Assessment of Soil Properties to Improve Water Holding Capacity in Soils

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Abstract : The cultivated and non cultivated land is about 114.84 lakh hectares in Telangana in which 43.2% i. e 49.61 lakh hectares land is cultivated and the remaining are fallow lands Most of the land is kept fallow may be due to deficiency in soil moisture or water holding capacity of soils. This deficiency is mainly due to insufficient rainfall and lack of natural water resources in Telangana region.

The present research paper discuss about the physio-chemical properties of some cultivated and non cultivated soils in Telangana to evaluate the deficiency of soil moisture and soil holding capacity of soils with the help of nutrients and analysis is carried out to improve the soil properties by addition of required amount of biomass and nutrients to improve the deficiency of soil moisture and water holding capacity. The paper discuss about the assessment of the soil properties of the cultivated and non cultivated soils and by improvement techniques soil moisture, water holding deficiency may be reduced.

Keywords: Soil properties, water holding capacity Organic manure, Clay, soil moisture*, Permeability,*

1. INTRODUCTION

Water holding capacity designates the ability of a soil to hold water. It is useful information for irrigation scheduling, crop selection, groundwater contamination considerations, estimating runoff and determining when plants will become stressed. By understanding some physical characteristics of the soil, you can better define the strengths and weaknesses of different soil types. Soil moisture limits forage production potential the most in semiarid regions. Estimated water use efficiency for irrigated and dry-land crop production systems is 50 percent, and available soil water has a large impact on management decisions producers make throughout the year.

Soil moisture available for plant growth makes up approximately 0.01 percent of the world's stored water. Soil texture and structure greatly influence water infiltration, permeability, and water-holding capacity Reference [1, 2]. Soil texture refers to the composition of the soil in terms of the proportion of small, medium, and large particles (clay, silt, and sand, respectively) in a specific soil mass. For example, a coarse soil is sand or loamy sand, a medium soil is a loam, silt loam, or silt, and a fine soil is a sandy clay, silt clay, or clay.Water holding capacity varies by soil texture Reference [1] .Permeability refers to the movement of air and water through the soil, which is important because it affects the supply of root-zone air, moisture, and nutrients available for plant uptake. A soil's permeability is determined by the relative rate of moisture and air movement through the most restrictive layer within the upper 40 inches of the effective root zone. Water-holding capacity is controlled primarily by soil texture and organic matter Reference [3, 5]. Soils with smaller particles (silt and clay) have a larger surface area than those with larger sand particles, and a large surface area allows a soil to hold more water. In other word a soil with a high percentage of silt and clay particles. Which Reference [3] describes fine soil, has a higher water-holding capacity. The table illustrates water-holding-capacity differences as influenced by texture. Organic matter percentage also influences water-holding capacity. As the percentage increases, the water-holding capacity increases because of the affinity organic matter has for water Reference [9].

2. STUDY AREA

The total land area of the State is 114.84 lakh hectares, out of which the area under forest cover is 27.43 lakh hectares, constituting 23.89 percent of the geographic area. Nearly,43.20 percent area is under cultivation (49.61 lakh hectares), 8.36 percent is Current Fallow Lands (9.60 lakh hectares), 7.79 percent Land is put to non-agricultural uses (8.95 lakh hectares),5.36 percent is barren and uncultivable (6.15 lakh hectares)

and 6.24 percent falls under other fallows (7.17 lakh hectares). The remaining 5.16 percent is under culturable waste, permanent pastures and other grazing lands, and land under miscellaneous tree crops and groves are not included in the net area sown (5.93 lakh hectares).

Soil samples were collected from three different locations of komapally area, in Telangana state for investigation for determining the physiochemical properties and to assess the relationship between moisture content and infiltration rate.

Three Soil samples are collected from three different places with GPS technique which are shown below:

Table 1: sample collection

Maisammaguda	Latitude: 17°33’47.19” N Longitude: 78°27’19.08” E
HMT	Latitude: 17°33’48.35” N Longitude: 78°27’39.56” E
Badurpally	Latitude: 17°33’48.35” N Longitude: 78°27’39.56” E

3. MATERIALS AND METHODS

Disturbed Soil samples were collected from various locations is analyzed for different physiochemical properties.

