Stubble management options in a continuous maize cropping system

Summary compiled December 2017

Project:	Stubble management options in a continuous maize cropping system *Summary created December 2017*
Location / address:	Ardmona Victoria
Organisation:	Maize Association of Australia and Pogue Fodder Services P/L
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Fund source:	Goulburn Broken CMA through the Australian Government's National Landcare Program
Year/s of trial:	2014 – 2015
Objectives of the demonstration	To determine a suitable stubble management option in a continuous maize cropping system by measuring a range of soil properties and maize yield in a demonstration trial.
Basis of trial	This trial aims to look at the benefits to a maize cropping system using different farming techniques. Compaction, bulk density and maize yield measurments will help ascertain which farming type is best suited for the soil type.
What did you do /soil treatments	Treatments 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 Maize was planted on 20 October 2014; no pre-emergent herbicides were used. The trial was sown at 92,000 seeds/Ha. Harvest occurred on 27 and 28 April 2015, using a trial harvester which was supplied and operated by Dupont Pioneer.
Measurements When/how/method	• Plant numbers were obtained by measuring out four 13.33m length plots along a row in each treatment. • Soil tests were conducted on 20 February 2015 and sent to Agvita for full chemical analysis. Soil samples were alos 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, Transpot and Resources).
Results	Bulk density (0-6.5cm) and soil strength (0-45cm) were measured across the treatment. Bulk density (0-6.5cm) results from the trial are shown in figure 1 below. 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 level 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 soil tested (for what) 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.

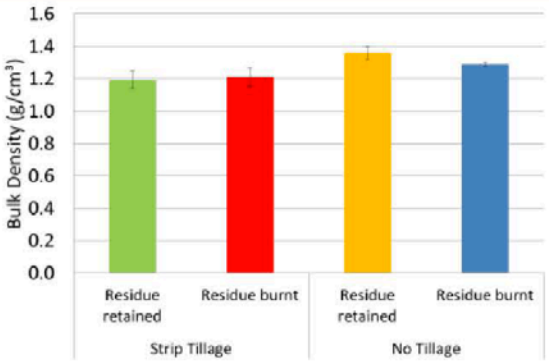

Figure 1. Soil bulk density

Soil strength (0-45cm) (Compaction) was also recorded using a cone penetrometer. Results are presented in Figure 2 below.
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 be slightly less compact than the burnt and strip till treatment.

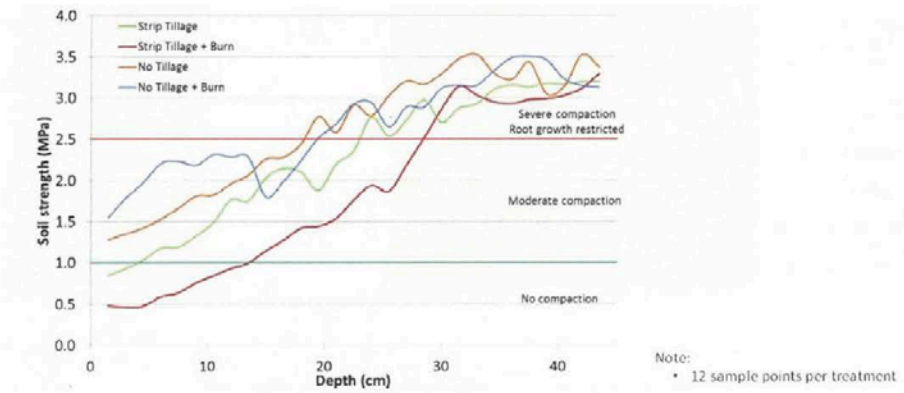

Figure 2. Soil strength measure by a cone penetrometer.

Chemical soil analysis was alos conducted across the treatments, with the soil test divided into 0-10cm and 10-20cm. Results are presented in Figure 3 below. From Figure 3 no substantial or consistent differences were observed between treatments in Chemical? test results.

			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	5.55	6.28		
pH ($CaCl_2$)	(pH)	5.2 - 6.5	5.55	6.24	5.57	5.91	5.26	6.04		
EC	dS/m	0 - 0.15	0.22	0.12	0.16	0.11	0.20	0.15		
Lime requirement	t/ha		0.93		0.65		2.79			
ESI	units		0.13	0.07	0.09	0.06	0.18	0.09		
Total Carbon	%		1.73	1.35	1.80	1.31	1.96	1.41		
Total Nitrogen	%		0.16	0.10	0.15	0.11	0.17	0.10		
Carbon:Nitrogen Ratio	(ratio)		10.74	13.01	12.16	12.51	11.88	14.77		
Organic Matter	%		2.66	2.07	2.76	2.01	3.02	2.17		
M3 PSR	(ratio)	0.06 - 0.23	0.08	0.01	0.08	0.01	0.05	0.02		
Phosphorus	ppm	40 - 90	22.93	9.96	28.50	9.74	46.88	16.84		
Potassium	ppm	245 - 400	174.95	86.28	150.53	82.92	210.66	119.57		
Sulphur	ppm	12 - 45	90.13	35.02	41.05	20.07	116.96	69.63		
Calcium	ppm	1950 - 3450	1703.04	1818.21	1689.52	1739.78	1560.89	1751.22		
Magnesium	ppm	220 - 440	170.80	150.89	161.20	158.68	161.75	163.15		
Sodium	ppm	32 - 115	50.81	51.27	50.67	54.00	46.91	50.13		
Chloride	ppm	0 - 200	23.20	16.90	24.90	24.65	31.00	16.90		
Zinc	ppm	2.2 - 11	1.01	0.63	1.12	0.96	1.67	1.23		
Copper	ppm	2.5 - 10	2.13	2.76	2.51	4.46	2.46	2.34		
Boron	ppm	2.2 - 6	0.73	0.65	0.66	0.61	0.66	0.64		
Manganese	ppm	18 - 70	137.63	154.55	132.88	157.43	121.67	126.16		
Iron	ppm	40 - 250	226.58	227.14	222.57	204.13	188.21	244.33		
CECe	meq/100g		12.93	12.59	12.60	13.04	12.66	13.59		
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)		
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)		
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)		
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 (1.8%CEC)	0.2 (1.6%CEC)		
Base Saturation	%	80 - 87	81.75	85.47	82.23	80.00	77.89	78.13		
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 (21.1%CEC)	3.0 (21.9%CEC)		
Aluminium Saturation	%		5.00	0.00	4.00	0.00	12.00	0.00		
Ca:Mg Ratio	(ratio)	3 - 5	6.05	7.31	6.35	6.65	5.85	6.51		
K:Mg Ratio	(ratio)	0.3 - 0.5	0.32	0.18	0.29	0.16	0.40	0.23		

Figure 3. Soil chemical analysis results

Plant counts indicated that the actual plant density was lower in the treatments where stubble was 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.

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 the lower bulk density and compaction readings than the stubble retention no till treatment.

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 1. Harvest results and plant counts

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 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 would be 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.