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Effect of Tillage Type on Soil Water Content and Chickpea Yields

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Introduction

The development of 2-wheel tractors (2WT) with planters attached has given rise to one-pass seeding, and the possibility of minimum tillage and conservation agriculture suitable for smallholder agriculture. The main advantages of minimum tillage techniques include: soil water conservation, targeted placement of seed and fertiliser, lower rates of fertiliser and seed, less labour and fuel required, and less time required to sow a crop (Haque et al. 2010). Germination, emergence and early seedling growth of cool and dry (*rabi*) season crops (such as chickpea and lentil) grown on residual soil moisture can be limited in the silty clay soils of the High Barind Tract, Bangladesh due to rapid drying and hard-setting of the surface soil. One-pass seeding can minimise the time taken from rice harvest to sowing of the next crop and increases the probability that the surface soil retains sufficient moisture for crop establishment (Kumar et al. 2007). Minimum tillage is also a practice often used to conserve water in the soil profile and it has been reported that in conditions of less tillage there was greater soil water storage in the profile or greater soil water storage at depth in the profile later in the growing season (Barzegar et al. 2003). The objective of this work was to determine the effect of tillage type on: (i) seed-bed conditions and early chickpea establishment; and (ii) available water content and crop water use.

Materials and methods

The trial was conducted in the Choighati village, Godagari, Rajshahi, Bangladesh, from November 2009 to March 2010. It was conducted on Aeric Haplaquept which was representative of the region in a randomised block design with four replications. The trial had four tillage treatments applied using the Versatile Multi-crop Planter (VMP) attached to a Dongfeng type 2WT: strip tillage (ST); zero tillage (ZT); broadcast; single pass shallow tillage (SPST); and there was also a fallow plot. In the ST, ZT, and SPST treatments, the fertiliser was delivered approximately 2 cm below the seed. Desi chickpea cv. Bari Chola 5 was sown at a rate of 45 kg/ha on 25 November 2009. Triple superphosphate (TSP) was applied at sowing at a rate of 100 kg/ha. The TSP was drilled with the seed for the ST, ZT and SPST treatments. Seed was primed with water for six hours, and dried for an hour prior to sowing. Volumetric soil water content (θv) was measured by the MP406 capacitance sensor (ICT International, Armidale NSW) intermittently in the soil surface of the seed row (0-6 cm) from 5 days before sowing to 23 days after sowing. Profile soil water content (SWC) to 60 cm depth was measured at sowing, 50% podding and physiological maturity. From sowing to harvest there was no rainfall. Analysis of variance (ANOVA) was used to test the effects of treatments using GenStat v11.1 (VSN International Ltd, UK).

Results and Discussion

At sowing, θv in the seed-bed was 26 %, within the range where successful chickpea crop establishment will occur, and slightly wetter than judged to be optimum. The rate of soil drying in the seed-bed changed with tillage technique. Uncovered furrows (in ZT) and the fallow soil lost more surface soil water than the other seed-beds created with variable levels of soil disturbance (Fig. 1). In ST and ZT under the higher soil water contents there is potential of smeared furrow walls and poor soil covering of the seed in the seed-bed which can limit seed-soil contact. In addition, soil aggregate size and distribution in the seed-bed is altered with the different tillage types. The difference in the aggregate size, pore distribution and openness of furrows in the seed-bed may account for the difference in drying of the seed-bed.

There was significant loss of SWC across all tillage treatments from sowing to podding (Fig. 2). The extraction of θv in the fallow treatment was limited to 20 cm from sowing to podding, whilst in the tillage treatments θv was extracted to 60 and 80 cm (data not shown). From podding to harvest there was little change in θv at each depth increment to 40 cm for sown plots, however in the fallow treatment during this period losses of θv did occur. The θv in 0 to 40 cm depth at podding was less than 50 mm indicating there was very little water remaining in that layer for pod filling, suggesting that plant roots were able to access water deeper in the profile to achieve grain yields of 1087 to 1817 kg/ha. Frequent measurements to monitor SWC of the profile between sowing and podding would determine if the different tillage techniques had varied drying patterns that altered the allocation of water to the plants during that period. Measurements only at podding and physical maturity have shown no difference in SWC between tillage types. The SWC was below wilting point to 40 cm depth at podding; indicating that any additional conservation of water in the profile due to minimum tillage in a conservation agriculture system would be an advantage.

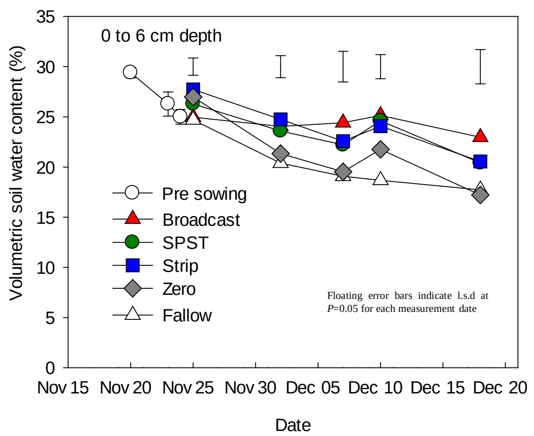

Figure 1. Volumetric soil water content pre and post-sowing at 0 to 6 cm depth.

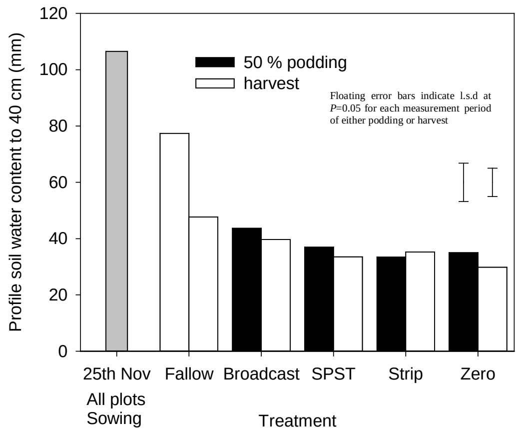

Figure 2. Profile soil water content (mm/40 cm) at sowing, 50 % podding and harvest.

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