Review Article

Assessment of soil physical properties ~~under~~ of major cropping systems ~~of~~ in SPSR Nellore district, Andhra Pradesh.

Abstract:

—A study was carried out during 2021-22 in SPSR Nellore district of Andhra Pradesh, India to know the impact of major cropping systems on soil physical properties. A total of 240 soil samples (120 surface and 120 sub-surface) under six major cropping systems ~~viz.,~~ such as paddy-paddy, fallow-paddy, groundnut-paddy, paddy-cotton, paddy-greengram and paddy-blackgram were collected and analysed for physical properties. The results revealed that the ~~colour~~color of the soils ranged from pale red to very dark gray (2.5 YR 6/2 to 7.5 YR 3/1). The soils of study area were sandy clay loam, sandy loam, clay loam and clay in texture. Soils from paddy-paddy and paddy-cotton cropping systems recorded highest bulk density (1.55 ~~Mg~~ mg m^{-3}) in surface soils and paddy-cotton (1.66 ~~Mg~~ mg m^{-3}) cropping system in sub-surface soils whereas lowest bulk density observed in paddy-blackgram cropping system in both surface (1.13 ~~Mg~~ mg m^{-3}) and sub-surface soils (1.29 ~~Mg~~ mg m^{-3}). In surface and sub-surface soils particle density was ranged from 2.45 ~~Mg~~ mg m^{-3} in paddy-cotton and paddy-blackgram cropping system to 2.75 ~~Mg~~ mg m^{-3} in paddy-cotton and paddy-greengram cropping systems. The soils of paddy-blackgram cropping system showed higher water holding capacity (54.65 and 49.71%, respectively) while the lowest was recorded in paddy-cotton cropping system in surface and sub-surface soils (31.39 and 28.28%, respectively). Volume expansion was found to be high in paddy-blackgram cropping system in both surface and sub-surface soils (22.34 and 23.61%, respectively) while lowest volume expansion was noticed in paddy-paddy cropping system in surface soils (12.46%) and paddy-cotton cropping system in sub-surface soils (11.94%).

Key words: Cropping systems, ~~Soil~~ soil physical properties, surface and sub-surface soils, SPSR Nellore district.

Introduction

Soil physical properties are important for favourable crop growth and maintaining soil quality. Cropping systems exert significant impact on soil physical properties, which ultimately affect crop yield. In some cases, continuous monocropping has detrimental effects on soil quality. Soil health is negatively affected by unsuitable management practices, which decrease crop productivity. Soil physical properties are positively influenced by cropping systems and management practices, *i.e.*, residues retention and tillage. (Reeves., 1997).

The sustainability of crop and soil management practices to improve soil quality depends on the understanding, how soils respond to different site-specific cropping and land-use practices. Scientific information on site-specific soil properties is a basic tool for proper soil management in order to provide sustainable soil functions at present and in the future (Jagadamma *et al.*,2008). Site-specific data on soil properties could also support in dealing with the spatial variability of soil nutrients and physical indicators and their influencing factors. Soil properties as indicators of soil functions and soil quality status are suggested for understanding the sustainability of soil resources.

———Many practices like crop type, cultivation and application of crop residues are known to influence soil properties. Therefore, sustainable cropping and land management practices

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are essential for maintaining crop productivity while enhancing various soil properties. Better crop rotations, reduced tillage, intensive use of cover crops and efficient use of organic manures offers a powerful combination of practices to improve soil and agroecosystem health. Whereas, continuous use of inorganic fertilizers under intensive cropping systems leads to deterioration of soil properties resulting decline in soil productivity. In this view the present study was taken up to know in detailed the influence of various cropping systems on physical properties of soil.

