

Soil-site suitability evaluation for cardamom - A case study

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Abstract

Nineteen soil profiles representing seven soil series with sixteen mapping units were collected, described and mapped at Indian Institute of Spices Research, Cardamom Research Centre, Appangala, Madikeri, Karnataka for evaluating their suitability for cardamom cultivation. Soil and site properties such as climate, depth, slope, elevation, shade, texture, drainage, etc were compared with suitability criteria and the soils were assessed for growing cardamom. It is indicated that the well distributed rainfall of 1500-2000 mm with well drained conditions, a soil depth of more than 80 cm and 900-1200 m elevation support good crop of cardamom. The critical limit of Available Water Capacity was found to be 100 cm. Of the total area of the research station, 42 per cent area is highly suitable for cardamom cultivation. About 53 per cent of the area is moderately suitable and about 4 per cent is marginally suitable.

Key words: cardamom, land evaluation, soil-site suitability

Introduction

Cardamom popularly called as "Queen of Spices" is a traditional and leading foreign exchange earning spice crop. It is an eco-friendly psophyte (shade loving) crop cultivated in about 72,000 ha in India under the shade of evergreen forest trees in the Western Ghats. In recent years cardamom cultivation is gaining more popularity because of higher returns per unit area coupled with availability of high production technologies. However, bringing indiscriminately any area under cardamom cultivation without assessing the soil suitability for its cultivation, would prove counter productive. Soil survey, classification and mapping of soils help in understanding the soil potential and suitability for the crop. Several researchers have worked out the suitability of soils for various crops (Reddy *et al.*

1990; Sehgal 1991; Giri *et al.* 1994; Kharche *et al.* 1995). The present study was, therefore, undertaken to establish soil-site suitability for cardamom cultivation at Cardamom Research Centre, Appangala of Indian Institute of Spices Research.

Materials and methods

Sixteen soil map units, with seven soil series, A to G (Fig.1) were selected for land suitability study at Indian Institute of Spices Research, Cardamom Research Centre, Appangala, Kodagu District, Karnataka. The research centre with an area of 17.4 ha is situated between 12° 23'30" latitude and 75° 43'00" longitude.

The climate is subhumid tropical with mean annual rainfall of about 2770 mm with about 135 rainy days. Seventy five per cent of the rainfall is received during South-West

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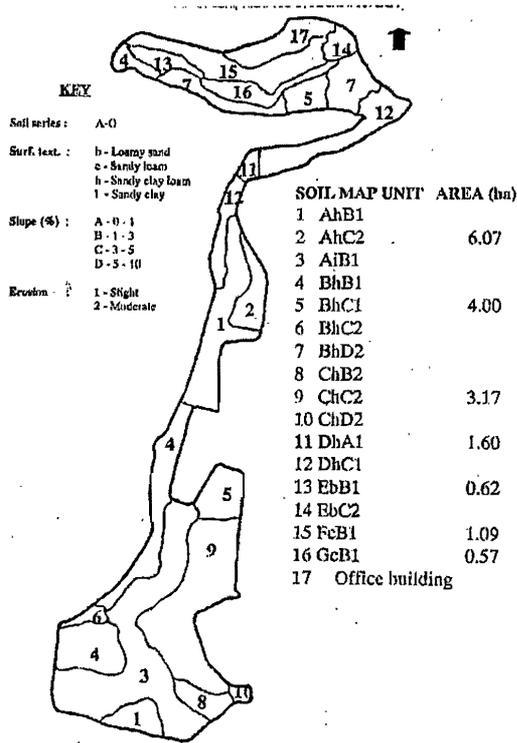


Fig. 1. Area, soil map units and key to soil map units of Cardamom Research Centre, Appangala, Karnataka

monsoon (unimodal) May to September and peak period of rainfall being July. The mean annual temperature is 22.1°C. The MAST is 24.1°C and MAWT is 21.3°C. The temperature regime is isohyperthermic and moisture regime is ustic bordering to udic (Udic Tropustic).

Physiographically the area forms a part of the high ranges of the Western Ghats and belongs to Archaean terrain having gneiss as the dominant rock with laterite material below the soil mantle. The area of the research centre is mostly uplands with dominant slopes of 1 to 5 per cent in southwest direction. Seven soil series were identified based on the physico-chemical and morphological characteristics.

For assessing the suitability of the soil for growing cardamom the FAO (1976) methodology for land evaluation, modified by Sehgal (1991), were adopted. The soil suitability was classified as: S_1 - highly suitable - land having no significant limitation; S_2 - moderately suitable - land having slight limitations causing moderate severity; S_3 - marginally suitable - land having aggregation of severe limitations; N_1 - currently not suitable - land having limitations which cannot be overcome at the current level of technology or at currently acceptable costs. The characteristics and management requirements of cardamom for optimum production were identified based on the important soil and land qualities.

