Research Article

THE EFFECT OF SOIL AMENDMENTS ON PHYSICAL PROPERTIES OF SANDY SOILS

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Abstract- Soil can be an excellent temporary storage medium for water, depending on the type and condition of the soil. In coastal sandy soil having high infiltration rate and poor water holding capacity. Soil amendments have significant effect on different properties of the soil. They may increase the field capacity and hydraulic conductivity, decrease infiltration rates and bulk density. Soil parameters of the crop were significantly affected by the application of the soil amendment like silt and aquasorb and showed an increment of 25% in field capacity and 95% of the Hydraulic conductivity. And there is a decrease in about 45% of infiltration rates. The good values of field capacity, bulk density infiltration and hydraulic conductivity were obtained when compared with control *i.e.*, in coastal sandy soils 25% of field capacity, 95% of hydraulic conductivity, 45% of infiltration rate shows the significant percentage of the soil physical parameters.

Keywords- Sandy Soils, Soil amendments, Aquasorb, Hydraulic conductivity.

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Introduction

India occupies coastal area of about 10.78 million hectares (107833 km²). In India, coastal region covers the long strip along the east coast (West Bengal, Orissa, Andhra Pradesh, Pondicherry and Tamil Nadu) and West coast (Gujarat, Maharashtra, Karnataka and Kerala). In Andhra Pradesh, total coastal region covers about 8.23 lakh ha consist of sandy loam and clay loam soil. Coastal sandy soil covers 0.61 lakh ha, which is 9% of total area of Andhra Pradesh [5].

The State of Andhra Pradesh is strategically located in the Indian sub-continent. It has the second largest coast line in the country with a length of 974 Km. It is the third largest state in the country with an area of 276754 km², and a population of 76 million. The average rainfall of the State is 940 mm with a least rainfall of 521 mm in Anantapur. The climate is generally hot and humid. The Forests cover 23% of the area. The State receives substantial rainfall during the north-east monsoon period [21].

All soils are composed of solid particles of various sizes, organic matter, and pore spaces that hold air and water. The pore spaces and water holding capacity depends on the texture and structure of the soil. Coastal sandy soil has high infiltration rate and low water holding capacity. Sandy soils are characterized by less than 18% clay and more than 68% sand in the first 100 cm of the soil. Sandy soils are characterized by a lack of structure or that it is weakly developed. Porosity ranges from 33% ($D_b = 1.78 \text{ g cm}^{-3}$) to 47% ($D_b = 1.40 \text{ g cm}^{-3}$) are commonly recorded. The porosity in sandy soils is usually smaller than in clayey and silt soils. Bulk density in sandy soil is 1.6g/cc [19]. Soil physical parameters like Hydraulic conductivity, Infiltration, Bulk density, Field capacity has the great impact on the soil. These parameters are varied differently in different soil compositions by the application of soil amendments like tank silt, Super Absorbent Polymers (SAP) and combination of these amendments. [10,14].

Silt with farm yard manure in different ratios effect on the soil physical properties like particle density, bulk density, porosity, water holding capacity [15]. Tank silt is an organic amendment for improving bulk density. The tank silt contains organic carbon, microbial biomass carbon, residual pesticides, etc., the sediment

composition and depth of deposition vary from tank to tank [16]. Super absorbent polymers while raising water holding capacity of light soils can address soil permeability problems of heavy soil. Since that Super absorbents absorb water hundreds of times of its own weight and being converted to long lasting gels, have a special place in agriculture, landscaping, erosion control and desert reduction. Super absorbents have no adverse effect on the soil, and are not considered as toxic in soil. Also, after 4-7 years, depending on the type and composition of soil, they are destroyed by microorganisms and do not cause environmental pollution. In addition to retaining water, super absorbents due to continuous volume change (expansion during inflation and contraction during losing water) will increase amount of air in the soil. Aquasorb is Super Absorbent Polymers (SAP) which stores water in the upper horizons of the soil where plant roots are found. Significant reductions in irrigation requirements of many plants due to an increase in water holding capacity by Aquasorb - amended soils have been reported [7]. It increases the plant available water in the soil which prolongs plant survival under water stress.

The main purpose of addition of super absorbent polymers is to increase water holding capacity of soil. It has been found that SAP has extensive applications as reactive materials based on the potential advantages of the specific active functional groups and the characteristic properties of the polymeric molecules. Super absorbent polymers are also used as releasing fertilizer agent of soil matrix, so that the polymer absorbs the nutrients needed by the plants and releases them gradually for the plants and thus prevent leaching of these elements. Aquasorb is mainly used to increase water storage of soils in the upper horizons of the soil [1]. Soil can be an excellent temporary storage medium for water, depending on the type and condition of the soil. In coastal sandy soil having high infiltration rate and poor water holding capacity. Influence of different soil amendment on soil has significant effect on its physical properties. The present study was carried out to find how the parameters *i.e.*, field capacity, bulk density, infiltration rate and hydraulic conductivity are varied in coastal sandy soils after the application of the

different soil amendments

The above mentioned constraints in coastal sandy soil lead for the study of the physical properties of soil. The specific objectives of the current study are

