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CONTENTS

Rating scale of pedological development in humid moisture regime of guava growing soils in north-east region of Haryana

DHARAM PAL* and DINESH

Department of Soil Science, CCS Haryana Agricultural University, Hissar-125004 (Haryana)
**Corresponding author'semail id: dharampalsagwal3238@gmail.com*

ABSTRACT: The present study was conducted to evaluate the Rating Scale of Pedological Development in Humid Moisture Regime of Guava Growing Soils in North-East Region of Haryana during 2021-23. For this fifteen representative pedonswere excavated from five districts (Ambala, Yamunanagar, Karnal, Kurukshetra, and Kaithal). The morphological characteristics of all the pedons under study were examined in situ in the field and horizon-wise soil samples were collected to analyze for chemicalcharacteristics in the laboratory at Department of Soil Science CCS HAU, Hisar. To evaluate pedological development of soil pedons two modified rating scales *i.e.,* Relative Horizon Distinctness (RHD) and Relative Profile Development (RPD) were used. The results obtained from all soil pedons were found to have RHD and RPD ratings varying from 0-10 & 3-11, 0-15 & 0-19 for two geomorphic units *i.e.,*recent and old alluvial plains, respectively. The data of field morphology rating scale indicated development of Guava Growing Soils in humid moisture regime pedologically to the order of old alluvial plains >recent alluvial plains. Application of these rating scale and suggested modification on some soils of North-East Haryana, achieved the chronosequence, as well as, the diagnostic horizons of soils which belong to Inceptisols and Alfisols order have higher values of RPD than the soils belong to Entisols orders. So, the rating scale can be used for comparing the development of soils pedologically in humid climatic regimes.

Key words*:*Horizon, morphology, pedon, relative horizons distinctness, relative profile development

A study by Gill *et al.* (2022) carried out to evaluate pedological development of soils in Eastern Agro-climatic zone of Haryana by rating scale and results obtained indicates that the soils of *Typic Udorthents* have values for RPD lower than soils of *Typic Ustochrepts* i.e. the soils of Inceptisols order are relatively more development than soils of Entisols order. Although, such type of results are also observed by Adel *et al.* (2022) while studying on soils in South El-Amiria. The pedological development evaluations need to include many more numbers of features from international soil development forums. Soil morphology ratings have been used significantly in the determinations of degree of development of soils and surface depositions for evaluating the development of profile. However, sometimes it is very difficult to determine the soil profile development under different landforms may be due to occurrence of discontinuities of parent material or any other disturbance.

The alteration or discontinuities of the parent material under different soil forming processes reflects the morphology of a soil. These alterations in soil morphology have to more quantitatively characterize as distinguished from those due to pedogenesis. To evaluate the pedological development of the soil a rating scale was presented by Bilzi and Ciolkosz (1977) by providing the quantitative scale for the different morphological characteristics of soil. The rating scale was used in the following two ways: (1) to determine the relative distinctness of horizon and (2) to determine the relative development of soil profile. Relative Horizon Distinctness (RHD) is determined by comparing the morphological characteristics of two adjacent horizons and can be used for identifying the discontinuities in deposition of parent material within the horizons. On the other hand, Relative Profile Development (RPD) is determined by comparing the morphological characteristics of discrete horizons to the C horizon within a pedon (Meixner and Singer, 1981 and Zayed *et al*., 2021). Relative Horizon Distinctness (RHD) ratings for soil pedonsgenerally found to less than 10; however, the ratings greater than 10 were also obtainedin some cases if either heterogeneity in parent material or

soil formation discontinuities were observed in the soil pedon. Although in some cases monogenetic soil formation will also resulting in higher RHD ratings, but the soils tested here have high rating usually due tosoil forming discontinuities. The Relative Profile Development (RPD) rating scales are increased with age and generally, higher values were found in the A horizons for younger soils and in the B horizons for older soils.

The guava-growing soils in North-East Haryana that lie between latitudes 29°29′30′′and 30° 30′05′′North and longitudes 29°47′55′′and 30° 30′05′′East were considered as a pilot area for applying the attempt to improve rating scale for the evaluation of the development of soils pedologically. Different pedological features of area under consideration are studied by Gill *et al.* (2022a). Thus, the interpretation of soil morphology and development depends upon the correct way that how efficiently you evaluate the soil parent material (Arnolod, 1968).