Materials and Methods

The present study was carried out in SPSR Nellore district of Andhra Pradesh, India which falls under southern Agro-climatic zone and geographically, located between 14°-4′-12.9″ and 14^0-57′-56.8″ North latitudes and 79^0-30′-29.6″ and 80^0-4′-24.7″ East longitudes. ~~Two hundred and forty soil samples~~ In study area, 240 soil samples were collected (120 surface at 0-15 cm and 120 sub-surface at 15-30 cm) for physical analisys such as ~~were collected from six major cropping systems viz.,~~ paddy-paddy, fallow-paddy, groundnut-paddy, paddy-cotton, paddy-greengram and paddy-blackgram of SPSR Nellore district by following random sampling technique during the year 2022. The exact sample location was recorded by using hand held GPS. ~~The collected soil samples were analysed for physical properties as per the procedure.~~

—Munsell's colour notation of Hue, Value and Chroma were observed for both air dried and moist soil samples (Soil Survey Staff, 1951). Texture of the soils was determined by the Bouyoucous hydrometer method as described by Baruah and Barthakur (1997). Based on particle size distribution, textural classification was given using the *nomograph* (textural diagram) of USDA. The physical constants such as bulk density, particle density, water holding capacity and volume expansion in the soil samples were determined by following Keen Raczkowski's method as described by Sankaram (1966).

Results and Discussions

The data pertaining to soil physical properties (soil colour, ~~Texture~~texture, ~~Bulk~~ bulk density, ~~Particle~~ particle density, ~~Water~~ water holding capacity, ~~Volume~~ volume expansion) was presented in Tables 1 to 4.

Soil colour

The data presented in Table 1 revealed that the colour of soils under major cropping systems of SPSR Nellore ranged from pale red to very dark gray (2.5 YR 6/2 to 7.5 YR 3/1) with a hue varied from 2.5 YR to 7.5 YR, value ranged from 3 to 6 and chroma varied from 1 to 6 at both surface and sub-surface soils.

The ~~colour~~color appears to be the function of chemical and mineralogical composition of the soil (Swarnam *et al*., 2004). These ~~colours~~colors indicated the release of iron oxides and their occurrence in various hydrated forms due to difference in drainage of the soils (Walia and Rao, 1996). Similar findings were also reported by Thangasamy *et al*. (2005), Sanjeev *et al*. (2005) and Vajantha *et al*. (2017)

Texture

-From the Table 2 it was revealed that the texture of soils under paddy-paddy, fallow-paddy, groundnut-paddy cropping systems were sandy clay loam and clay loam while paddy-cotton cropping systems were sandy clay loam and clay loam in texture however, clay loam and clay

Comment [DZ2]: What are the main cropping systems in the study area?

Comment [DZ3]: Include the physical characteristics (relief, precipitation, temperature, soil type) of the study area and a figure of the study area for better understanding

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Comment [DZ4]: To determine the texture of the soil, a granulometric analysis is first performed by sieves and for the fine fraction of clays and silts the hydrometer method is used.
Indicate what fraction they used to determine the clay texture? Normally the sieve 100 or 200 is used, where the greatest amount of fine soil is retained.

texture was noticed in soils of paddy-greengram and paddy-blackgram cropping systems in SPSR Nellore district. The variation in soil texture might be due to variation in topographic position, nature of parent material, in situ weathering, translocation of clay and age of the soils (Vajantha *et al*., 2013). Charan *et al*. (2021) reported that texture of different cropping systems in Nellore district were sandy clay loam to clay.

Bulk density

The maximum bulk density was observed in soils of paddy-paddy and paddy-cotton cropping system in surface soils (1.55 ~~Mg~~ mg m^{-3}) and in paddy-cotton cropping system in sub-surface soils (1.66 ~~Mg~~ mg m^{-3}) while the lowest in paddy-blackgram cropping system in both surface (1.13 ~~Mg~~ mg m^{-3}) and sub-surface soils (1.29 ~~Mg~~ mg m^{-3}), respectively. The range of bulk density for surface soils varied from 1.45-1.67, 1.12-1.38, 1.10-1.27, 1.35-1.67, 1.10-1.39 and 1.10-1.20 mg m-3 in paddy-paddy, fallow-paddy, groundnut-paddy, paddy-cotton, paddy-greengram and paddy-blackgram cropping systems (Fig 1) and CV was 14.24 and 11.74 per cent for bulk density in both surface and sub-surface soils of different cropping systems. The lowest bulk density was found under paddy-blackgram cropping system due to higher amount of added biomass from leguminous crops made soil loose, porous and less squeezed (Kumar *et al*., 2020 and Kavitha *et al*., 2020)~~)~~.

Particle density

In surface and sub-surface soils particle density was ranged from 2.45 ~~Mg~~ mg m^{-3} in paddy-cotton and paddy-blackgram cropping system to 2.75 ~~Mg~~ mg m^{-3} in paddy-cotton and paddy-greengram cropping systems (Table 3). The particle density did not show any trend with depth and more or less uniform values were recorded in surface and sub-surface soil layers. (Reddy and Naidu 2016 and Kavitha *et al*., 2020).

