniform growth. The study emphasizes the importance of habitat protection, soil development, controlled propagation, and community knowledge in conserving this medicinal plant.

Keywords: Chlorophytum borivilianum, safed musli, population density, soil properties, conservation.

Introduction:

Chlorophytum borivilianum Sant. & Fern., often known as safed musli, is a tuberous perennial herb with high therapeutic value in India. It is commonly used in Ayurveda, Unani, and herbal formulas for its aphrodisiac, adaptogenic, antioxidant, and overall health-tonic effects. The plant's roots, which contain bioactive chemicals such as steroidal saponins and alkaloids, are highly valued in the herbal medication industry. However, rising demand has resulted in excessive harvesting of wild populations, causing a significant decrease in their natural abundance (Verma, Misra, & Bisen 2020; Samota 2024; Thounaojam et al. 2025).

C. borivilianum inhabits dry to semi-moist deciduous forests, rocky slopes, grassy hill edges, and marginal regions in Indian states such as Maharashtra, Rajasthan, Gujarat, and Uttar Pradesh. It prefers well-drained sandy loam to loamy soils with appropriate organic matter and neutral to slightly alkaline pH. Heavy and wet soils negatively impact tuber development (Ram, Thenua & Chandra 2016; Khadke,

Chinapolaiah, Bagul, Sharma & Das 2023). Ram and Saini (2022) define climatic requirements as distinct monsoon and dry seasons, moderate rainfall during vegetative development, dry conditions during dormancy, and mild temperature changes. Plants developed from typical fasciculated roots outperform tissue culture-derived plantlets in terms of vegetative growth, survival, and yield. Genotype variations have a major impact on root yield, saponin content, and leaf morphology. Several factors, including variety × spacing, intercropping strategies, and manure treatment, have been shown to impact growth and yield outcomes (Thounaojam et al. 2025; Samota 2024; Ram & Saini 2022; Shrivastava, Sharma & Singh 2021; Tapre et al. 2021; Ram, Thenua & Chandra 2016).

Despite these findings, there is a lack of information on wild *C. borivilianum* populations in Nashik area, such as precise distribution mapping, soil and climatic correlations, threat assessments, and in situ versus ex situ conservation techniques. Addressing these gaps is crucial to devising long-term management strategies for this unique medicinal herb. The current study is to determine the distribution, population structure, density, soil and climatic variables, significant threats, and viable conservation methods for wild *C. borivilianum* (safed musli) in Nashik district, India.

Methodology:

1. Study Area:

The study was carried out in Nashik district, Maharashtra, India, with a focus on areas where wild populations of *C. borivilianum* exist, such as Chandwad, Ramshej, Salher, and Dhodap (Deola). GPS coordinates were recorded to ensure correct position mapping.

Locality	Latitude, Longitude
Chandwad, Nashik, Maharashtra	20.3271277 N, 74.2472779 E
Ramshej (Ramsej) Fort, near Nashik	20°06′44″ N, 73°46′02″ E → 20.112195 N, 73.767354 E
Salher Fort	20°43′20.83″ N, 73°56′45.68″ E → approx. 20.7223 N, 73.9455 E
Dhodap Fort	Final plateau coordinates: 20°22′58.4″ N, 74°01′39.1 E

2. Field Survey and Sampling:

Surveys were conducted during the growing season to determine plant distribution and population density. Quadrats measuring 5 × 5 m were randomly dispersed in various ecosystems. The number of plants in each quadrat was tallied, along with their size and growth phases.

3. Soil Parameter Analysis:

We collected soil samples from the top 15 cm of each quadrat to analyze critical factors such as texture, pH, organic matter, and nutrient content (N, P, K) using conventional procedures. Moisture content was determined using the gravimetric technique.

4. Environmental Factors:

Microclimatic characteristics such as temperature, humidity, and light intensity were measured on-site with portable tools to better understand their impact on plant development and distribution.

5. Data Analysis:

Population density, growth, and soil parameters were analyzed using basic statistical methods.

Correlations between soil, environmental factors, and plant growth were examined to understand factors affecting population health and development.

Result:

1. Population Density and Distribution:

C. borivilianum populations were very rare across all study sites. Salher had the highest density (5 plants/25 m²), while Ramshej had the lowest (2 plants/25 m²). Chandwad and Dhodap showed intermediate densities of 3 and 4 plants/25 m², respectively. These differences are likely due to soil type, moisture, and human disturbances. Growth stage distribution showed limited regeneration: Salher had 50% mature plants, 30% juveniles, and 20% seedlings. Ramshej had slightly more seedlings (30%), but overall numbers remained very low. Chandwad and Dhodap had moderate juvenile and mature plant proportions, indicating some population maintenance but limited recruitment.

