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Short Communication

Rainfed Groundnut Yield Prediction Based on Edaphic Characters in Aravalli East Upland of Udaipur District

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In Rajasthan, groundnut is mainly cultivated during kharif season, on about 2.12 million ha area, producing 3.32 million tons (Govt. of Rajasthan, 2006). To find out the most suitable areas for its production under the prevailing climate and soil variabilities in the agro-ecological subregion 4.2 in Udaipur district of the state, a study was carried out to predict groundnut crop yield at three locations in the district.

A regression model, which can simulate reasonably the impact of climatic (Sulochana *et al.*, 1999) and soil variability (Singh and Singh, 2007) on the specific crop under consideration was used for the study.

The study was carried out in Udaipur district (N23°50′-N25°05′; E73°05′-E 74°40′), which has a hot, dry, semi-arid climate and forms a part of agro-ecological sub-region (AESR) 4.2 (Aravali East Upland). The region receives rainfall between 500 and 600 mm, with PET of 1380 mm. The precipitation exceeds 0.5 PET for 95 days. The growing period varies between 105 and 125 days, and increases with depth and fineness of soil. Eight soil profiles at Changeri and one profile each at Navania and Vana were examined for morphological characteristics (Soil Survey Staff, 2003). Horizon-wise samples were collected and processed for laboratory investigation. Crop suitability for groundnut was evaluated by matching soil characteristics with crop requirements using modified suitability criteria as suggested by Sys *et al.* (1991) and Jain *et al.* (2000). The yield was monitored continuously at all locations during kharif season for three years, 2004, 2005 and 2006. The soil moisture at different depths was monitored at farmers' fields during the study period.

Based on soil physico-chemical characteristics, soil depth, slope, AWC, rainfall, drainage and management practices, a multiple regression model was used to predict the groundnut yield. For this, weightage was given (0.10 to 0.85) to the seven independent variables controlling groundnut yield. The highest numerical value was assigned for maximum groundnut production by each factor. Similarly the lowest value was assigned for lowest yield obtained by each factor (Table 1).

Groundnut crop yield (kg ha^{-1}) was then predicted as:

$$\beta 0 + \beta 1 \times 1 + \beta 2 \times 2 + \beta 3 \times 3 + \beta 4 \times 4 + \beta 5 \times 5 + \beta 6 \times 6 + \beta 7 \times 7 \quad \text{... (Eq. 1)}$$

where,
$\beta 0$ = intercept, $\beta 1$= soil depth (cm), $\beta 2$ = soil texture, $\beta 3$ = soil slope (%), $\beta 4$ = AWC, $\beta 5$ = rainfall, $\beta 6$ = drainage, $\beta 7$ = management.

The yield data for 2004 was used for developing the multiple regression equation, and then the regression equation was used to predict the 2005 and 2006 yield, which was then compared with actual yield observed at farmers' fields. The yield was also predicted for all the three years for putting fertilizer and management figures as 'low', 'medium' and 'high', where 'low' was assumed to have 25% fertilizer application of recommended dose, very poor crop stand, and no hoeing and weeding, etc., 'medium' was assumed to have 50% fertilizer application, medium crop stand and medium weed management, while 'high' stood for 100% fertilizer application, full crop stand and full weed management.

Out of the ten selected soils four belonged to shallow (<50 cm), two to medium (50 to 75 cm), three to deep (75 to 100 cm) and one to very deep (>100 cm) categories. Shallow soils were well-drained, moderately alkaline, with dark brown, sandy loam at the surface and sandy clay loam in the sub-surface, situated on partially cemented carbonate rich Ckm horizon. Moderately shallow soils were well drained, calcareous, strongly alkaline and dark brown with loamy surface, sandy clay loam to clay loam sub-surface on partially weathered C horizon. Deep soils were

Table 1. Soil suitability ratings for groundnut during kharif 2004

Depth (cm)	Texture	Slope	AWC	Rainfall	Drainage	Management
0.30	0.65	0.50	0.30	0.30	0.40	0.20
0.30	0.67	0.70	0.32	0.35	0.75	0.60
0.35	0.70	0.50	0.35	0.40	0.60	0.70
0.45	0.55	0.50	0.45	0.50	0.60	0.40
0.55	0.70	0.50	0.55	0.60	0.60	0.60
0.60	0.65	0.75	0.60	0.65	0.75	0.65
0.65	0.70	0.70	0.70	0.70	0.75	0.55
0.70	0.70	0.75	0.75	0.75	0.75	0.80
0.65	0.60	0.75	0.70	0.70	0.75	0.60
0.70	0.50	0.75	0.75	0.75	0.20	0.20

well drained, moderately alkaline and alkaline, with dark brown, sandy loamy surface horizon, strongly alkaline, dark yellowish brown, sandy clay loam sub-surface horizon. Very deep soils were fine on very gentle sloping plains with interspersed monadnocks, having clayey surface, moderately eroded, but associated with deep well drained, moderately saline and slightly sodic soils.