3.1 Sampling Depth

Sample number one: to a depth of 15-30 cm
Sample number two: to the depth that of 15-30 cm
Sample number three: sample is collected at depth of 15-30 cm

3.2 Sampling Equipment

A soil-sampling probe, an auger, a spade or shovel is used for cutting the soil sample at site

Sample collection

The sample should represent the area it is taken from. A soil sample must be taken at the right time and in the right way.

3.3 Methods for Determination of properties of soil samples

3.3.1 Determination of moisture content

The moisture content was determined by drying a known weight of the soil sample in an electric oven at 105°C for about 15 minutes. The moisture bottle and the stopper is removed and placed in desiccators

3.3.2 Bulk density of soil

The soil bulk density (BD), also known as dry bulk density, is the weight of dry soil (M_{solids}) divided by the total soil volume (S_{oil}). The total soil volume is the combined volume of solids and pores which may contain air (V_{air}) or water (V_{water}), or both.

3.3.3 Specific gravity

The value of specific gravity helps up to save extent in identification and classification of soils. It gives an idea about the suitability of the soil as a construction material. Higher value of specific gravity gives more strength for roads and foundations.

3.3.4 Sieve analysis

A sieve of set of sizes 4.75, 2.36, 1.18, 0.6, 0.3, 0.15, 0.075 mm including lid and collecting pan are placed on mechanical sieve shaker. Allow to shake for ten minutes. Retained material on each pan is weighed and results are tabulated and a grain size distribution curve is drawn. Coarse grained soils are classified mainly by sieve analysis. The grain size distribution curve gives an idea regarding the gradation of the soil.

3.3.5 Liquid limit

About 120 gm. of air dried soil from thoroughly mixed portion of material passing 425 micron IS sieve is obtained. Distilled water is mixed to the soil thus obtained in a mixing disc to form uniform paste. The paste shall have a consistency that would require 30 to 35 drops of cup to cause closer of standard groove for sufficient length. A portion of the paste is placed in the cup of casagrande device and spread into portion with few strokes of spatula. It is trimmed to a depth of 1 cm. at the point of maximum thickness and excess of soil is returned to the dish. The soil in the cup is divided by the firm strokes of the grooving tool along the diameter through the centre line of the follower so that clean sharp groove of proper dimension is formed. Then the cup is dropped by turning crank at the rate of two revolutions per second until two halves of the soil cake come in contact with each other for a length of about 12 mm. by flow only. The number of blows required to cause the groove close for about 12 mm. is recorded.

3.3.6 Plastic limit

Take out 30g of air-dried soil from a thoroughly mixed sample of the soil passing through 425µm IS Sieve. Mix the soil with distilled water in an evaporating dish. Take about 8g of the soil and roll it with fingers on a glass plate. The rate of rolling should be between 80 to 90 strokes per minute to form a 3mm dia.

3.3.7 Compaction

Take a representative oven-dried sample, approximately 5 kg in the given pan. Thoroughly mix the sample with sufficient water to dampen it to approximately four to six percentage points below optimum moisture content.

3.3.8 Permeability

Water flowing through soil exerts considerable seepage forces which have direct effect on the safety of hydraulic structures. The rate of settlement of compressible clay layer under load depends on its permeability. The quantity of water escaping through and beneath and earthen dam depends on the permeability of the embankment and the foundation soils respectively. Shear strength of soils depends indirectly on its permeability, because dissipation of pare pressure is controlled by its permeability.

4. RESULTS AND DISCUSSIONS

Results are obtained from the laboratory tests conducted on the soil samples. These tests are conducted to elevate the

Soil physiochemical properties. Chemical tests i.e., N, P, K tests are conducted at soil laboratories outside the college. Soil sample is given to laboratory technician and values of NPK are collected. Bulk density, specific

gravity, Atterburg limits, compaction, tests are conducted to find out the moisture content in the soil sample, that optimum moisture content is used in permeability test and the foundation soils respectively. Shear strength of soils depends indirectly on its permeability, because dissipation of pare pressure is controlled by its permeability.

Table: 3 Results of soil properties

For sample one: The soil which is collected from the Maisamaguda has the moisture content value 0.961

For sample two: The soil which is collected from the HMT has the moisture content value 0.90

For sample one: soil is black in colour. These soils are often associated with high levels of organic matter (peats). Soil has more water logging, low pH and high denitrification

Types of sample	Depth Cms	Physical properties	
		Color	Texture
Sample 1 (Maisammaguda)	30	Black	Clay
Sample 2 (HMT)	30	Red	Red soil
Sample 3 (Badhurpally)	30	Red	Loamy sand

(variable head method) are analyzed in college laboratory are discussed in this chapter.

