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Bypass Flow Behavior of Paddy Soil under Alternate Flooding and Drying Cycles in Cracked Clay Soil

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Abstract: **-- Bypass flow is rapid downward movement of water and solutes beyond the root zone of the crop along with air-filled of the cracked soils. Paddy field is generally subjected to many cycles of alternative flooding and drying condition (AFD) during rice growing period. This alternate condition cycles can create a large variation in soil structure that subsequently affects soil water and nutrient retention and migration. Bypass flow processes were studied in a cracked, previously puddle rice soil. Vertical continuity of soil cracks 12 mm in width was determined in the field using a morphological staining technique. An infiltration experiment showed that water was mainly absorbed in the subsoil between 0.3 and 0.6 m depth. This study aimed to investigate the soil shrinkage behavior, cracked surface area and its consequences on water percolation in paddy fields under AFD.**

Index terms- Engine, jatropha oil, producer gas, gasification, transesterification, emission.

I. INTRODUCTION

Entry of free water in to macro pores through an unsaturated soil matrix. It occurs widely in the field when water infiltrates in to open macro pores in dry or moist soil (Beven and Germann., 1992). It may be partially absorbed laterally along crack faces or at the bottom of a crack or macro pore, process called internal catchment. Reducing water losses through bypass flow is very important in rice-growing areas (rainfed and irrigated) where water losses during the land preparation for rice growing are high owing to soil cracking on the surface and a relatively permeable subsoil. The low percolation rate of Vertisols under water-saturated conditions makes this type of soil very suitable for rice cultivation. At the onset of rice growing season large cracks are often visible in the field, as Vertisols shrink to form deep vertical cracks in the dry state. Due to salinization processes, Constraint to irrigation in arid climates is the risk of land degradation. Salts brought into the field with the irrigation water tend to accumulate in the topsoil, due to the high evaporation rates associated with climate. Water content change is the cause for soil shrinkage and soil swelling. Four ranges of soil volume change includes Structural, Normal, Residual and Zero. The soil volume change less than the volume of water due to inter aggregate water removal and it starts from the saturation state called structural shrinking. In continuous drying, it leads to a range where the soil volume change is equal to the volume of water removed from the soil. This range is called normal shrinking. When an air enters in to the soil, the change in soil volume becomes smaller than the volume of water removed. This is called residual shrinking. At the end of drying process shrinking stops and the soil volume does not change anymore, this range is called zero shrinking.

Soil properties

Soil properties at the plow layer which were closely related to soil shrinkage and cracking in this study but the other two layers provided additional information. Soil shrinkage depends much on clay content and its clay mineral composition. Remarkable change in paddy soil structure resulted from alternative flooding and drying (AFD). During the whole season of early rice growing the paddy fields were subjected to AFD, which caused temporal changes in soil bulk density, soil shrinkage, cracks, water loss rate and percolation. The response of old paddy field to AFD was different due to their soil properties and the intensity of AFD.

Bypass flow measurement

Flow through the cracked soil was measured by using of stain which allowed flowing in to the undisturbed soil column having a length of 40 cm. Colour stain was mixed with water and constant head of 5 cm have been maintained. Size of polygons formed on the soil surface after drying of the

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soil was estimated by tracing them on transparent sheet and measuring surface area with Planimeter. When the evaporative demand was high, cracking of soils occurred within a few hours after irrigation. Size of polygons formed on the soil surface after drying of the soil was estimated by tracing them on transparent sheet and measuring surface area with Planimeter.

$$A = \sum_{j=1}^{n} \sum_{i=1}^{n} \Delta ZP \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where, A = Total sample area of the vertical cracks, j, i = layer number and stain number, Δz = segment thickness, P = perimeter of the stain

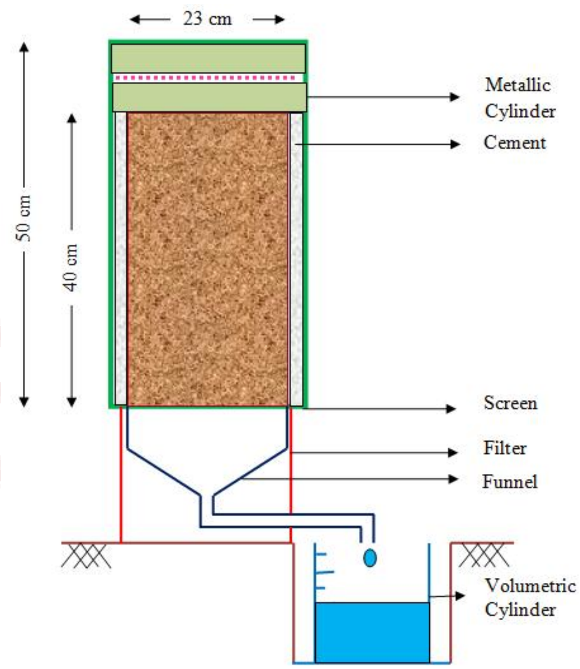

Fig. 1 Experimental set up for measurement of cracked area

The very low percolation rate of Vertisols, bypass flow in cracks at the onset of the growing season may play an important role in redistribution of salts in the soil profile. The occurrence of bypass flow under such dry soil conditions may, however, be limited in time as cracks may gradually close due to soil swelling. Many clayey soils shrink when drying and swell when wetted. Such soils often classified as Vertisols or vertic intergrades are found across the globe, including within numerous agricultural and urban regions. Vertic soils include significant variation in physical properties, such as bulk density (Peng and Horn., 2007), pore size distribution and field-saturated hydraulic conductivity with changes in the soil water content. During periods of drying, individual clay particles shed hydration layers, causing compaction of the soil aggregates. This process results in subsidence and cracking of the soil.