1. To study the effect of application of different soil amendments on field capacity and bulk density sandy soils.
2. To study the effect of application of different soil amendments on infiltration rate and capacity sandy soils
3. To study the effect of application of different soil amendments on hydraulic conductivity of sandy soils

Materials and Methods

Experimental Site and Climate

The experiment was conducted in the Soil and Water Engineering field irrigation laboratory, College of Agricultural Engineering, Bapatla from the first week of February to the second week of April, 2013. Geographically Bapatla is located at altitude of 15° 54' N and longitude of 80° 30' E with an altitude of 4.5 m above mean sea level. The mean annual rainfall in the region is 1167 mm. Out of total annual rainfall South west monsoon (June to September) accounts for 768 mm of rainfall, North east monsoon (October to December) accounts for 296 mm of rainfall, Winter (January to February) accounts for 17 mm of rainfall and Summer (March to May) accounts for 86 mm of rainfall. The soil texture in the region is sandy. The soil infiltration rate is 48 cm/h. The average temperature throughout the year is 35° C and relative humidity is around 73% (Lai 1978).

Preparation of the Field for the Experiment

The field was prepared for loosening the soil and for removal of weeds prior to sowing by using rotavator. After one week again the plot was tilled with rotavator to remove the weeds which are remained in the field. After that, the field should be divided into 16 plots, each plot having the size of 5×2.5m² and the spacing between plots is 1m. The experimental design of the plots was carried out by factorial randomized block design (FRBD). About 0.92tonnes of Farm yard manure was applied throughout the field having area of 375m²(15m×25m) i.e., 24.5 t/ha. About 168t/ha of tank silt was applied.

Details of the experiment

Current experiment having the following four treatments

1. Controlled condition - T₁
2. Silt application- T₂
3. Super absorbent polymer application-T₃
4. Silt and super absorbent polymer application –T₄

A completely factorial randomized block design (FRBD) with 4 replicates for each treatment was used in this experiment.

Table-2.1 Different types of treatments

Treatment	Applicant	Quantity
T ₁	Control	Control
T ₂	Silt	168t/ha
T ₃	Super absorbent polymer	52kg/ha
T ₄	Silt and super absorbent polymer	168t/ha+52kg/ha

Arrangement of Experimental Plots (FRBD)

With a randomized block design, the experimenter divides subjects into subgroups called blocks, such that the variability within blocks is less than the variability between blocks, shown in Fig.1 Then, subjects within each block are randomly assigned to treatment conditions. Compared to a completely randomized design, this design reduces variability within treatment conditions and potential confounding, producing a better estimate of treatment effects. In RBD the number of experiment unit in each block is equal to the number of treatments and each treatment will appear only once in each block.

Soil Amendments

Tank silt:

Silt is fine granular material derived from rock or soil. Silt is very economical

means to increase the soil fertility. The soil surface can be covered with the silt collected from tanks and lakes, before sowing. The adhesive properties of silt allow it to mix with soil in the fields. Advantages of silt application include increased soil fertility and, therefore, crop yields, increased moisture content of soil, improvement in water table due to increased filtration, among many others. In the experiment field 168 t/ha silt was applied.

Fig-1 Arrangement of plots in FRBD

Super Absorbent Polymer (SAP):

Before applying to the field the SAP was tested to know the capacity of water uptake by super absorbent polymer (SAP). In the experiment 1 gm of super absorbent polymer (SAP) was taken on a plastic film and water was poured continuously. 1g of super absorbent polymer (SAP) was allowed to absorb water until it attains saturation state. In the experimental field the super absorbent polymer (SAP) was applied at 3cm depth. 65g of SAP was mixed with 1kg of sand and applied the mixture by removing a layer of 3cm in the respective plots and then covering back with removed soil.

Soil Properties

Soil properties like infiltration, field capacity, bulk density and hydraulic conductivity were estimated. Infiltration is estimated by using double ring in filterometer. The values of accumulated infiltration, y and the infiltration rate are plotted as a function of elapsed time, t. Field capacity of the soil in the experimental field was determined using the field method by collecting the soil samples from desired soil depth layer with auger at every 6 hours interval starting from saturation. The sample collected is kept in the oven to measure the moisture content.

The bulk density expresses the ratio of mass of an oven dried soil to its total field volume (soil and interstices together). Bulk density of soils is closely related to total porosity. Bulk density is also estimated by field method. Hydraulic conductivity is determined by using Constant Head laboratory apparatus.

Results and Discussion

Field capacity of different treatments

Field capacity of the soil was computed in the lab before the field experiment was conducted. The average values of the field capacity in each treatment were given in the below table. There was a significant effect of silt and aquasorb application in the soil. Increase in field capacity was observed in T₂ (Silt application) compared with T₁ (Control). Treatment T₄ (Silt and aquasorb application) showed the highest field capacity next to T₃ (aquasorb application). There was a variation about 10- 15% in the field capacity with the application silt whereas effect of aquasorb was around 20%. Combination of silt and aquasorb application gave the increment around 25% compared to the control i.e. only sandy soil.