Results and discussion

The rainfall pattern and soil site characteristics of the area are presented in Tables 1 and 2. The soils in the area are Ultisols and Entisols (Anon. 1999) with depth ranging from shallow (50 cm)

Table 1. Rainfall (mm) at Cardamom Research Centre, Appangala (1988-98)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1988	—	8.0	22.0	118.9	49.6	307.7	837.7	427.7	272.8	52.0	8.4	59.6	2164.4
1989	—	—	29.0	46.4	117.4	380.9	1106.6	654.5	262.8	161.2	3.5	—	2762.3
1990	—	—	12.8	11.6	253.8	607.4	603.0	777.1	139.4	362.2	14.0	—	2751.3
1991	—	—	—	113.6	100.6	864.0	1015.8	644.8	133.2	76.0	34.4	—	2802.4
1992	—	—	—	62.8	251.6	931.0	863.7	647.8	220.2	208.0	196.7	—	3381.8
1993	—	—	—	84.8	128.0	344.2	693.0	439.2	101.8	228.0	9.0	15.8	2064.6
1994	4.6	—	9.4	138.8	83.4	745.4	1558.1	510.2	197.1	302.1	16.6	—	3565.7
1995	23.6	—	—	34.8	149.6	289.6	951.0	431.0	502.4	96.0	52.2	—	2530.2
1996	—	—	3.0	103.6	28.2	685.8	824.8	504.5	233.7	313.5	32.0	64.9	2854.0
1997	3.40	—	45.40	26.8	57.4	556.9	896.1	819.0	87.7	230.1	121.2	32.1	2876.1
1998	—	—	—	59.7	114.9	792.0	719.7	285.4	249.7	221.3	155.9	36.0	2634.6

to deep (150 cm), with high organic carbon in the surface ranging from 1.45 to 3.86%. The CEC of the soil is low, ranging from 4.77 to 9.90 C mol (P⁺) kg⁻¹ soil indicating the dominance of Kaolinitic type of clay (Korikanthimath 1994). These soils generally have low base saturation, varying from 14.0 to 30.0% except F soil series indicating high leaching of the soils. They are acidic in soil reaction with pH ranging from 5.1 to 6.4.

Though the rainfall is high (2064.6 to 3565.7 mm), its distribution is erratic (Table 1). Most of it is received during May to September (unimodal). Potential evapo-transpiration generally exceeds rainfall for about five months in a year, resulting in moisture deficit for more than 90 days. Hence, it requires an assured irrigation during summer months (February-May). According to criteria (Table 3) for optimum yield, well distributed rainfall of about 1000 to 1500 mm and AWC of 100 to 150 mm are required. The critical limit for AWC is of

about 100 mm. In general, cardamom grows well at 900 to 1200 m MSL with 40-50% shade. The crop also requires well drained and well aerated deep soil (>80 cm).

Topography of soil is also important for its cultivation, steep slopes and fairly level lands are not suitable for cultivation. Slope of 2 to 5% is suitable. Fairly level lands may create an anaerobic or waterlogged condition during rainy season and leads to mortality of plants due to rhizome rot.

Texture is considered important and its influence can be modified by structure, clay minerals, organic matter, etc. Although cardamom is cultivated well under sandy clay loam (Scl) to sandy loam (Sl) soils, the very fine as well as sandy soils are considered to be critical in the evaluation criteria.

In the soil site suitability approach, the soil site characteristics are evaluated and the degree of limitation is determined. Based on the number,