4.1 Soil moisture content:

Table: 2 Results of moisture content

Types of sample	Wet wt of soil (gm)	Dry wt of soil (gm)	Moisture content (%)
Sample 1 (Maisammaguda)	55	30	0.961
Sample 2 (HMT)	52	50	0.90
Sample 3 (Badhurpally)	62	54	0.909

The moisture content was determined by drying a known weight of the soil sample in an electric oven at 105°C for about 15 minutes. The moisture content was calculated by the loss in weight of the soil and in weight of the soil and expressed in oven dry basis.

For sample three**:** The soil which is collected from the Badurpally has the moisture content value Is0.909.

Color of soil:

Discussion

For sample two: soil is Red in color. This color indicates good drainage. Iron found within the soil is oxidized more readily due to the higher oxygen content. This causes the

Types of sample	Bulk density g/cm³	Specific gravity	Liquid limit	Plastic Limit	Compaction	Permeability
Sample 1 (Maisammaguda)	0.961	2.093	36%	83.3	11%	7.17×10^{-3}
Sample 2 (HMT)	0.9	2.60	28%	83.3	13%	8.25×10^{-3}
Sample 3 (Badhurpally)	0.909	2.73	28%	150	11%	-

soil to develop a 'rusty' color. The color can be darker due to organic matter. It has low plant availability of water

For sample three: soil is yellow in color. These soils often have poorer drainage than red soils. The iron compounds in these soils are in a hydrated form and therefore do not produce the 'rusty' color. It has low plant availability of water

Texture of soil

For sample one: Soils with the finest texture are called clay soils, Hence the soils texture is clay

For sample two: Soil that has a relatively even mixture of sand, silt, and clay and exhibits the properties from each separate is called a loam. Hence the soils texture is silty loam soil.

For sample three: Soils with the coarsest texture are called sands. Hence the soils texture is loamy sand soil.

Table 4 Results of soil properties

Types of sample	pH	Chemical properties		
		N	P	K
Sample 1 (Maisammaguda)		2.4	1.5	1.3
Sample 2 (HMT)		1.2	0.8	1.0
Sample 3 (Badhurpally)		0.7	0.5	0.8

4.2 pH

Discussion:

For sample one: The soil which is collected from the Maisamaguda has the PH value of 6 is in between the standard value between 6-7. Soil contains alkaline this is because of using fertilizers for growing the crops

For sample two: The soil which is collected from the HMT has the PH value of 7.1 is exceeded the standard value, hence soil exceeding the ph range above 7 is alkaline soil, this soil has so because it is industrial soil

For sample three: The soil which is collected from the Badurpally has the PH value of 6.2 is in between the standard value between 6-7. Soil contains alkaline this is because of using fertilizers for growing the crops, Soil contains all types of grain sizes

Table: 5 soil characteristics

4.3 Bulk density of soil:

Discussion:

For sample one: Bulk density of the soil sample is 0.961 g/cm^3 are medium due to medium coarse fraction of soils.

For sample two: Bulk density of the soil samples is 0.9 g/cm^3 are lower.

For sample three: Bulk density of the soil samples is 0.909 g/cm^3

4.4Specific gravity

Discussion:

For sample one: Hence the soil sample is found as organic soil because of its specific gravity 2.093.

For sample two: Hence the soil sample is found as fine grained soil because of its specific gravity 2.73.

For sample three: Hence the soil sample is found as coarse grained soil because of its specific gravity 2.64.