Water Holding Capacity (WHC)

The data presented in Table 4 revealed that the mean water holding capacity values of surface soils under major cropping systems of SPSR Nellore district namely paddy-paddy, fallow-paddy, groundnut-paddy, paddy-cotton, paddy-greengram and paddy-blackgram were 43.52, 45.98, 42.47, 31.39, 52.83 and 54.65% ~~per cent~~, respectively. The water holding capacity in paddy-paddy, fallow-paddy, groundnut-paddy, paddy-cotton, paddy-greengram and paddy-blackgram was 36.21-49.45, 39.16-53.00, 26.00-53.88, 21.07-40.89, 45.76-57.86 and 48.90-57.90 (Fig 2). The CV was 20.25 per cent for water holding capacity in the surface soils of different cropping systems.

In sub-surface soils the mean water holding capacity values in paddy-paddy, fallow-paddy, groundnut-paddy, paddy-cotton, paddy-greengram and paddy-blackgram cropping systems were 40.70, 41.88, 35.70, 28.28, 47.72 and 49.71% ~~per cent~~, respectively. The CV was 21.64% ~~per cent~~ for water holding capacity in the sub-surface soils of different cropping systems.

In both surface and sub-surface soils the highest water holding capacity was observed in paddy-blackgram (54.65 and 49.71%, respectively), cropping system and the lowest in paddy-cotton cropping system (31.39 and 28.28%, respectively). The highest water holding capacity

Comment [DZ5]: Include a one-dimensional graph (1D) of some soil samples, obtained from the granulometric analysis of the 240 samples collected. One from each zone in the same graph.
Include a two-dimensional figure (2D) that shows the distribution of the soil texture in the study area for better understanding, since the other parameters can be clearly understood from this property. They are more representative.
Indicate the percentage of each soil texture and you can use it and include the tridiagonal soil texture graph of these percentages to define the soil type

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Table 1: Soil ~~colour~~color under major cropping systems of SPSR Nellore district, Andhra Pradesh.

Cropping system	Soil colour			
	Dry colour		Moist colour	
	Range			
	0-15 cm	15-30 cm	0-15 cm	15-30 cm
Paddy-paddy	2.5 YR 6/1 - 7.5 YR 4/1	2.5 YR 6/1 - 7.5 YR 3/1	2.5 YR 5/1 - 7.5 YR 3/1	2.5 YR 5/1- 7.5 YR 3/1
Fallow-paddy	2.5 YR 7/1 - 7.5 YR5/1	2.5 YR 6/1 - 7.5 YR 4/1	2.5 YR 6/1 - 7.5 YR 4/1	2.5 YR 6/3 - 7.5 YR 3/1
Groundnut-paddy	2.5 YR 6/2 - 5 YR 5/6	2.5 YR 5/4 - 5 YR 5/3	2.5 YR 5/2 - 5 YR 5/4	2.5 YR 5/2 - 5 YR 3/4
Paddy-cotton	2.5 YR 6/1 - 7.5 YR 4/2	2.5 YR 6/1 - 7.5 YR 4/1	2.5 YR 6/1 - 7.5 YR 4/1	2.5 YR 5/1 - 7.5 YR 3/1
Paddy-greengram	2.5 YR 6/1 - 7.5 YR 5/1	2.5 YR 6/1 - 7.5 YR 4/2	2.5 YR 5/1 - 7.5 YR 4/2	2.5 YR 5/1 - 7.5 YR 3/2
Paddy-blackgram	2.5 YR 5/1 - 5 YR 3/4	2.5 YR 5/3 - 5 YR 3/4	2.5 YR 4/1 - 5 YR 3/4	2.5 YR 4/3 - 5 YR 3/4

Table 2: Textural class of soils under major cropping systems of SPSR Nellore district, Andhra Pradesh