The study area falls in alluvial plain is the important one socio-economic hinterland of Haryana and contributing a major and significant share to the food-grain reserve of the state. It comprises vast riverine plains of the older and the newer alluvium. Therefore, the lithological diversity in alluvial monotony has a strong base for the distributional pattern of land use, cropping pattern and agricultural productivity. The Ghaggar and Markanda streams and Yamuna River have left their imprint to the area to make the alluvial plain. The plain imperceptibly slopes from north-east to south and south-west, the lines of natural drainage.

Thus, the aim of the study is an attempt to quantify some morphological and chemicalcharacteristics of soils, which are located in subtropical to humid zone. The data obtained was compared and interpreted as per the rating scales principals and evaluating the pedological development of soils underrecent and old alluvial plains for guava growing soils in North-East Haryana. In this context, all suggestions will be tested on the area under consideration.

MATERIALSAND METHODS

The area under present study islies between 29°09' to 30°29' N latitude and 76°09' and 77°36' E longitude comprising five districts (Kaithal, Karnal, Kurukshetra, Ambala and Yumunanagar) in Haryana, India. The general characteristics of geomorphic units of the area under study recognized two major geomorphic units viz. recent alluvial plains and old alluvial plains. The parent material the flood plains and alluvial plains are part of the Great Plains of India formed by alluvial sedimental deposition from recent to Pleistocene times. The plains are extraordinarily homogenous with slight variations in relief features. The shifting of river courses in the areas of frequent floods is a specific geomorphic process in the plains. The seasonal streams locally called chaos, engendered erosion and adversely altered undulating topography to the south of the Shivaliks.

In the present study, fifteen guava orchards (two to four from each district) were selected based on two major parameters *i.e.* variation in soils characteristics and guava dominance (Fig. 1) and profiles were excavated. The climate of the area is sub-humid with

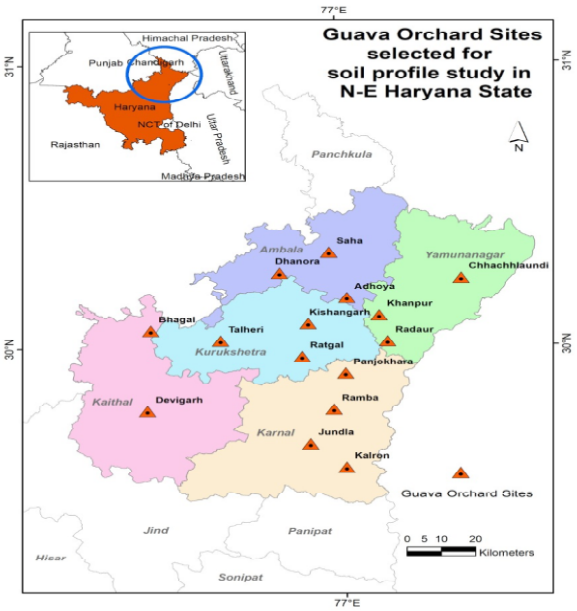

Fig. 1: Map of the study area showing selected guava orchard sites

ustic&udic moisture regimes, hyperthermic temperature regimes, and a mean annual temperature of more than 20°C. The profiles were excavatedand the morphological features were examined *insitu* in the field as per the Soil Survey Manual (2017). Horizon-wise soil samples of each profile were collected and analyzed in the laboratory at Department of Soil Science, CCS HAU, Hisar during 2021-23.

The relative indices of soil development viz. relative horizon distinctness (RHD) and relative profile development (RPD) were calculated from the soil morphological and chemical characteristics data recorded while study as per the procedure defined byBilzi and Ciolkosz (1977).The points obtained from the different soil characteristics of a horizon were summed up to evaluate RHD ratings and these valueswere further plotted against the depth of soil horizons for graphical representation of the RHDto the soil profile. All the points obtained from the different soil characteristics for every horizon were summed upto evaluate RPD ratings and the values plotted for graphical representation of the relative profile development (RPD) of the soil. Some suggested modifications were included according to the environmental conditions to give ratings as per the Soil Survey Manual (USDA, 1993) and guidance of FAO (2015). Application of these ratings depends on the same idea that of Bilzi and Ciolkosz (1977). The illuvial concentration of carbonates or gypsum is dominant by obliteration of all or much of the original rock structure, including as B horizons were contiguous to another genetic horizon that is the result of pedogenic processes (USDA, 1993). Thus, while calculating the RHD and RPD ratings to evaluate the soil pedological development, the points assigned according to the environmental condition as described below:

1- The points of every horizon are summed up separately.
2- The average of all horizons of the representative profile was calculated.
3- The presence of any of the diagnostic horizons and their points are summed for the average of RHD and RPD ratings. The modification in rating scale was effective in evaluating the pedological development of soils in the udic/ ustichumid moisture regime.