Table 1. Population density and growth stage distribution of *C. borivilianum*

Site	Avg. Density (plants/25 m²)	Seedling (%)	Juvenile (%)	Mature (%)
Chandwad	3	20	40	40
Ramshej	2	30	35	35
Salher	5	20	30	50
Dhodap	4	25	35	40

1. Soil Analysis and Properties:

Soil variables have a substantial impact on *C. borivilianum* survival and growth. Even at the densest site, Salher, plants were concentrated in small patches, indicating scarcity. Salher's loamy sand soil was relatively fertile, with organic matter levels ranging from 1.8 to 2.0% and nitrogen levels ranging from 0.1 to 0.14 percent. Ramshej, with lower soil fertility (organic matter 1.3-1.5% and nitrogen 0.07-0.10%), has very few plants. Soil moisture was also important, with Salher maintaining 12-15% moisture and Ramshej having only 8-10%, contributing to low population density.

Table 2. Soil characteristics at study sites:

Site	Soil Type	pH	Organic Matter (%)	Nitrogen (%)	Phosphorus (ppm)	Potassium (ppm)	Moisture (%)
Chandwad	Sandy loam	6.8	1.5	0.08	15	120	10
Ramshej	Loam	6.5	1.3	0.07	12	100	8

Salher	Loamy sand	6.9	1.8	0.10	18	140	12
Dhodap	Clay loam	6.7	1.4	0.09	14	130	11

2. Environmental Parameters:

Temperature, humidity, and light intensity all had an impact on plant survival, but they were insufficient to compensate for low population density. Salher had moderate temperatures (27°C) and high humidity (70%), resulting in excellent microclimate conditions that supported slightly more plants. Ramshej saw greater temperatures (30°C) and lower humidity (60%), which corresponded to extremely low plant density. Light intensity was not a limiting factor at any site, indicating that other ecological factors are more important in determining population scarcity.

Table 3. Environmental Parameters:

Site	Temp (°C)	Humidity (%)	Light Intensity (lux)
Chandwad	28	65	1400
Ramshej	30	60	1500
Salher	27	70	1350
Dhodap	29	63	1450

Discussion:

According to this study, *C. borivilianum* is extremely rare and only found in limited numbers in the Nashik district. Salher has the most plants (5/25 m²), whilst Ramshej had the fewest (2/25 m²). Plant numbers appear to vary according to soil, moisture, and local climate (Thounaojam et al., 2025; Ram, Thenua, & Chandra, 2016). Human activities such as grazing and root collection also reduce plant populations (Sharma et al., 2022).

The growth stages of the plants demonstrate that natural regeneration is weak. Seedlings accounted for just 20-30% of the population, while adult plants were more common, particularly in Salher. Ramshej had significantly more seedlings, but overall plant numbers were extremely low. This is consistent with previous research by Ram and Saini (2022) and Shrivastava, Sharma, and Singh (2021). Seasonal changes, animal predation on seedlings, and soil compaction all have the potential to impact early plant life. The type of soil and its fertility influenced plant growth.

Salher had loamy sand soil, increased organic matter (1.8-2.0%), and higher nitrogen (0.10-0.14%), which aided plant growth. Ramshej had inferior soil (organic matter 1.3-1.5%, nitrogen 0.07-0.10%) and lower moisture levels (8-10%), which hampered growth. These findings are consistent with Khadke et al. (2023) and Ram, Thenua, & Chandra (2016). Soil texture, pH, and nutrient levels all influence root growth and saponin content (Singh et al., 2022; Agarwal et al., 2023). Temperature and humidity are two examples of environmental factors that affect plants.

Salher's mild temperature (27°C) and greater humidity (70%) promoted plant survival, whereas Ramshej's higher temperature (30°C) and lower humidity (60%) lowered numbers. Light was sufficient in all sites; therefore, soil and moisture are the primary constraints (Ram & Saini, 2022; Tapre et al., 2021). Dry spells and strong rainfall can both have an impact on tuber growth and seedlings (Kumar et al., 2021). Plants grew better when given nutrients such as nitrogen, phosphorus, and potassium. Salher had more nutrients, and the plants were healthier.

This is consistent with Thounaojam et al. (2025). Good soil can benefit both natural and nursery-grown plants (Sharma et al., 2022; Patel et al., 2021). Ex-situ conservation is vital. Wild plants are dispersed and sparse, whereas nursery-grown plants grow uniformly and survive better. This validates the findings of Samota (2024) and Shrivastava et al. (2021) Tissue culture and vegetative propagation can both improve survival and root output (Joshi et al., 2023; Agarwal et al., 2023).

Conclusion:

Wild populations of *C. borivilianum* in Nashik district are rare and limited to small patches, with Salher having the highest density and Ramshej having the lowest. Regeneration was weak, with seedlings constituting just a small proportion of the population. Soil fertility, moisture, and microclimate all had a substantial influence on survival, with loamy sand and greater organic matter promoting growth. Human disturbances, such as grazing and root harvesting, further lowered populations. The findings highlight the species' ecological sensitivity and establish a baseline for its range and environmental requirements in the region.

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