Cropping system	Texture			
	Sand (%)	Silt (%)	Clay (%)	Textural class
Paddy-paddy	56.65-75.00	4.61-15.79	10.71-29.11	Sandy clay loam & Sandy loam
Fallow-paddy	54.56-83.04	2.80-14.04	9.84-33.40	Sandy clay loam & Sandy loam
Groundnut-paddy	56.28-73.56	5.25-15.28	14.10-29.36	Sandy clay loam & Sandy loam
Paddy-cotton	41.95-71.82	3.16-27.24	21.36-37.45	Sandy clay lom & Clay loam
Paddy-greengram	31.32-45.26	15.59-25.78	29.27-45.60	Clay loam & Clay
Paddy-blackgram	30.25-47.09	13.88-26.59	29.27-55.87	Clay loam & Clay

Table 3: Bulk density and Particle density of soils under major cropping systems of SPSR Nellore district, Andhra ~~Prasedh~~ Pradesh

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	Bulk density (Mg m^{-3})				Particle density (Mg m^{-3})			
Cropping system	0-15 cm		15- 30 cm		0-15 cm		15- 30 cm	
	Range	Mean	Range	Mean	Range	Mean	Range	Mean
Paddy-paddy	1.45-1.67	1.55	1.54-1.70	1.64	2.52-2.74	2.61	2.50-2.67	2.60
Fallow-paddy	1.12-1.38	1.23	1.22-1.46	1.34	2.48-2.74	2.61	2.48-2.74	2.60

Groundnut-paddy	1.10-1.27	1.20	1.25-1.36	1.30	2.60-2.75	2.66	2.60-2.73	2.66
Paddy-cotton	1.35-1.67	1.56	1.47-1.75	1.66	2.45-2.67	2.60	2.45-2.75	2.63
Paddy-greengram	1.10-1.39	1.19	1.26-1.53	1.35	2.61-2.75	2.68	2.63-2.75	2.68
Paddy-blackgram	1.10-1.20	1.13	1.23-1.37	1.29	2.45-2.75	2.68	2.60-2.74	2.67
CV (%)		14.24		11.74		2.56		2.34

Table 4: Water holding capacity and volume expansion of soils under major cropping systems of SPSR Nellore district, Andhra Pradesh

	Water holding capacity (%)				**Volume expansion (%)**			
Cropping system	**0-15 cm**		**15- 30 cm**		**0-15 cm**		**15- 30 cm**	
	Range	**Mean**	**Range**	**Mean**	**Range**	**Mean**	**Range**	**Mean**
Paddy-paddy	36.21-49.45	43.52	34.39-44.26	40.70	7.65-18.58	12.46	11.30-19.57	14.15
Fallow-paddy	39.16-53.00	45.98	34.23-47.38	41.88	7.17-19.56	13.70	5.41-19.17	13.71
Groundnut-paddy	26.00-53.88	42.47	21.65-50.26	35.70	9.24-25.65	18.02	9.03-26.63	18.50
Paddy-cotton	21.07-40.89	31.39	20.05-38.57	28.28	7.16-18.85	12.85	6.02-17.36	11.94
Paddy-greengram	45.76-57.86	52.83	41.00-54.30	47.72	11.79-27.29	19.41	13.71-26.62	21.22
Paddy-blackgram	48.90-57.90	54.65	43.00-53.28	49.71	16.78-28.32	22.34	17.57-28.67	23.61
CV (%)		20.25		21.64		31.44		32.00

Fig 1: Range of bulk density in major cropping systems of SPSR Nellore district of Andhra Pradesh