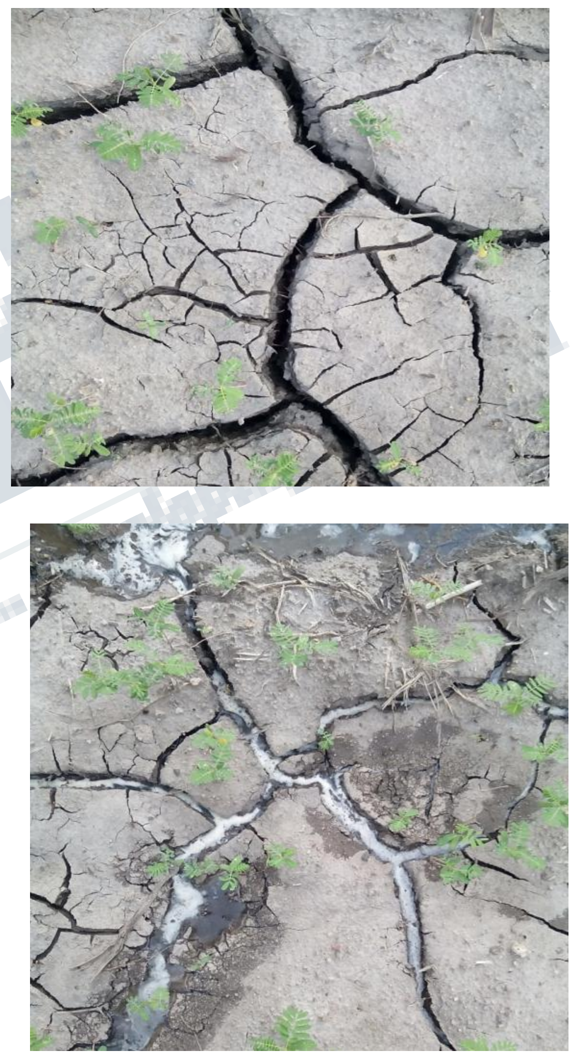

Fig.2 Formation of Bypass flow in cracked soil before and after irrigation

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To our knowledge very little information is available on the dynamics of crack closure with time, and corresponding water distribution in the soil profile. Quantification of the importance of Vertisols cracking and swelling processes on water economy and soil salinity requires focused field experimental work, the results of which should eventually be taken into account in water and solute transfer simulation models. Development of alternative water management techniques for salinity control also required detailed studies on soil-water movement. Some more study has related crack closure to water dynamics and soil swelling over time upon re-wetting of a dry cracked Vertisols and to investigate implications for modeling of water and solute flow.

Table 1. Characterization of cracked surface area

Soil	Size of the polygons (cm2)		Clay Content
	On surface	At 55 cm depth	(%)
Sample 1	586	374	46
Sample 2	572	226	45
Sample 3	480	352	33
Sample 4	465	280	32
Sample 5	434	212	30

Physical Considerations and Assumptions

Naturally occurring shrink and swell (vertic) soils are characterized by crack networks that extend from the soil surface to a depth at which either the soil texture changes, the soil water content level remains sufficiently high (thus preventing soil shrinkage), or the overburden pressure becomes large enough to inhibit soil swelling and shrinking. We define a control volume that spans of this “active” zone from the bottom of the lowest cracking layer to the maximum height of the soil surface, with length and width selected to be larger than the size of an individual pedon. Erosion and other mass movements to be insignificant, and we assume that the total mass of solid particles within this volume is constant. We can focus on near surface soils, avoiding complications that can arise from changing overburden pressures.

II. CONCLUSIONS

Surface irrigation and high intensity rainfall on dry, cracked soil induced rapid crack closure at the soil surface within 4.5 h, mainly due to swelling of soil. Cracks closed from the soil surface downwards. Swelling of the soil continued after crack closure, but its contribution to crack closure will not exceed 30% after 24 h. Very rapid swelling processes may be of great importance to water flow into cracked Vertisols. Due to rapid crack closure, bypass flow processes were a matter of hours only. Bulk measurements of soil shrinkage and swelling behavior will give little insight in the dynamics of crack closure and water redistribution with time and may be of limited value for modeling of preferential solute and water flow.

REFERENCES

1. Beven,K., Germann,P.,1994. Macropores and water flow in soil. Water Resource Res., 18, 1311-1325.

2. Peng,X., Horn,R. Anisotropic shrinkage and swelling of some organic and inorganic soils. Eur.J. Soil Science, 58, 98-107.