Impact of tillage system on sweet corn yield and some soil properties

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Abstract

A single season and non-replicated comparison of conventional and no-tillage was evaluated by measuring sweet corn (*Zea mays* L.) crop yield and soil properties on a wind erosion prone soil in Hawke's Bay. Tillage treatment did not affect plant population or crop yield. By harvest, indicators of soil quality such as earthworm numbers, microbial biomass carbon, soil aggregate size and soil aggregrate stability were higher under no-tillage than conventional tillage.

Additional key words: *no-tillage, conventional tillage, earthworm numbers, microbial biomass, soil aggregates,* Zea mays

Introduction

Over the past 20 years, increased competition from other land uses on the Heretaunga Plains in Hawke's Bay has forced annual cropping onto more marginal soils where productivity can be low and the environment more fragile (Reid *et al.*, 2000).

Soil degradation is a global issue with long-term impacts on productivity and environmental quality. Tillage methods play an important role in maintaining high quality soil, and tillage effects on crop production, soil quality and other environmental consequences are generally more pronounced on marginal soils. Soil quality properties likely to be affected by tillage include soil bulk density, soil structure and soil fauna.

Here we report on a comparison of two tillage systems on a typical wind erosion prone soil in the Hawke's Bay. Tillage effects were evaluated by monitoring crop yields and selected soil properties.

Experimental and Discussion

Site description

The trial site, on the southern outskirts of Hastings, had a Pakipaki silt loam derived from ash and alluvial deposits of Taupo pumice as the predominant soil type. The New Zealand soil classification was a mottled orthic allophanic soil. The 1999/2000 season was the first time a no-tillage system was implemented on the property, the site having been conventionally cultivated in the two preceding seasons for squash followed by regrassing and grazing. Prior to the squash crop the site had been in permanent pasture for dry stock grazing.

Treatments

Two non-replicated tillage regimes were established within the paddock, conventional tillage and no-tillage. A forty metre wide strip along the eastern boundary of the paddock was used for no-tillage (total area 1.3 ha). The no-tillage area was sprayed with glyphosate in late October to kill the existing ryegrass pasture and the residue lightly grazed.

The remainder of the paddock was conventionally tilled by ploughing to 16 cm, then cultivated twice to 10 cm with a Duncan spring tyne cultivator followed by a crumbler and roller. For comparison with no-tillage, a forty metre wide conventionally tilled strip adjacent to the no-tillage strip was monitored.

Both treatments were sown in sweet corn (cultivar "Dynasty") on 8 November 1999 with a John Deere planter fitted to a Great Plains minimum tillage system which uses disc cultivation to loosen a narrow band of soil for proper seed coverage and fertiliser placement. Fertiliser was applied at planting and a side-dressing six weeks later. Regular irrigation ensured crop yields were not limited by soil moisture.

Four monitoring plots were established in each of the tillage strips. Each monitoring plot was 15 m x 15 m. The four contiguous plots gave a total monitoring area within in each tillage treatment of 15 m x 60 m. The distance between the two monitoring areas was 11 metres.

Yield measurements

Yield assessments were made from each monitoring plot on 25 February 2000, just prior to commercial harvest. Plant populations were measured by counting plant numbers along two randomly selected 5m rows. For yield measurements, all the cobs from 25 randomly selected plants within those rows were collected and the moisture content determined. Total yield (cob plus husk) was corrected to 76 % moisture content. Harvestable (or payable) yield (i.e., cobs more than 15 cm long and 4 cm wide) was also corrected to 76 % moisture content.

Soil measurements

Soil samples were taken from 0-15 cm in each plot at planting in November 1999 and again after harvest in March 2000. Five earthworm counts were made per plot using the 'farmers spade method' as described by Fraser *et al.* (1999). Samples for soil microbial biomass carbon were collected using a 25 mm wide soil corer, with 20 cores collected and bulked per plot. Microbial biomass C was determined on 25 g of field moist soil using the chloroform fumigation-extraction method (Vance *et al.*, 1987).

Five spade-sized samples of soil (0-15 cm) were collected per plot. These samples were bulked then subsampled for soil aggregate size and soil aggregate stability. The average aggregate size, reported as mean weight diameter, was determined by sieving approx. 2 kg air dry soil sample through a sieve nest as described by White (1993). Aggregate stability, reported as % of stable aggregates remaining in the 2mm sieve, was determined by wet sieving (Kemper and Rosenau, 1986).

Statistical methods

Due to logistical constraints the tillage treatments were not replicated. However, the paddock was surveyed before applying the treatments to ensure there were no consistent differences between the monitoring sites other than the applied treatments. Variation in the topsoil depth (range 25 to 45 cm) was observed along the length of the tillage strips but this was consistent for both strips. Pre-treatment chemical analysis of soil samples 0-15 cm depth gave similar results for each tillage treatment. The means of the four monitoring plots in each tillage treatment are reported.

Sweet corn yields

The paddock was originally sown at 65,000 plants per hectare. Some crop damage from slugs, argentine stem weevil and greasy cut worm, which took two days to identify and treat, caused some damage to emerging seedlings. While there was a reduction in plant population in some parts of the paddock because of these pests, there was no evidence of an effect of tillage treatment on plant population (Table 1).

