Incorporation of organic soil ameliorants to boost productivity of sandy soils in the medium to high rainfall zones of the Wheatbelt of Western Australia.

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AIM

To increase crop productivity on sandy soil types in medium to high rainfall zones through the incorporation of organic soil ameliorants; hay, stubble/straw and manure. The overall objective will be to encourage growers in the Central Wheatbelt region of WA to implement a form of incorporation of organic ameliorants on their sandy soils by 2024, by providing evidence that these types of soil amelioration practices can lift the profitability of poor performing sandy soils by 20%.

TRIAL DETAILS

Property:	Gary Lang. Farm: Howes. Paddock: Machinery Shed
Plot size & replication:	12 x 20m x 3 reps
Soil type:	Sand
Crop Variety:	Spartacus Barley
Sowing Date:	4/06/2020
Seeding Rate:	65kg
Fertiliser:	CuZn Mix 1L, UAN 50L, Azoxistrobilin 0.4L, MAP/Mop 72 Kg.
Paddock rotation:	2019 pasture
Herbicides: **Insecticides** **Fungicides:**	Knockdown 19/02/2020 24D Ester 600 0.25L, Glyphosate 450 CT 3L & 16/03/2020 0.2L, 1L & 30/05/2020 Glyphosate 450 CT 2L. IBS: Triflur 480 1.8L. Gramoxone 250 1.5L Prosulpocarb ALLY 1.5L

METHODOLOGY

This grower scale demonstration trial is to be conducted over three seasons (2020-2022)

The selection for the site is based on the requirement to locate a poor performing sandy paddock that has a history of lower than average yields. The three organic ameliorants selected for incorporation are Chicken manure, Straw and Hay, applied at two different rates of 10t/ha & 5t/ha for manure and 6t/ha & 3t/ha for hay and straw. The higher rates of organic ameliorants will be incorporated into the soil using a Mouldboard plough, whilst the lower rates will be incorporated by speed tiller with the exception of the low rate hay which has been incorporated by mouldboard plough. A grower practice of mould boarding (with no addition of organic ameliorant) will also be used as a benchmarking treatment along with a nil control. For the purpose of also gauging yield response to other common soil amelioration practice, an application of clay incorporated by speed tiller will be used for comparison in this experiment. (NB* The plot treatments that were incorporated by Mouldboard plough were also tillage rolled)

A pretrial soil analysis was conducted to provide a baseline for measuring improvements in soil nutrition and health as well as a full analysis of the mineral and organic composition of the manure and plants. In season recording of plant emergence numbers, plant growth and biomass, weed counts and grain yield and quality will be recorded to form the basis for conducting statistical and economic analysis over the three-year trial period.

Table 1: Trial Layout

Quadrant 3	(1,3)	(2,3)	(3,3)	(4,3)	(5,3)	(6,3)	(7,3)	(8,3)	(9,3)
Quadrant 2	(1,2)	(2,2)	(3,2)	(4,2)	(5,2)	(6,2)	(7,2)	(8,2)	(9,2)
Quadrant 1	(1,1)	(2,1)	(3,1)	(4,1)	(5,1)	(6,1)	(7,1)	(8,1)	(9,1)
	tmt 1	tmt 2	tmt 3	tmt 4	tmt 5	tmt 6	tmt 7	tmt 8	tmt 9

Treatment length = 60m

Table 2: Treatment list

Treatment	Treatment name & Incorporation method Mouldboard plough (MBP) & Speed Tiller (ST)
1	Chicken manure high rate 10t/ha (MBP)
2	Chicken Manure low rate 5t/ha (ST)
3	Straw high rate 6t/ha (MBP)
4	Straw low rate 3t/ha (ST)
5	Hay high rate 6t/ha (MBP)
6	Hay low rate 3t/ha (MBP)
7	Grower practice (MBP)
8	Control
9	Claying (ST)

RESULTS & DISCUSSION

A composite soil test was taken at the trial site on the 20th April 2020, analysing the soil to a depth of 50cm (table 3).

Table 3: *Pre-seeding composite soil test of the trial site.*

Soil test	0-10cm	10-30cm	30-50cm
pH (CaCl2)	5.7	4.9	4.8
Al (mg/kg)	0.1	0.3	0.3
P Col(mg/kg)	10	6	6
PBI	9	6	7
K Col(mg/kg)	25	25	25
S (mg/kg)	3	2	2
EC (dS/m)	0.03	0.01	0.01
OC (%)	0.37	0.11	0.05
NO3 (mg/kg)	5	2	1
NH4 (mg/kg)	2	1	1

An analysis of each of the soil ameliorants was recorded prior to the commencement of the trial (table 4).

