Stubble Management Options in a Continuous Maize Cropping System

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Objective

To determine a suitable stubble management option in a continuous maize cropping system by measuring a range of soil properties and maize grain yields in a demonstration trial.

Method

The following treatments were established:

1. Stubble Burn, strip tillage
2. Stubble Burn, no tillage
3. Stubble Retention No Tillage
4. Stubble Retention Strip Tillage, including ripping to 15cm depth

Table 1: Demonstration Trial Plan

Buffer
Burn – Strip Till
Burn – No Till
Residue – No Till
Residue - Strip Till

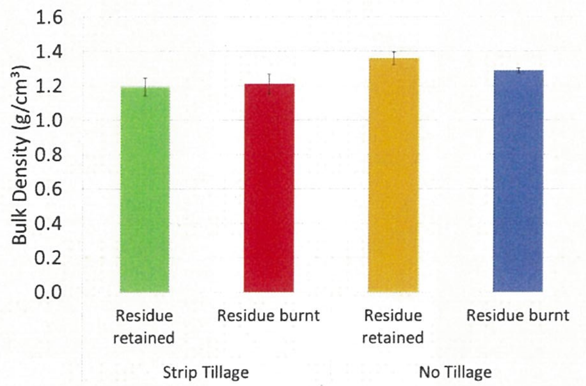
Maize, (Pioneer 1467) was planted on 20 October 2014; no pre-emergent herbicides were used. Trial was sown at 92,000 seeds/ha. Harvest occurred on 27/28 April 2015, using a trial harvester which was supplied and operated by Dupont Pioneer.

Plant numbers were obtained by measuring out four 13.33m length plots along a row in each treatment.

Soil tests were conducted on 20 February15 and sent to Agvita for full chemical analysis. Soil samples were also collected on the same day for physical tests, including soil strength and bulk density. These were conducted by Nick O'Halloran (Department of Economic Development, Jobs, Transport and Resources).

Results

Bulk density (0-6.5 cm) and soil strength (0-45 cm) were measured across the treatments. Bulk density (0-6.5 cm) results from the trial are shown in Figure 1.

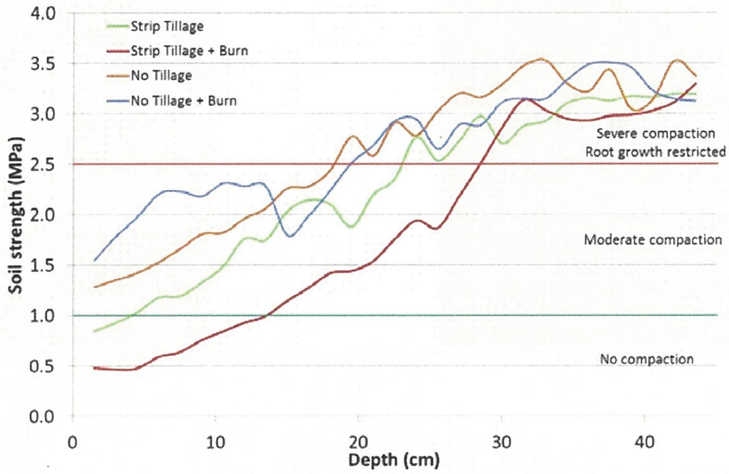


Note:

- 4 sample points per treatment
- Error bar = 1 standard deviation

Figure 1: Soil Bulk Density

Soil strength (0-45 cm) (compaction) was also recorded using a cone penetrometer. Results are presented in Figure 2.



Note:

- 12 sample points per treatment

Figure 2: Soil penetrometer readings

Chemical soil analysis was also conducted across the treatments, with the soil test divided into 0-10cm and 10-20cm. Results are presented in Figure 3.