Table 1. Sweet corn population and yield.

	Conventional Tillage	No-tillage
Plant Population/ha	58 550	56 580
Total Crop Yield (t/ha)	30.2	29.8
Harvestable Crop Yield (t/ha)	26.6	25.9

Tillage treatment also had no effect on total and harvestable crop yields (Table 1). Harvestable yields were greater than the Hawke's Bay 1999-2000 season average of 21.5 t/ha as measured by Heinz Wattie Australasia (D. Mathers, pers. comm.).

Soil Properties

Earthworm numbers were lower under conventional tillage than no-tillage at planting, probably due to the mechanical disturbance of the soil shortly before measurements were taken (Fig. 1). By harvest, earthworm numbers under conventional tillage had recovered to be close to that of no-tillage.

At planting and harvest, microbial biomass C was higher under no-tillage than under conventional cultivation (Fig. 2). In other studies, significantly higher microbial biomass carbon levels in the topsoil have been measured under no-tillage compared with conventional tillage after two years (Aslam *et al.*, 1999).

The average size of soil aggregates at planting was higher under no-tillage (Fig. 3) and this can be attributed to the lack of soil disturbance. Large soil aggregates are an important benefit on the Pakipaki soil type that is susceptible to wind erosion during the spring equinox. The larger soil aggregates under no-tillage remained through to harvest.

At planting, the proportion of stable soil aggregates was higher under the no-tillage regime (Fig. 4). This trend continued through to harvest, when again there were more stable aggregates under no-tillage. Marked

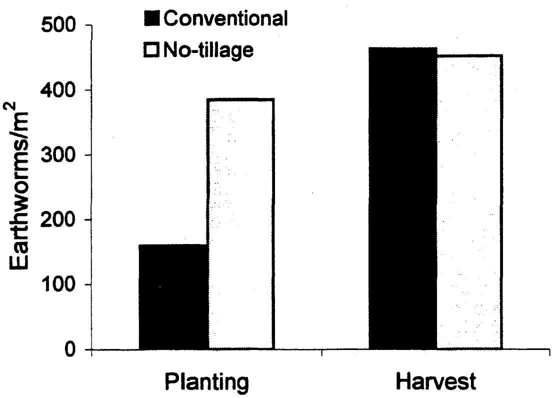

Figure 1. Tillage effects on earthworm counts.

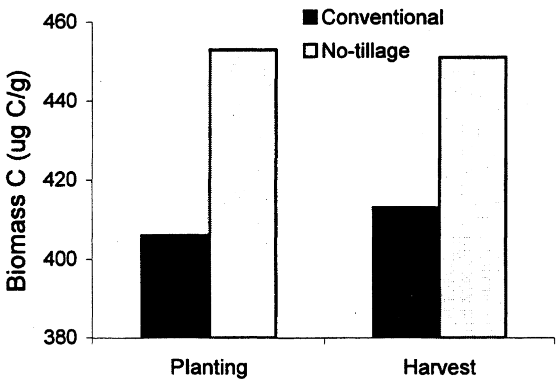

Figure 2. Tillage effects on microbial biomass C.

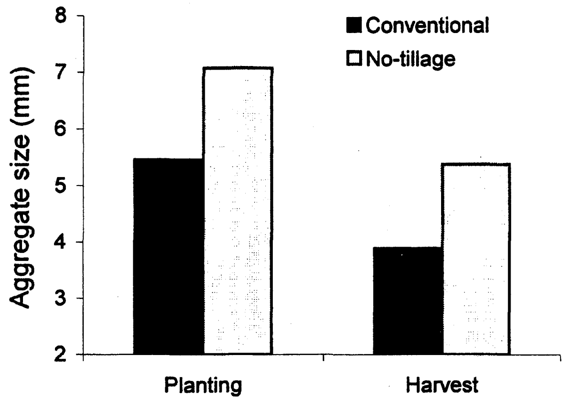

Figure 3. Tillage effects on soil aggregate size.

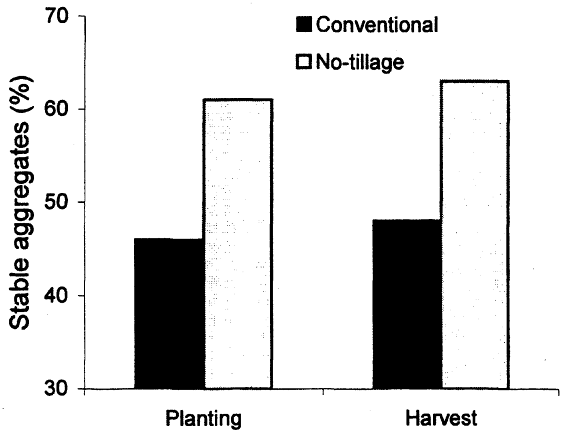

Figure 4. Tillage effect on soil aggregate stability.

decreases in aggregate stability have been observed over two years of conventional cultivation following permanent pasture which can be attributed to losses in soil organic matter (Sparling *et al.*, 1992).

Conclusions

- Sweetcorn population and yield was unaffected by tillage treatments
- Indicators of soil quality such as earthworm numbers, microbial biomass carbon, soil aggregate size and soil aggregate stability were higher under no-tillage than conventional tillage.

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