A soil management technique to enhance lateral infiltration (subbing) in Permanent Raised Beds

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Summary

Permanent raised beds (PRBs) are less susceptible to poor subbing in Australian Vertosol due to prolonged irrigation times and faster subbing in cracks. In contrast, subbing was very poor in sandy clay loam soil. This study revealed enhanced lateral subbing with blade ploughing. However, additional measures of irrigation optimisation for improved infiltration opportunity time and/or water depth in furrow can be beneficial in sandy clay loam soil.

Introduction

Wide beds are preferred to narrow beds because they reduce deep drainage losses and increase the production of land under crop. However, poor subbing in wide permanent raised beds (PRBs) has been reported in many countries (Akbar et al. 2007; Jin et al. 2007; Lucy 1993), always where the soils being irrigated are structurally unstable to wetting. Most irrigation research on furrow irrigation and most irrigation simulation models assume uniform penetration of water to the centre of beds, and studies of the extent of lateral infiltration in raised beds are scarce. The poor subbing in PRBs, particularly in developing countries where water and food security are pressing issues is proving to be a barrier in its adoption, which is unfortunate because these are countries where the need for improved irrigation efficiency and food production is greatest. This paper examines the effect on subbing of three permanent raised beds renovation technique.

Methods and Materials

The study was conducted in heavy clay Vertosol with substantial swelling properties in South Eastern Queensland Australia and non swelling sandy clay loam soil in North Western, Pakistan. Three renovation treatments including T1: furrow cleaning only, T2: shallow cultivation (15 cm) prior to furrow cleaning and T3: blade ploughing the bed at its base (30 cm deep) prior to furrow cleaning. Each treatment was replicated three times. One meter long section of centre furrow in each treatment was isolated at both ends by steel sheets inserted to a depth of 10 cm into furrow bottom that extended 5cm to both adjacent beds shoulder. The furrows were filled with water to a depth of 9cm after recording antecedent moisture content. The change in soil moisture was monitored with a micro-gopher and a constant water level was maintained in furrow. Changes in soil moisture content were measured at 10cm depth interval in profiles located at four positions (furrow centre, 33cm, 67cm from furrow centre and bed middle) in Australia and three positions (bed middle, 22cm and 44cm from furrow centre in Pakistan using 100cm deep access tubes.

Results & Discussion

The lateral subbing to bed middle was significantly different among the three treatments at 5% significance level in both soils after nine hours of wetting. In Vertosol soil, field capacity (43%) front reached to 90cm in treatment T1 and crossed the bed middle in treatments T2 and T3 after nine hours of infiltration opportunity time. The bed middle received 36 mm, 57mm and 120mm increase in antecedent soil moisture of T1 (352 mm), T2 (383mm) and T3 (367mm) respectively as shown Figure 1(a-b).

The sandy clay loam soil of Pakistan has shown poor subbing with relatively larger vertical infiltration into the furrow bottom and larger horizontal into the bed middle for T2 followed by T2 and then T1. However, the given infiltration opportunity time and depth of water in furrow was not sufficient to increase soil moisture up to field capacity levels (23.5%) in bed middle as shown in Figure 1(c-d).

The average bulk density of surface (0-30cm) profile in Vertosol at the time of experiment was 4% and 8% lower for T2 and T3 than T1(1.13 gm cm^{-3}) respectively. For sandy clay loam soil it was 9% and 17% less in T2 and T3 than T1 (1.4 gm cm^{-3}). The loose soil conditions and large porosity in T3 have increased its lateral subbing and water storage capacity.

It can be inferred from these results that lateral subbing is not a major issue in Australian Vertosol soil where subbing is generally faster due to cracks and long irrigation times (>6 hrs) of lengthy furrows (600 to 1000 m). However, it can affect the germination of densely grown crops in the bed mid due to poor subbing caused by absence of cracks in moist deep soil. In contrast, poor subbing is a significant problem under non swelling sandy clay loam soil in Pakistan due to relatively quick irrigation times (2 hrs) of existing short furrows (30 to 100m). Thus, the poor subbing of sandy clay loam soil can be improved by blade plough renovation in combination with measures to increase water depth and/or infiltration opportunity time by optimum irrigation management and field design.

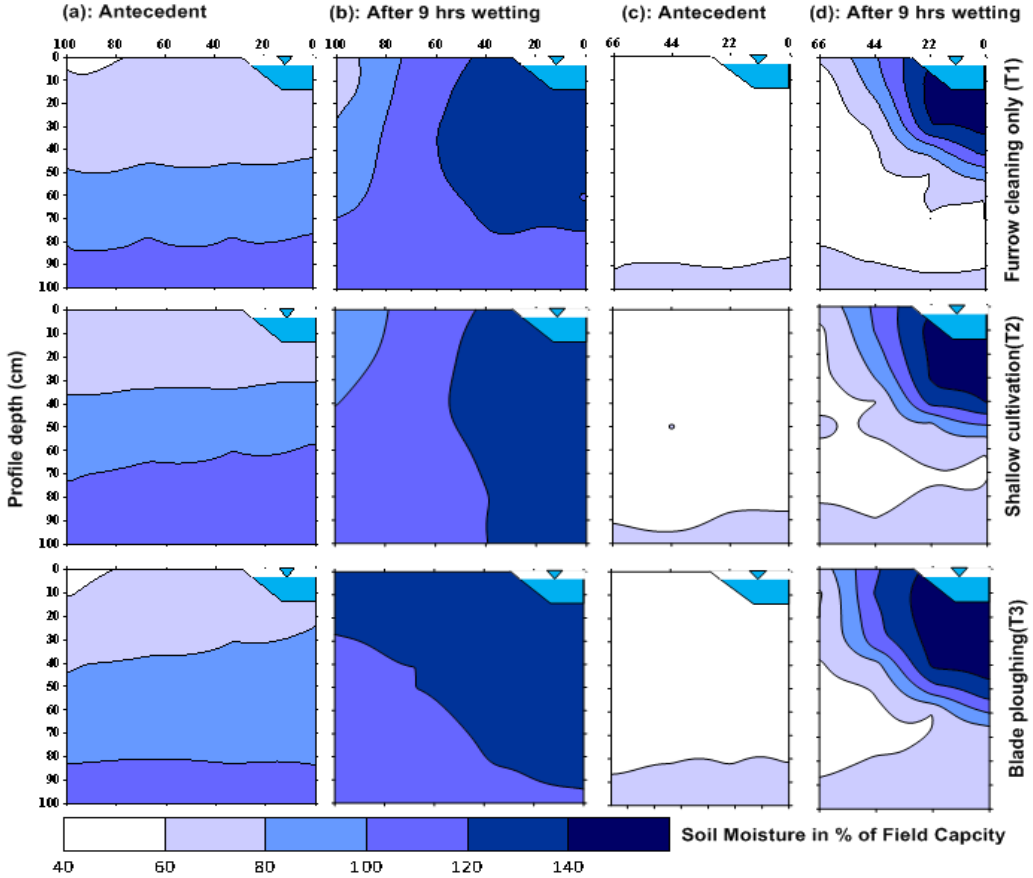

Figure 1: Temporal variation in soil moisture distribution (shown in percent of field capacity) in three PRBs renovation treatments under half bed width: 100 cm in Australian Vertosol (a & b) and 66 cm in Pakistani sandy clay loam soil (c & d)

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