RESULTS AND DISCUSSION

The parameters such as variations in the development of horizon boundary, moist colour, texture, structure and consistency all contributed to the field morphological ratings. The soilsof recent alluvial plains (pedons 1, 4, 7 & 13) have RHD value ranging from 0 to 10 and the average value ranged between 2.5-5.17 (Table 1& Fig. 1). The data shows moderate distinctness within the soil horizons may be due to coarse fragments present in the horizons and/or weathering of parent materials as influenced by more precipitation or river flood in the recent alluvial plains (Gill *et al.,* 2022). The average of RHD for the soilpedons in recent alluvial plains was observed to less than 10 may be due to the effect of water erosion and variation in soil pH and salinity. The RHD data for recent alluvial plain soils confirmed the homogeneity in parent material and the differences in horizons occur only may be due to pedologicalprocesses rather to the geological processes.

The soils of old alluvial plains (pedons 2, 3, 6, 8, 9, 10, 11, 12, 14 & 15) have RHD value ranging from 0 to 15 and average RHD value ranging from 4.4 to 12.4 (Table 2& Fig. 2).The data obtained shows that the RHD ratings for the profiles under old alluvial plains varied within the pedons maybe due to change in structure, texture (Reza *et al.,* 2010). Meixner and Singer (1981) observed that the RHD rating values less than 10 indicates differences may only be due to pedologicalprocesses and thevalues above 10 indicate that the differences may only be due to geological processes. The average of RHD profile was found varied from 2.5 to 5.17 and 4.4 to 12.4 for recent and old alluvial plain soils, respectively and similarly the average of RHD units was found 3.8 and 6.1 for recent and old alluvial plain soils, respectively. The high value of average horizon and profile ratingsrepresentshigher the development of profile. The data confirmed the nomenclature of the unit, too (Adel *et al.,* 2022).

The higher average RHD profile or unit rating describe the more pedological development of the soil profile (Zayed *et al.*, 2021). Moreover, in recent alluvial soils the surface horizons were found to have

Table 1: RHD and RPD ratings for soil pedons under recent alluvial plains

Pedon	Horizon	Total RHD Rating	Average of RHD Profile	Average of RHD Unit	Horizon	Total RPD Rating	Average of RHD Profile	Average of RHD Unit
1	Ap/AB	5	5.17	3.8	Ap/ C1	8	6.6	5.4
	AB/ B1	4			AB/ C1	7		
	B1/ B2	6			B1/ C1	11		
	B2/ B3	2			B2/ C1	4		
	B3/C1	4			B3/C1	3		
	C1/C2	10						
4	Ap/AC	6	3.75		Ap/C1	6	6	
	AC/ C1	5			AC/ C1	6		
	C1/ C2	1						
	C2/ C3	3						
7	Ap/AC	5	3.75		Ap/C1	7	4.5	
	AC/ C1	2			AC/ C1	2		
	C1/ C2	6						
	C2/ C3	2						
13	Ap/AC	5	2.5		Ap/C1	6	4.5	
	AC/ C1	3			AC/ C1	3		
	C1/ C2	2						
	C2/ C3	0						