The clay content in shallow, moderate, deep and very deep soils varied from 11.50 to 24.68, 17.41 to 22.06, 16.28 to 32.3 and 42.13 to 45.20%, respectively. $CaCO_3$ content increased down the profile, and it was highest in clayey soils (5.19-5.65). Soil moisture content was associated with clay content present in the soils. In shallow, moderate, deep and very deep soil at 0.03 MPa it ranged from (%) 9.74-16.15, 13.50-16.84, 16.53-30.94 and 42.13-45.20, respectively. Similar trend was observed at 0.1, 0.3, 0.5 and 1.5 MPa. Higher organic carbon content and lower soil pH values were recorded in surface horizons. In shallow soils lower EC was recorded. In moderately deep to deep soils where irrigation to the rabi crops was given EC values were higher.

For regression analysis to predict groundnut yield, factors having significant correlation with groundnut yield such as soil depth (r=0.54), texture (r=0.50), slope (r=0.40), AWC (r=0.54), rainfall (r=0.57), drainage (r=0.71) and management (r=0.89) were chosen. These were individually significant at 5% level of significance. The factors accounted for 98% variations in groundnut yield. The following result was obtained from the analysis:

Groundnut yield (kg ha^{-1}) = 3.475171-6.59235 (soil depth, mm) – 4.60455 (soil texture) – 7.69649 (slope %) + 39.38491 (AWC, mm) – 23.9893 (rainfall) + 0.80525 (drainage) + 17.51469 (management). R^2 = 0.99 .....(eq. 2)

The performance of model was tested in the year 2005 and 2006. The predicted yield was then compared with observed yield in field.

It was found that during 2004 the observed yields ranged from 31-1150 kg ha^{-1}, which were quite close to predicted yield (r=0.99). Low yields in shallow soils were observed basically due to lower availability of water. It was observed that in most of the sandy loam soils, the water availability at 0.03 MPa ranged from 9.85 to 16.15%, but during growing season water availability during stress period remained at 0.3-0.5 MPa. This was an important reason for low observed and predicted yield. In medium soils observed yield ranged from 1040 to 1100 kg ha^{-1}, whereas in deep soils it was 1240 to 1600 kg ha^{-1}. In medium and deep soils water availability in 0.30 cm soil during stress period remained at 0.1-0.3 MPa, but from 30 cm and deeper the water availability remained at 0.03 MPa level. The basic reason for getting higher yields in deep soils appeared to be higher AWC, better management and drainage conditions.

In very deep clay loam-clay soils very low yield of 580-650 kg ha^{-1} was observed in all the three years. This was mainly due to high clay content that resulted in very poor drainage.

The regression model predicted that in shallow soils the groundnut yield was 309 to 384, 835 to 910 and 1360 to 1435 kg ha^{-1} under low, medium and high management, respectively. It was further observed that in medium soils predicted groundnut yield varied from 397 to 403, 928 to 998 and 1454 to 1524 kg ha^{-1} under low, medium and high management, respectively.

In moderately deep soils (80 cm) the predicted yield increased from 546 kg ha^{-1} in low management

Table 2. Predicted and observed yield of groundnut crop in Changeri watershed

Soil depth (cm)	Yield (kg ha^{-1})					
	2004		2005		2006	
	Observed	Predicted	Observed	Predicted	Observed	Predicted
30-35	310	309	350	385	300	385
30-35	800	834	850	900	625	649
35-40	1150	1102	1250	1260	625	665
40-50	750	734	1050	1102	940	991
55-60	1040	1104	1350	1384	1250	1273
60-65	1100	1078	1200	1235	950	981
80	1200	1159	1650	1676	1750	1767
100	1600	1603	1620	1690	1400	1445
85-90	1230	1254	1300	1364	750	805
>100	600	599	650	569	580	569

to 1597 kg ha^{-1} in high management during 2004. Trends were similar in 2005 and 2006.

The prediction indicated that by better management even in shallow and medium soils higher yield of groundnut crop is possible. However, distribution of rainfall affects the prediction. During 2006 there was continuous rain for 25-30 days, leading to stagnation of water in the field, resulting in poor yield. In very deep clay loam soils (>100 cm) model prediction did not work properly due to high clay content and poor drainage condition.

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