Table 2. Soil site characteristics of soil map units

Soil Unit*	Rain-fall (mm)	Topo-graphy (slope %)	Elev-ation (m)	Drain-age Class**	Soil depth (cm)	Soil Texture		Gravelliness		pH	O.C. (%)	AWC (mm)	CEC	BS (%)	Shading (%)
						Sur-face	Sub-surface	Sur-face	Sub-surface						
1AhB1	2770	1-2	960	5	>150	Scl	Scl-Sc	9	45	5.1	2.88	50-100	4.77	14	50-60
2 AhB2	2770	3-5	980	5	>150	Scl	Scl-Sc	5	45	5.1	2.88	50-100	5.00	14	50-60
3 AiB1	2770	1-2	960	5	>150	Scl	Sc	10	45	5.1	2.88	50-100	5.00	14	50-60
4 BhB1	2770	1-2	940	5	>150	Scl	Sc	—	—	5.3	3.86	100-150	6.60	21	50
5 BhC1	2770	3-5	960	5	>150	Scl	Sc	—	—	5.2	3.58	100-150	7.00	21	50
6 BhC2	2770	3-5	960	5	>150	Scl	Sc	—	—	5.3	3.80	100-150	6.50	21	50
7 BhD2	2770	5-10	960	5	>150	Scl	Sc	—	—	5.2	3.46	100-150	6.60	21	50
8 ChB2	2770	1-2	940	5	>150	Scl	Sc-c	—	—	5.6	2.49	100-150	5.20	26	50
9 ChB2	2770	3-5	950	5	>150	Scl	Sc-c	—	—	5.6	2.53	100-150	5.20	26	50
10 ChD2	2770	5-10	970	5	>150	Scl	Sc-c	—	—	5.6	2.38	100-150	5.20	26	50
11 DhA1	2770	0-1	940	5	>150	Scl	Scl	—	—	5.3	2.03	100-150	9.20	26	50
12 DhC1	2770	3-5	970	5	>150	Scl	Scl	—	—	5.3	2.38	100-150	9.20	30	50
13 EbB1	2770	1-2	910	3	50-70	Ls	Ls	—	15	5.5	2.24	<50	4.80	30	40
14 EbC2	2770	3-5	910	3	50-70	Ls	Ls	—	15	5.5	2.03	<50	4.80	30	40
15 FcB1	2770	1-2	890	5	>150	Sl	Sl	—	—	6.4	2.07	50-100	9.60	60	40
16 GCB1	2770	1-2	880	5	>150	Sl	Scl	—	—	5.5	1.45	100-150	9.90	26	40

* For key to soil unit please refer Fig. 1. ** 3-imperfectly drained; 5-well drained

Table 3. Land suitability for cardamom cultivation

Site characteristic		Suitability rating			
		S1	Suitable S2	S3	Not suitable N2
Climate	Rainfall (mm)	1500-2000 (Well distributed)	2000-3000 1000-1500	3000-4000 1000-500	< 500
	Temperature (°C)	15-25	10-15, 25-30	30-35	>35 <10
Land	Elevation (m)	900-1200	1200-1500 900-600	1500-2000 <600	>2000
	Slope %	2-5	1-2	5-15	>15
	Shade %	40-45	45-50	50-60	>60
Soil depth (cm)		>80	80-60	< 60	<25
Texture	Surface	scl,sl	cl,c,sc	ls	s
	Subsoil	scl,cl,sc	sl,c (<40%)	ls,c (>40%)	c (>60%)
Gravel	Surface %	<15	15-35	35-60	>60
	Sub surface%	<15	5-15	15-35	>35
Drainage*		WD	MWD	ID	PD
pH		5.2-6.0	6.0-6.5 5.2-4.8	4.8-4.5	<4.5
	Organic carbon %		>2	1-2	0.7-1 <0.7
C.E.C. (Soil)		5-10	10-25	25-35	>35
Base saturation%			<35	35-50	50-60 >60
AWC (mm)		100-150	50-100	<50	<25

*WD=Well-drained, MWD=Moderately well-drained, ID=Imperfectly drained, PD=Poorly drained

kind and degree of limitation, the overall degree of limitation of a given soil and its phases (soil map unit) is determined which is matched with the criteria for assessing suitability.

The various soil site characteristics-physico-chemical as well as morphological characters (Table 2) are matched with soil suitability criteria (Table 3) for cardamom. It is seen that 42.0% of the area is highly suitable (Table 4).

It comprises the seven mapping units - AhC₂, BhB₁, BhC₁, BhC₂, ChB₂, ChC₂ GcB₁ of four soil series.

The area moderately suitable for cardamom cultivation is about 53.0% and comprised of seven mapping units of AhB₁, AiB₁, BhD₂, ChD₂, DhA₁, DhC₁, FcB₁ of five soil series. The area of about 4% is marginally suitable and

Table 4. Suitability of soils for cardamom

Suitability class	Mapping units	Area	
		Hectares	Per cent
S1 (highly suitable)	AhC ₂ , BhB ₁ , BhC ₁ , BhC ₂ , ChB ₂ , ChC ₂ , GcB ₁	7.26	42
S2 (moderately suitable)	AAhB ₁ , AiB ₁ , BhD ₂ , ChD ₂ , DhA ₁ , DhC ₁ , FcB ₁	9.24	53
S3 (marginally suitable)	EbB ₁ , EbC ₂	0.62	4

includes EbB₁ and EbC₂ mapping units of one soil series.

The marginally suitable land can be brought under cultivation by over coming poor moisture availability by practising mulching, shade regulation, higher dose of organic matter etc. Steeper land could be made suitable by constructing field bunds across the slopes. By adopting these measures, the class S₃ land may be brought to class S₂ land. Thus from the study it is clear that 42% of the area is highly suitable, 53% is moderately suitable and 4% of the area is marginally suitable for cardamom cultivation.

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