4.5Sieve analysis

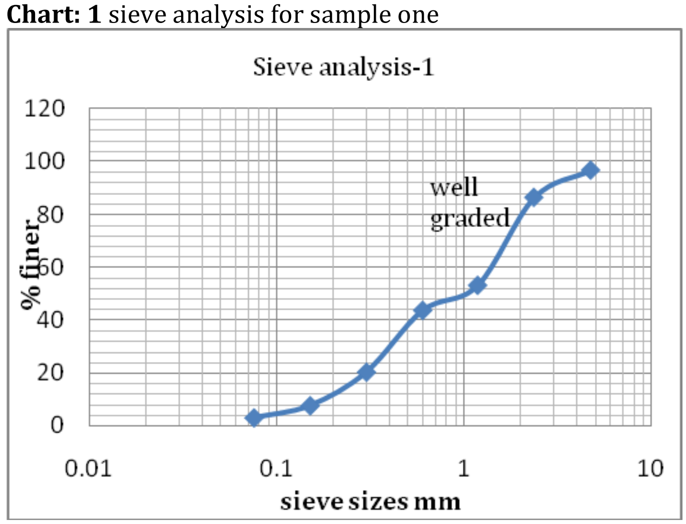
For sample one: This curve represents a soil which contains the particles of different sizes in good proportion. Such soil is called a well graded or uniformly graded soil

Uniformity of soil $C_u=D_{60}/D_{10}$

C_u> 4 gravels; C_u>6 for sands; C_u>5 for well graded gravel: C_u> 3 for uniform soil

C_u= 10.34 hence soil is well graded

Chart: 1 sieve analysis for sample one



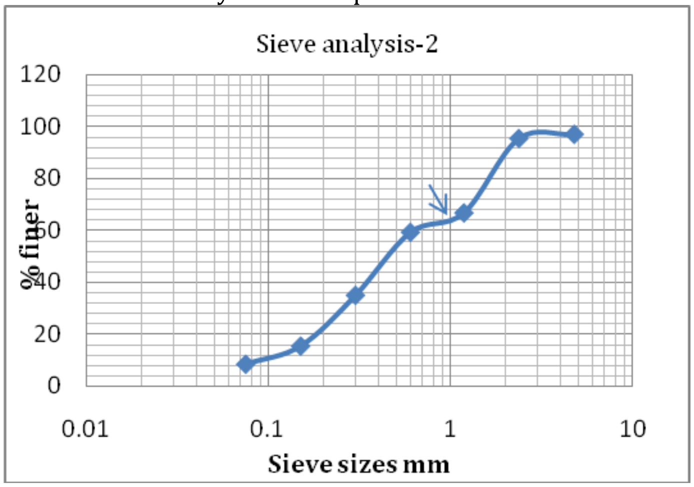
Discussion

For sample two: This curve represents a soil which contains the particles of different sizes in good proportion. Such soil is called a well graded or uniformly graded soil

Uniformity of soil $C_u=D_{60}/D_{10}$

C_u= 7.5 hence soil is well graded

Chart: 2 sieve analysis for sample two

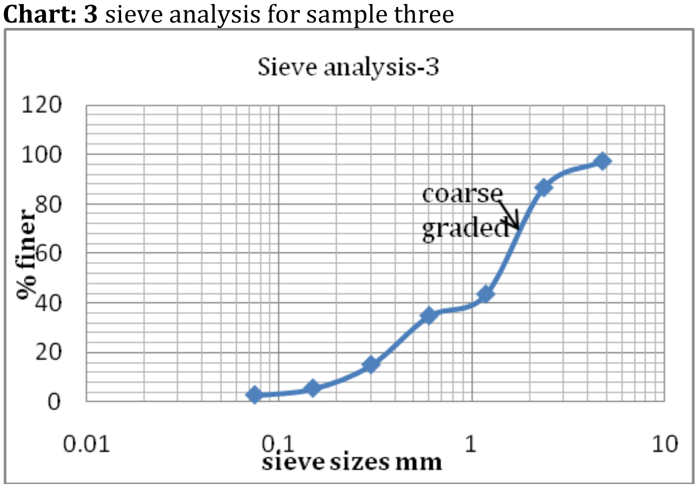


This curve represents a soil which contains the particles of different sizes in good proportion. Such soil is called a well graded or coarse graded soil

Uniformity of soil $C_u=D_{60}/D_{10}$

C_u= 7.4 hence soil is coarse graded

Chart: 3 sieve analysis for sample three



4.6 Liquid limit

Discussion

For sample one: The liquid limit value of soil is 36% is obtained at standard 25 blows from the graph. The value of liquid limit if in between 35-50 then soil indicates Medium compressibility soil. So 1the amount of water which is responsible for this state of consistency of soil is called liquid limit of soil.

For sample two: The liquid limit value of soil is 28%is obtained at standard 25 blows from the graph. The value of liquid limit if in between 0-35 then soil indicates low compressibility soil.