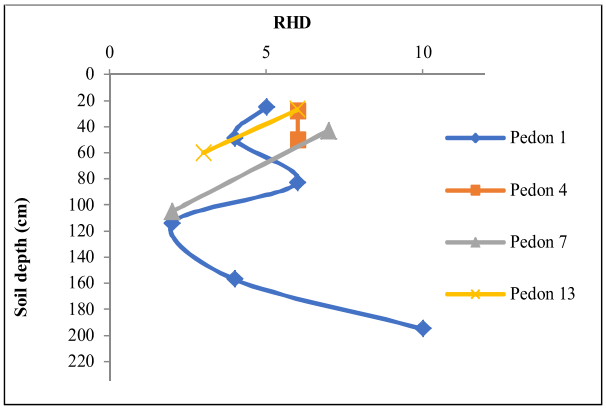

Fig. 1: RHD rating for recent alluvial soil pedons

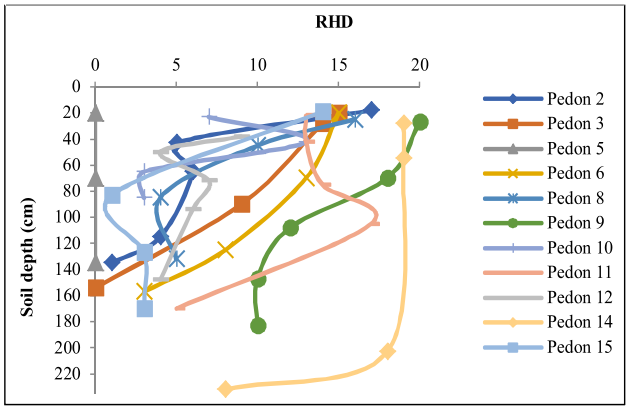

Fig. 2: RPD rating for old alluvial soil pedons

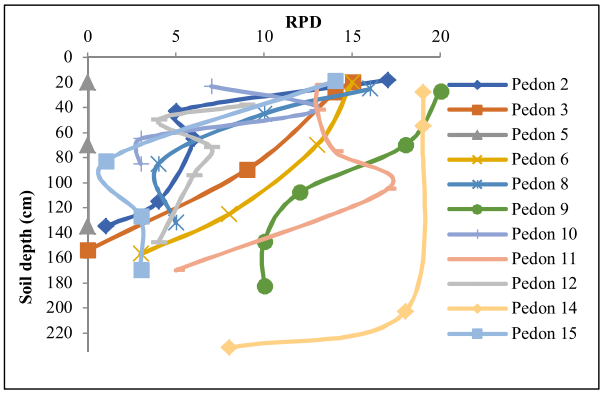

Fig. 3: RPD rating for old alluvial soil pedons

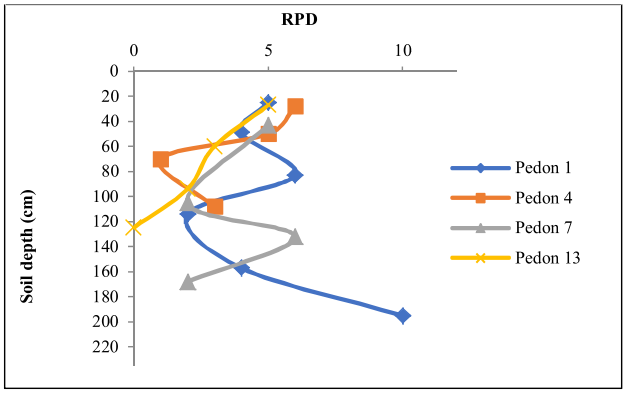

Fig. 4: RPD rating for recent alluvial soil pedons

higher pedological ratings rather than subsurface/ lower horizons to the old alluvial soils where subsurface/lower horizons were found to have higher pedological ratings in comparison to surface horizons. The weathering of parent material from hilly areas due to high precipitations at the hills and later on deposited to the recent alluvial plains is the main reason for homogeneous materials that differ