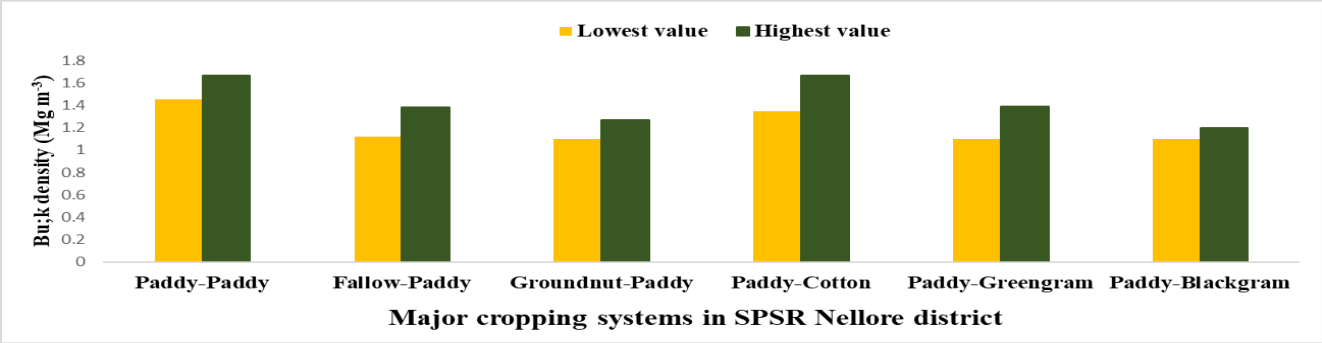
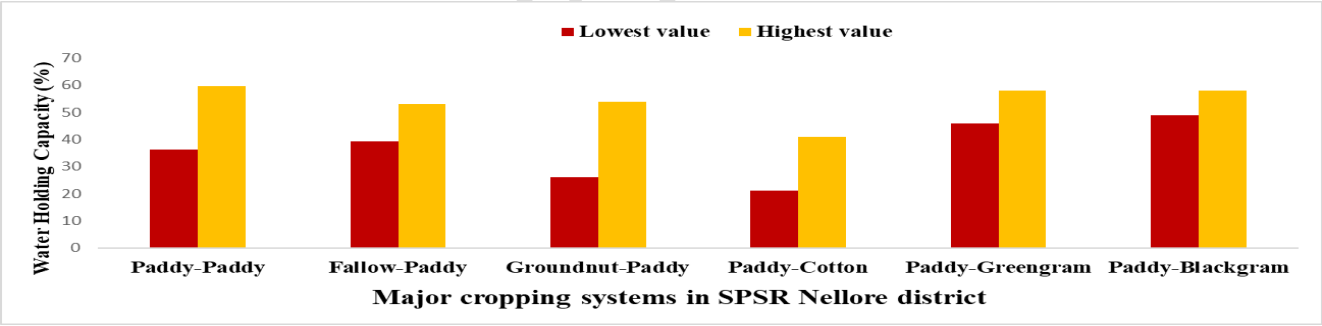


Fig 2: Range of water holding capacity in major cropping systems of SPSR Nellore district of Andhra Pradesh



in paddy-blackgram cropping system is due to rice-legume cropping systems store large amount of carbon in to the soil, which bind soil particles, increase mean weight diameter, improve water stable aggregates, and consequently increase in water holding capacity of soil (Bama and Somasundaram 2017).

Volume expansion

In surface soils the mean volume expansion in different cropping systems was in the order of paddy-paddy (12.46%) followed by paddy-cotton (12.85%), fallow-paddy (13.70%), groundnut-paddy (18.02%), paddy-greengram (19.41%) and paddy-blackgram (22.34%) while in sub-surface soils the mean volume expansion in different cropping systems was in the order of paddy-cotton (11.94%) followed by fallow-paddy (13.71%), paddy-paddy (14.15%), groundnut-paddy (18.50%), paddy-greengram (21.22%) and paddy-blackgram cropping system (23.61%). From the data it was observed that the soils under paddy-blackgram cropping system showed the highest mean volume expansion in both surface (22.34%) and sub-surface soils (23.61%). Whereas the soils of paddy-paddy (12.46%) in surface soils and paddy-cotton (11.94%) cropping systems in sub-surface soils reported the lowest volume expansion. The CV for volume expansion in both surface and sub-surface soils of different cropping systems was 31.44 and 32.00 per cent. The volume expansion indicates the presence of shrinking and swelling type of clay minerals. This variation in volume expansion was due to presence of significant amount of smectite type of clay. Similar results were reported by Leelavathi *et al*. (2009) and Kavitha *et al*. (2020)

Conclusions

From this study, it was concluded that the different rice based cropping systems affects the physical properties of soils of SPSR Nellore district of Andhra Pradesh. Among, the cropping systems paddy-blackgram followed by paddy-greengram cropping system sustained better physical properties of soil in terms of lower bulk density, higher water holding capacity and volume expansion than that of soils under paddy-paddy, fallow-paddy, groundnut-paddy and paddy-cotton cropping systems. Therefore, present study recommended that to sustain soil health to become productive for next generation rice-legume cropping systems could be more effective.

References Check reference format for IJPSS

Bama, K. S., and E. Somasundaram. 2017. Soil quality changes under different fertilization and cropping in a Vertisol of Tamil Nadu. International Journal of Chemical Studies 5 (4):1961–68.