For sample three: The liquid limit value of soil is 28% the value of liquid limit if in between 0-35 then soil indicates low compressibility soil.

4.6Plastic limit

Discussion

For sample one: The average plastic limit W_p = 83.3 for the soil sample

For sample two: The average plastic limit W_p = 150 for the soil sample

For sample three: The average plastic limit W_p = 83.3

4.7 Compaction

Discussion:

For sample one: The dry density is maximum at the optimum water content. A curve is drawn between the moisture content and the dry density to obtain the maximum dry density and the optimum water content. From the above graph the Maximum dry density: 2.45 g/cm^3 Optimum moisture content: 11% are obtained

For sample two: A curve is drawn between the moisture content and the dry density to obtain the maximum dry density and the optimum water content. From the above graph the Maximum dry density: 2.8 g/cm^3 Optimum moisture content: 7% are obtained

For sample three: A curve is drawn between the moisture content and the dry density to obtain the maximum dry density and the optimum water content. From the above graph the Maximum dry density: 2.38 g/cm^{3}Optimum moisture content is 11%

4.6Permeability

Discussion

For Sample one the coefficient of permeability=7.17x10^{-3} mm/s

Soil sample having maximum water holding capacity that the water can permits easily.

The permeability test is a measure of the rate of the flow of water through soil. In this test, water is forced by a known constant pressure through a soil specimen of known dimensions and the rate of flow is determined.

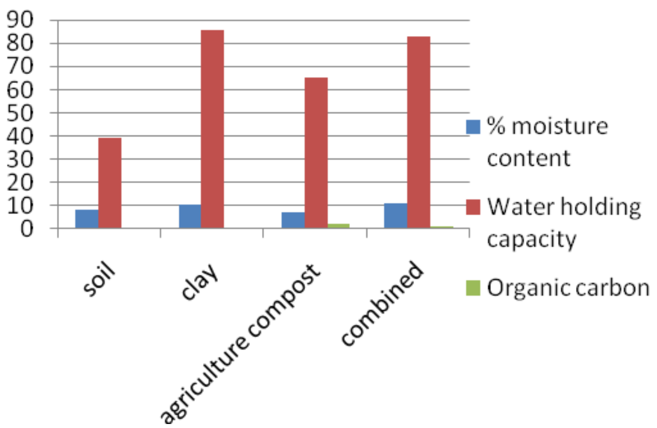
For sample two: The coefficient of permeability=8.12x10^{-3} mm/s. The soil bought from HMT area is having enough water holding capacity to irrigate the crops.

For sample three: The soil of badurpally did not permit the water into it, hence to increase the soils water holding capacity Organic matter is added in percentages thus water holding capacity may increase, the main aim of the project i.e., water holding capacity may increase in the soil which gives more crop yield

4.7 RESULTS OBTAINED WHEN SOILS TREATED SOIL WITH ORGANIC MANURE AND CLAY

Table: 6 Changes in physiochemical properties of sample soil (Badurpally)

Chart: 4 showing Changes in physiochemical properties of sample soil (Badurpally)



Discussion:

The different physicochemical properties such as soil pH, percentage moisture content, water holding capacity, organic carbon, were estimated (Table5.23). The soil moisture content was found to be increased from 8.3% in soil to 10.3, 7.2% and 10.94% in soil, clay agricultural compost (manure) and combined treatment respectively. The incorporation of organic residue also leads to reduction of evaporation of the soil water (Mandal et al., 2004). The water holding capacity in the untreated soil was very low and treated soil (combined treatment) 82.69%. The central role of soil organic carbon in maintaining soil function and plant productivity in agro-ecosystem has long been recognized. The results in the combined treatment of organic residue were extremely good in comparison to other and in untreated soil it was least.

IMPROVEMENT TECHNIQUE ADOPTED FOR WATER RETENTION CAPACITY IN SOIL COLLECTED IN BADHURAPALLY AREA

From the above Results and Discussion it is has revealed that the soil sample collected in Badurpally has very less Water retention and Water holding capacity ,it has varied soil structure and it has very least permeability factor. As permeability factor is very important factor for conduction of water in soils and this property helps in water holding and water retention capacity in soils. And this water which is available is very important for plant growth.

To Rectification this soil from all the above deficiencies, we have adopted an improvement technique for water holding capacity in soil and this technique also improves the binding nature.