Table 2: RHD and RPD ratings for soil pedons under old alluvial plains

Horizon	Total RHD Rating	Average of RHD Profile	Average of RHD Unit	Horizon	Total RPD Rating	Average of RPD Profile	Average of RPD Unit
Ap/AB	12	4.8	6.1	Ap/C1	17	6.6	8.6
AB/ B1	3			AB/ C1	5		
B1/ B2	5			B1/ C1	6		
B2/ B3	3			B2/ C1	4		
B3/C1	1			B3/C1	1		
Ap/AB	3	4.75		Ap/C1	15	9.5	
AB/ B1	10			AB/ C1	14		
B1/ B2	6			B1/ C1	9		
B2/ C1	0			B2/ C1	0		
Ap/AB	8	4.67	NOT CALCULATED DUE TO				
AB/ B1	1		UNAVAILABILITY OF C				
B1/ B2	5		HORIZON				
Ap/AB	8	5.25		Ap/ C1	15	9.75	
AB/ B1	5			AB/ C1	13		
B1/ B2	5			B1/ C1	8		
B2/ C1	3			B2/ C1	3		
Ap/AB	8	5.5		Ap/ C1	16	8.75	
AB/ B1	6			AB/ C1	10		
B1/ B2	3			B1/ C1	4		
B2/ C1	5			B2/ C1	5		
Ap/AB	4	4.4		Ap/ C1	20	14	
AB/ B1	10			AB/ C1	18		
B1/ B2	2			B1/ C1	12		
B2/ B3	0			B2/ C1	10		
B3/C1	6			B3/C1	10	6.5	
Ap/AB	14	5.4		Ap/ C1	7		
AB/ B1	10			AB/ C1	13		
B1/ B2	0			B1/ C1	3		
B2/ C1	2			B2/ C1	3		
C1/C2	1					12.5	
Ap/AB	13	12.4		Ap/ C1	8		
AB/ B1	13			AB/ C1	17		
B1/ B2	14			B1/ C1	8		
B2/ C1	17			B2/ C1	17		
C1/C2	5					5.6	
Ap/AB	9	6		Ap/ C1	8		
AB/ B1	4			AB/ C1	7		
B1/ B2	7			B1/ C1	5		
B2/ B3	6			B2/ C1	4		
B3/C1	4			B3/C1	4	16	
Ap/AB	3	8.5		Ap/ C1	19		
AB/ B1	13			AB/ C1	19		
B1/ B2	10			B1/ C1	18		
B2/ C1	8			B2/ C1	8		
Ap/AB	15	5.25		Ap/ C1	14	5.25	
AB/ B1	2			AB/ C1	1		
B1/ B2	1			B1/ C1	3		
B2/ C1	3			B2/ C1	3		

only due to pedologicalprocesses rather than the geological processes as in case of old alluvial plains, that's why high RHD rating values even 10 or more were recorded for old alluvial plains. The data also revealed that in old alluvial plains the RPD values of all the soil pedons were found higher in the B horizon except for pedons 2, 6, 7, 8, 13, and 15 may be due to maximum pedological development influenced by weathering of surface soil (Sarkar *et al*., 1997 and Dinesh *et al*., 2017). The soils of recent alluvial plains (pedons 1, 4, 7 & 13) have RPD values ranging from 3 to 11 (Table 1& Fig. 4). However, the RPD rating for pedon 1 ranged from 3 to 11 is much higher as compared to the other pedons*i.e.* from 3 to 6may be due to more stratification processes occurred in pedon 1(Reza *et al*., 2014 and Gill *et al*., 2022). In old alluvial plains with levelled and stable landforms, soils of pedons have RPD ratings varied from 0 to 19 (Tables 2& Fig. 3) and the variation in rating may be due to variations in horizons boundary, moist colour, texture, structure, consistency, pH and EC (Deka *et al.,* 2009). The results revealed that higher the RPD rating values more the pedological development of a horizon and vice-versa. However, under stable land form conditions, the changes in different soil morphological parameters resulting in more soil profile development, also contributing to more RPD values (Zayed *et al*., 2021). The average RPD profile ratings for the soil pedonsin recent and old alluvial plains ranged 4.5 to 6.6 and 5.25 to 16.0, respectively and the average RPD unit ratingfrom for recent and old alluvial soil pedons were 5.4 and 8.6, respectively.The data obtained indicate that the field morphology rating clubbed with other modified ratings which are suggested in the current study can be become useful tool to evaluate the pedological development of soils of udic/ustichumid moisture regime under the guava growing soils of North-East Haryana, India.

The results of present study revealed a very close relationship between landform units and profile development inthe two main physiographic unitobserved during the course of study *i.e*. recent alluvial plains and old alluvial plains. The soil profilesunder old alluvial plains were found more developed pedologicallyto the recent alluvial plains. However, the less developed recent alluvial soils even lacked in showing the distinct diagnostic horizons as compared to moderately well-developed old alluvial plains. The pedogenic development of the soils assessed by the field morphological rating coupled with the other modified ratings may help to the researchers to evaluate the profile development of the soils of the other areas and landform. The current study is an attempt to adapt land development research under the conditions of guava growing humid region in NE Haryana, India, since these soils may be characterized by A, B, and C horizons, this attempt must be repeated for more crops in other regions of Haryana to confirm its suitability to express the pedological development of soil at various degree and level and also may be applied at the international level to include all climates and land environmental parameters.

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