Application of aquasorb and silt amendments in the soil helps the soil in holding the water and hence the field capacity was increased from T₁ to T₄ which was depicted clearly in the below [Fig-2].

Fig-2 Field capacity of different treatments

Bulk Density for different treatments:

Bulk density of the soil in the experimental field was determined by laboratory method. The average values of the bulk density in each treatment were given in the below table. Bulk density in treatment T₁ (control) 1.50g/cc, in treatment T₂ (Silt application) it is 1.33g/cc, in treatment T₃ (aquasorb application) it is 1.48g/cc, and in treatment T₄ (Silt and aquasorb application) it is 1.68g/cc was found. Decrease in the bulk density was observed in T₂ (Silt application) compared with T₁ (Control). Treatment T₄ (Silt and aquasorb application) showed the highest bulk density next to T₃ (aquasorb application). There was a variation about 75-80% in the bulk density with the application silt whereas effect of aquasorb was around 85-90%. Combination of silt and aquasorb application gave the increment around 90-95% compared to the control i.e. only sandy soil. This initial bulk density was observed at the moisture content of about 10-12%.

The average values of the final bulk density in each treatment were given in the below table. Bulk density in treatment T₁ (control) 1.50g/cc, in treatment T₂ (Silt application) it is 1.33g/cc, in treatment T₃ (aquasorb application) it is 1.48g/cc and in treatment T₄ (Silt and aquasorb application) it is 1.68g/cc was found. Decrease in the bulk density was observed in T₂ (Silt application) compared with T₁ (Control). Treatment T₄ (Silt and aquasorb application) showed the highest bulk density next to T₃ (aquasorb application). Decrease in the bulk density was observed in T₂ (Silt application) compared with T₁ (Control). Treatment T₄ (Silt and aquasorb application) showed the highest bulk density next to T₃ (aquasorb application). There was a variation about 70-75% in the bulk density with the application silt whereas effect of aquasorb was around 80-85%. Combination of silt and aquasorb application gave the increment around 85-90% compared to the control i.e. only sandy soil. This final bulk density was observed at the moisture content of about 5-10% [Fig-3].

Fig-3 Final average bulk density on different treatments

Hydraulic Conductivity of soil with different treatments:

Hydraulic Conductivity of the soil in the experimental field was determined using the constant head laboratory apparatus. The average values of the hydraulic conductivity in each treatment were given in the below table. Hydraulic conductivity in treatment T₁ (control) 58.08 m/day, in treatment T₂ (Silt application) it is 4.75m/day, in treatment T₃ (aquasorb application) it is 11.95 m/day and in treatment T₄ (Silt and aquasorb application) it is 5.05m/day was found. The treatment T₂ has showed the least hydraulic conductivity when compared to T₁. Treatment T₄ (Silt and aquasorb application) showed the least hydraulic conductivity next to T₃ (aquasorb application). From the fig 4.3 the value of hydraulic conductivity decreases 85-90% in T₄ when compared to T₁ and 90-95% in T₂ and 75-80% in T₃ [Fig-4].

Fig-4 Hydraulic conductivity on different treatments

Infiltration rates for different treatments:

Infiltration values are taken by recording the time and water infiltrated into the soil for every 5 minutes. The average values of the field capacity in each treatment were given in the below table. There was a significant effect of silt and aquasorb application in the soil. The infiltration rate in treatment T₁ (control) m/day, in treatment T₂ (Silt application) it is 4.75m/day, in treatment T₃ (aquasorb application) it is 11.95 m/day and in treatment T₄ (Silt and aquasorb application) it is 5.05m/day was found. Decrease in infiltration rate was observed in T₂ (Silt application) compared with T₁ (Control). Treatment T₄ (Silt and aquasorb application) showed the less infiltration next to T₃ (aquasorb application). There was a variation about 25% in the infiltration with the application of silt whereas effect of aquasorb was around 35%. Combination of silt and aquasorb application gave the drop down of infiltration of around 45% compared to the control i.e., only sandy soil [Fig-5].

Fig-5 Infiltration rates on different treatments

Conclusion

Based on the results of the study the following conclusions were drawn. Combination of silt and aquasorb application had the highest field capacity (25% of increment), less bulk density (6-8% decrease), more hydraulic conductivity (85-90% increase) compared to the other respective treatments. Control shows the lowest value of field capacity as soil moisture retention characteristics is low in coastal sandy soils and highest value of bulk density, highest value of hydraulic conductivity. Aquasorb application showed the more hydraulic conductivity next to the silt and aquasorb application. The study revealed that coastal sandy soils have more infiltration rates. This could be reduced with the addition of soil amendments. Combined application of silt and aquasorb showed the best to reduce the infiltration. Application of silt alone has also showed the desirable decrease in soil infiltration rates. There was about 45% decrease in infiltration rates in the combination of silt and aquasorb application. Whereas the aquasorb application showed the significance decrease next to the silt application.

Application of research: This study is helpful in arid regions where the irrigation frequency can be reduced by improving the soil properties with the application of soil amendments

Research Category: Soil amendments

Abbreviations:

SAP-Super Absorbent Polymers

FRBD-factorial randomized block design

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