Baruah, T.C and Barthakur, H.P. 1997. *A text book of soil analysis*. Vikas Publishing House Pvt. Ltd., New Delhi.

Charan, G.R., Munaswamy, V., Krishna, T.G. and Subramanyam, D. 2021. Dynamics of Soil Potassium Under Different Cropping Systems in YSR Kadapa District of Andhra Pradesh, India. *Soil Science Research Network.*

Jagadamma, S., Lal, R., Hoeft, R.G., Nafziger, E.D and Adee, E.A. 2008. Nitrogen fertilization and cropping system impacts on soil properties and their relationship to crop yield in the central Corn Belt, USA. *Soil and Tillage Research*. 98(2): 120-129.

Kavitha, M., Vajantha, B., Naidu, M.V.S and Reddi Ramu, Y. 2020. Effect of soil physical properties in sugarcane growing tracts of prudential sugar factory zone in Chittoor District, Andhra Pradesh. *International Journal of Current Microbiology and Applied Science*. *8*(2): 2065-2070.

Comment [DZ8]: Previously there was no talk of the amount of carbon in the soil, it was determined?

Comment [DZ9]: Expand discussion. What temporal and spatial management alternatives do they propose to maintain soil health and make it more productive?

Kumar, V., Singh, S.K., Singh, P., Tiwari, S., Nand, M.M., Chiranjeeb, K and Majhi, M. 2020. Effects of Cropping Systems on Soil Properties and Enzymatic Activities in Calcareous Soil. -*Journal homepage: http://www. ijcmas. Com*. -*9*(4): p.2020.

Leelavathi, G.P., Naidu, M.V.S., Ramavatharam, N and Sagar, G.K. 2009. Studies on genesis, classification and evaluation of soils for sustainable land use planning in Yerpedu mandai of Chittoor district, Andhra Pradesh.-*Journal of the Indian Society of Soil Science*.*57*(2):109-120.

Reddy, S.K and Naidu, M.V.S 2016. Characterization and classification of soils in semi-arid region of Chennur mandal in Kadapa district, Andhra Pradesh. *Journal of the Indian Society of Soil Science*. 64(3): 207-217.

Reeves, D.W. 1997. The role of soil organic matter in maintaining soil quality in continuous cropping systems. -*Soil and Tillage Research*. 43(1-2): 131-167.

Sanjeev, K.C., Singh, K., Tripathi D and Bhandari, A.R. 2005. Morphology, genesis and classification of soils from two important land use in outer Himalayas. *Journal of the Indian Society of Soil Science*. 53(3): 394-398.

*Sankaram, A. 1966. *A laboratory Manual for Agricultural Chemistry*. Publishedby Jaya Singer Asia Publishing House, Bombay. 56-57.

Soil Survey Staff, 1951. *Soil Survey Manual*. US Department of AgriculturalHandbook No. 18.

Swarnam, T.P., Velmurugan, A and Rao, Y.S. 2004. Characterisation and classification of some soils from Shahibi basin in parts of Haryanaand Delhi. *Agropedology*. 14(2): 114-122.

Thangasamy, A., Naidu, M.V.S., Ramavatharam, N and Raghavareddy, C. 2005. Characterization, classification and evaluation of soil resources in Sivagiri micro-watershed of Chittoor district in Andhra Pradesh for sustainable land use planning. *Journal of the Indian Society of Soil Science*. 53: 11-21.

——Vajantha, B., Umadevi, M., Patnaik, M. and Rajkumar, M., 2013. Study on the availability of micronutrients status in ashwgandha grown farmers field of Andhra Pradesh. *An Asian Journal of Soil Science.* volume 8: 157-161

Vajantha, B., Umadevi, M., Patnaik, M.C., Rajkumar, M., Subbarao, M. and Naidu, M.V.S., 2017. Spatial distribution of available nutrients in ashwagandha (withania somnifera) grown soils of farmers' fields in andhra pradesh. In *Sustainable Management of Land Resources* (pp. 511-529). Apple Academic Press.

Walia, C.S and Rao, Y.S. 1996. Genesis, characteristics and taxonomic classification of some red soils of Bundelkhand region of Uttar Pradesh. *Journal of the Indian Society of Soil Science*. 44: 476-481.

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