Table 4: Plant and manure elemental analysis table

Element	Rate	Hay	Straw	Manure
Boron	mg/kg	6.88	5.225	26.29
Calcium	%	0.28	0.295	13.54
Copper	mg/kg	3.775	1.81	68.18
Iron	mg/kg	197.69	353.5	3582
Magnesium	%	0.165	0.095	0.84
Manganese	mg/kg	41.955	66.97	838.9
Phosphorus	%	0.215	0.035	4.205
Potassium	%	1.285	1.295	2.635
Sodium	%	0.195	0.59	0.49
Sulfur	%	0.155	0.095	0.73
Zinc	mg/kg	26.235	5.545	1070.4
Nitrate	mg/kg	51.07	60.78	46553

Barley plant emergence counts, NDVI and weed counts were conducted at barley growth stage Z14, with three counts per quadrant. The averages for each treatment were recorded (Table 5).

Table 5: *Average barley plant numbers, NDVI and weed count for each treatment at Z14.*

Treatment	Barley Plants per/sqm	NDVI	Average Weeds per/sqm
Chicken manure high rate 10t/ha (MBP)	24	0.11	0.1
Chicken manure low rate 5t/ha (ST)	35	0.15	1.8
Straw high rate 6t/ha (MBP)	40	0.14	2.5
Straw low rate 3t/ha (ST)	32	0.12	2.0
Hay high rate 6t/h a(MBP)	24	0.10	0.9
Hay low rate 3t/ha (MBP)	4	0.09	0.3
Grower practice MBP	26	0.15	0.8
Control	45	0.16	1.6
Claying (ST)	28	0.17	2.8

The target density for barley plants was 150 plants per/sqm for the seeding rate of 65kg/ha. At Z14, the average rate of emergence was low among all treatments.

A one-way ANOVA (α=.05) was used to analyse the relationship between soil ameliorant and barley plant numbers at Z14. Ameliorant treatment was found to have a significant impact on barley plant numbers. The addition of a low rate of hay (3t/ha via MBP) reduced the emergence of barley plants per/sqm compared to all other treatments. The control group had statistically significantly higher plants per/sqm compared to every treatment except chicken manure low and straw high.

The relationship between soil ameliorant and plant NDVI was also assessed using a one-way ANOVA (α=.05). A significant relationship was found between soil ameliorant and plant NDVI at growth stage Z14. The Claying and Control treatments produced the highest NDVI compared to the remaining treatments.

No statistical analysis was conducted to determine any relationship between weed count and soil ameliorant. It was observed however that there was very low germination of weeds amongst all treatment groups.

Harvest was undertaken utilising grower machinery with yield data collected via a yield monitor. Yield information is yet to be extracted and analysed to determine whether there is any significant differences between treatments in the first year of the trial. From in paddock assessments there is likely to be a very low yield across most of the treatments and it is expected that in following years that there will be more evident differences in yield once the soil profile has settled and establishment of crop across treatments is more even.

CONCLUSION

The plant density and crop vigour assessments taken at Z14 indicated a poor start in the establishment and growth of the barley crop across the entire trial site. The suppression of weed germination was high across all treatments. High winds occurred following seeding, which covered the trial site in sand resulting in furrow filling. This problem was exacerbated where the ameliorants were incorporated by mouldboard plough and speed tiller, with the least soil disturbance in the control treatment which also had the highest germination count.

Although the results of this year's trial indicate that the control outperformed the majority of treatments in respect to barley plant emergence and NDVI, this is the first of a three year study that will assess changes in soil health and crop productivity in response to the addition of organic ameliorants. A soil test will be conducted in each treatment plot in early 2021, which will provide an indication of any changes in soil quality in response to the addition of the ameliorants.

ACKNOWLEDGEMENTS

The GRDC for investing in and supporting this project in collaboration with the Corrigin Farm Improvement group, (Project 9178102/cfg2003-001SAX): Gary Lang for hosting, installing and maintaining this site and to Veronika Crouch from Corrigin Farm Improvement group for her assistance and advice.