Table: 6 Changes in physiochemical properties of sample soil (Badurpally)

Physiochemical properties	Soil	Clay	Agriculture compost (manure)	Combined
Soil pH	6.2	7.1	6.5	7.0
% moisture content	8.3	10.3	7.2	10.94
Water holding capacity	39.25	85.5	65.3	82.69
Organic carbon	0.52	0.63	2.1	1.28
% Mix	1Kg	2%	2%	2:2
Coefficient of permeability at T k_t	7.17×10^{-3}	8.12×10^{-3}	8.25×10^{-3}	8.65×10^{-3}

Experiment has been conducted by adding different proportions of clay and manure equally to the soil sample and water holding and enrich of fertility has been analyzed.

5. CONCLUSION

The present study with respect to reclaiming the Badhurpally soil sample soil by using the organic manure and clay shows increase in water holding capacity and also shows improves characteristics of fertility. And after the treatment it increased. Through this experiment it is clear that the incorporation of waste organic residues in Badhurpally soil can convert it into a fertile soil as these treatments were able to increase the range of all the required nutrients and were also successful to fulfill the physical, chemical and biological requirements needed in a healthy soil.

Organic matter behaves somewhat like a sponge, with the ability to absorb and hold up to 90 percent of its weight in water. A great advantage of the water-holding capacity of organic matter is that the matter will release most of the water that it absorbs to plants. In contrast, clay holds great quantities of water, but much of it is unavailable to plants.

Thus a good supply of soil organic matter is beneficial in crop or forage production. Consider the benefits of this valuable resource and how you can manage your operation to build, or at least maintain, the organic matter in your soil. Of all the components of soil, organic matter is probably the most important and most misunderstood. Organic matter serves as a reservoir of nutrients and water in the soil, aids in reducing compaction and surface crusting, and increases water infiltration into the soil.

REFERENCES

Vega Dhrmana, A, and Jashothan,*J. Nat. Prod. Plant Resour*., *2012,* 2012 Effect of organic fertilizers on the water holding capacity of the soils in different terrians. *2 (4):500-5*03.

Mbah C.N., Nenneji R.K. 2010 Effect of different crop residues management techniques on selected soil properties and grain production Vol. 6(17), pp. 4149-4152, 5 September, 2011

Hedley, C,B And Yule, I,J, 2009 Soil water status mapping and two variable rate irrigation, Volume 10, Issue 4, pp 342-355

Seenarious. Lawes, R.A 2009 Integrating effects of climate and plant available soil water holding capacity. Volume 113, Issue 3, Pages 297–305

Reynolds, W.D. and Top 2008 soil water analysis, principles and parameters soil samples and methods of analysis

Kemka, H.O, Rebecca, 2007 Influence of temperature and pH bio resource and protein bio synthesis.

Litter M.M, 2006 Nutrient manipulation methods are coral reef studies. Journal of Experimental Marine Biology and Ecology. Volume 336, Issue 2, 5 September 2006, Pages 242–253

Grace, Chart, M, 2006 laboratory manual of the soil microbial biomass group.

Das T.H. Sarkar etal. 2005 Water retention characteristics of some typical soil

Singh R. and Kundu D.K., 2005 Prediction of profile water storage capacity for major soil groups. Volume 36: issue: 3 pages 169-171

Iyenger,S.R, Bhav, 2005 composting of house hold waste.

Havlin, J.L., S.L. Tisdale, 2005 Soil fertility and fertilizer.

Board, N. 2004 the complete Technology Book on *Biofertilizer and organic Farming,* New Delhi

Mishra upasana, 2004 A potential bio fertilizer for crops.

Malik F.R, Ahmeds. Riziki Y.M, 2001 Utilization oflignocellolosic waste for the preparation of nitrogenous fertilizer.

Martens Dean, 2000A Plant residue bio chemistry regulates soil carbon cycling and carbon sequestration.

Adetunji MT (1997). Organic residue management, soil nutrient
changes and maize yield on a humid Ultisol. Nutr.Cycl. Agro Ecosyst., 47: 181-188

Plaster, E. J. 1996. *Soil Science and Management.* 3rd ed. Albany: Delmar Publishers,

Maheshwari BL etal 1992 Infiltraion characteristics of some clayey soil measured during boarder irrigation Agricultural Water Management Volume 21, Issue 4, September 1992, Pages 265-279