			Strip Till		No Till		Burn - No Till		Burn-Strip Till	
		Optimal Range	0-10cm	10-20cm	0-10cm	10-20cm	0-10cm	10-20cm	0-10cm	10-20cm
pH (H_2O)	(pH)	6 - 7	5.87	6.65	5.91	6.33	5.53	6.28	5.31	5.77
pH ($CaCl_2$)	(pH)	5.2 - 6.5	5.55	6.24	5.57	5.91	5.26	6.04	5.16	5.61
EC	dS/m	0 - 0.15	0.22	0.12	0.16	0.11	0.29	0.15	0.58	0.40
Lime requirement	t/ha		0.93		0.65		2.73		3.33	1.33
ESI	units		0.13	0.07	0.09	0.06	0.18	0.09	0.87	0.23
Total Carbon	%		1.73	1.35	1.80	1.31	1.96	1.41	1.77	1.33
Total Nitrogen	%		0.16	0.10	0.15	0.11	0.17	0.10	0.15	0.10
Carbon:Nitrogen Ratio	(ratio)		10.74	13.01	12.16	12.51	11.89	14.77	11.59	13.96
Organic Matter	%		2.66	2.07	2.76	2.01	3.02	2.17	2.73	2.05
M3 PSR	(ratio)	0.06 - 0.23	0.03	0.01	0.03	0.01	0.05	0.02	0.04	0.02
Phosphorus	ppm	40 - 90	22.93	9.96	28.50	9.74	46.88	16.84	38.38	16.54
Potassium	ppm	245 - 400	174.95	86.28	150.53	82.92	210.66	119.57	209.97	126.88
Sulphur	ppm	12 - 45	90.13	35.02	41.05	20.07	116.36	60.63	244.36	176.99
Calcium	ppm	1950 - 3450	1703.04	1818.21	1689.52	1739.78	1560.89	1753.22	1777.92	1771.71
Magnesium	ppm	220 - 440	170.80	150.89	161.20	158.68	161.75	163.25	204.33	171.20
Sodium	ppm	32 - 115	50.81	51.27	50.67	54.00	46.91	50.13	57.84	50.76
Chloride	ppm	0 - 200	23.20	16.90	24.90	24.65	31.00	16.90	38.45	24.30
Zinc	ppm	2.2 - 11	1.01	0.63	1.12	0.96	1.67	1.25	1.97	0.85
Copper	ppm	2.5 - 10	2.13	2.76	2.51	4.46	2.46	2.34	3.99	2.35
Boron	ppm	2.2 - 6	0.73	0.65	0.66	0.61	0.66	0.64	0.79	0.54
Manganese	ppm	18 - 70	137.63	154.35	132.88	157.43	121.67	126.26	126.92	123.79
Iron	ppm	40 - 250	226.53	227.14	222.57	204.13	263.21	244.33	237.30	212.39
CECe	meq/100g		12.93	12.59	12.60	13.04	12.66	13.59	14.142	12.96
Calcium	meq/100g	9.7 - 17.2	8.5 (65.7%CEC)	9.1 (72.1%CEC)	8.4 (66.9%CEC)	8.7 (66.6%CEC)	7.8 (61.5%CEC)	8.7 (64.4%CEC)	8.9 (62.7%CEC)	8.8 (68.2%CEC)
Potassium	meq/100g	0.6 - 1.0	0.4 (3.5%CEC)	0.2 (1.8%CEC)	0.4 (3.1%CEC)	0.2 (1.6%CEC)	0.5 (4.3%CEC)	0.3 (2.3%CEC)	0.5 (3.8%CEC)	0.3 (2.5%CEC)
Magnesium	meq/100g	1.8 - 3.6	1.4 (10.9%CEC)	1.2 (9.9%CEC)	1.3 (10.5%CEC)	1.3 (10.0%CEC)	1.3 (10.5%CEC)	1.3 (9.9%CEC)	1.7 (11.9%CEC)	1.4 (10.9%CEC)
Sodium	meq/100g	0.1 - 0.5	0.2 (1.7%CEC)	0.2 (1.8%CEC)	0.2 (1.7%CEC)	0.2 (1.8%CEC)	0.2 (1.6%CEC)	0.2 (1.6%CEC)	0.3 (1.8%CEC)	0.2 (1.7%CEC)
Base Saturation	%	80 - 87	81.75	85.47	82.23	80.00	77.89	78.13	80.20	83.33
Exchangeable Acidity	meq/100g	13 - 20 %CEC	2.4 (18.2%CEC)	1.8 (14.5%CEC)	2.2 (17.8%CEC)	2.6 (20.0%CEC)	2.8 (22.1%CEC)	3.0 (21.9%CEC)	2.8 (19.8%CEC)	2.2 (16.7%CEC)
Aluminium Saturation	%		5.00	0.00	4.00	0.00	12.00	0.00	19	6.00
Ca:Mg Ratio	(ratio)	3 - 5	6.05	7.31	6.35	6.65	5.85	6.51	5.28	6.27
K:Mg Ratio	(ratio)	0.3 - 0.5	0.32	0.18	0.29	0.16	0.40	0.23	0.32	0.23

Figure 3: Soil test results

Plot size 375 m^2 Adjusted to 14% Moisture

Treatment	Moisture (%)	Yield (kg) per plot	Yield t/ha	Plant number/ha
Buffer	Not harvested			
Burn – Strip Till	15.67	614.11	16.06	79,500
Burn – No Till	16.23	615.68	15.99	78,500
Residue - No-Till	14.46	644.78	17.10	72,500
Residue - Strip Till	15.68	668.74	17.48	69,250

Table 2: Harvest results and plant counts

Discussion

From the soil bulk density tests shown in Figure 1 it can be seen that the soil in the strip tillage treatments showed the lowest bulk density results. Bulk density increases in value as compaction increases. High bulk density can restrict root growth and could negatively impact upon crop yield. The actual values whereby this will occur will vary with soil type varies (Hunt and Gilkes, 1992) but, in general, bulk densities greater than 1.6 g/cm^3 tend to restrict root growth (McKenzie *et al.*, 2004). Clay soils would be expected to have bulk densities in the range of (1.1 – 1.6 g/cm^3) because they have larger, but fewer, pore spaces. All bulk density soil tests across the trial site were shown to be within the expected range, with the soil not subjected to a strip till showing the highest readings. As soil compaction is also related to tillage, these results could be expected.

Soil strength results obtained from this demonstration trial (Figure 2) were consistent with past research conducted by Packer et al (1992) which showed that it may take many years (4-7) to detect a measurable improvement in soil quality, depending upon soil type, in stubble retention and minimum tillage cropping systems. The burnt and no tillage treatment did show a higher level of compaction though than the stubble retention and no tillage treatment. The burnt and strip tillage resulted in the lowest level of compaction, although at depth the stubble retention and strip tillage may produce slightly less compaction than the burnt and strip till treatment.

From Figure 3 no consistent differences were observed between treatments in Chemical test results.

Plant counts indicated that the actual plant density was lower in the treatments where stubble remained on the soil surface. This could be due to a higher presence of slugs and wireworms under the stubble, thereby chewing plants off at ground level during emergence.

During the season it was also noted that a greater number of weeds were present in the burnt plots compared to the stubble retention. There was also approximately 30cm difference in crop height , with the stubble retention plots being the tallest.

From Table 2 it can be seen that the stubble retention treatments yielded the highest, while at the same time they had the lowest plant counts. The stubble retention and strip till treatment resulted in the highest yield. This could be due tolower bulk density and compaction readings than the stubble retention no till treatment.

Conclusion

This demonstration trial appears to indicate that higher maize yields may be obtained in a continuous maize cropping system where maize stubble is retained. The soil test results do not necessarily show the improvement in soil bulk density or compaction as a result of retaining the stubble but, as previous research reports have indicated, this improvement may not be measurable for a number of years.

As a result it is recommended that this trial be continued on the same site for an additional 1-2 years, with measurements focused on soil bulk density, compaction, and maize yield.

Acknowledgements

Soil physical analysis was undertaken by Peter Fisher of the Department of Economic Development, Jobs, Transport and Resources.

Harvest was conducted by Dupont Pioneer.

References

Hunt N and Gilkes R (1992) *Farm Monitoring Handbook*. The University of Western Australia: Nedlands, WA.

McKenzie NJ, Jacquier DJ, Isbell RF, Brown KL (2004) *Australian Soils and Landscapes An Illustrated Compendium*. CSIRO Publishing: Collingwood, Victoria.

Packer I, Hamilton G, Koen T (1992) Runoff, soil loss and soil physical property changes of light textured surface soils from long term tillage treatments. *Soil Research* 30, 789–806.