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Organic Matter as a Source of Nitrogen.

A Reincke

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DEPARTMENT OF AGRICULTURE

Western Australia

SUMMARY OF EXPERIMENTAL RESULTS 1981

Organic Matter as a Source of Nitrogen

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1. THE EFFECTS OF SEEDING CLOVER AT THREE RATES OF SOIL TYPES

81GH1

This glasshouse trial involved seed clover at three rates (4, 12, 24 seeds/pot) on three soil types:-

- | | | | | | |
|----|--------------|---|---------------|-------|-----|
| 1. | Wongan Hills | - | approximately | 0.04% | TSN |
| 2. | Avondale | - | " | 0.1% | TSN |
| 3. | Mount Barker | - | " | 0.35 | TSN |

The dry weight of the tops and roots were measured after 42 days growth, and measured for nitrogen and carbon content.

All soils were subjected to three treatments:-

1. Tops cut and incorporated (tops and roots)
2. Tops cut and removed (roots only)
3. Tops from treatment 2 incorporated into a fresh pot (tops only)

The Wongan Hills soil was subjected to two further treatments:-

1. Soil with roots sieved through 2m sieve and roots removed (fine roots only).
2. Coarse roots from above treatment incorporated into a fresh pot (coarse roots only).

After the treatments were incorporated soil samples were taken and the pots were sown to wheat for 42 days. The soil samples were measured for available nitrogen using a two week aerobic incubation, and measuring the NH_4^+ + NO_3^- . The plants were sampled analysed for nitrogen content.

i) Effect on dry matter of tops and roots, and their nitrogen contents

TABLE 1

Soil Type	Seeding rate of clover	Wt-tops (g)	%N	N in tops (mg)	C/N tops	Wt roots (g)	% N roots	N in roots (mg)	C/N* roots	% of N in tops
Wongan Hills	4	1.24	4.05	50	9.7	0.47	2.35	11	17.0	81
	12	2.54	4.00	101	9.5	1.5	2.15	32	18.3	76
	24	3.20	4.12	131	9.9	2.0	2.69	54	14.8	70
Avondale	4	1.85	4.84	89	8.4	0.47	2.5	12	16.0	88
	12	3.19	4.40	140	9.3	1.43	2.65	38	15.0	78
	24	3.19	4.28	168	9.6	1.66	2.97	49	13.4	77
Mount Barker	4	0.88	5.12	45	9.0	0.37	2.70	10	14.8	81
	12	2.29	4.79	109	8.4	1.57	2.74	43	14.6	71
	24	3.29	4.37	143	9.6	2.28	2.50	57	16.0	71

* calculated assuming %C = 40

Comments:

- a) The tops contain much more nitrogen than the roots; due to larger amounts of dry matter and higher nitrogen contents.
- b) At higher seeding densities, more nitrogen is found in the roots.
- c) The roots have a higher C/N ratio than the tops.
- d) The top/root ratio decreases with increased density.

ii) Effect on mineral nitrogen, yield and N uptake

TABLE 2

SOIL TYPE		WONGAN HILLS			AVONDALE			MT. BARKER		
TREATMENT	Seeding Rate	Min-eral* N	Yield (gm)	N Uptake (mg)	Min-eral* N	Yield (gm)	N Uptake (mg)	Min-eral* N	Yield (gm)	N Uptake (mg)
Tops & roots	4 seeds	28	1.68	34	71	4.55	116	128	3.37	114
Roots only	4 "	20	1.32	25	64	3.83	94	113	3.07	103
Tops only	4 "	23	2.66	57	105	4.80	172	147	2.32	102
Fine roots	4 "	16	1.38	28	-	-	-	-	-	-
Coarse roots	4 "	32	2.34	45	-	-	-	-	-	-
Tops & roots	12 seeds	55	2.73	57	64	4.41	112	126	3.64	122
Roots only	12 "	21	1.50	29	51	3.61	71	90	3.05	85
Tops only	12 "	31	2.97	79	92	4.70	183	128	2.45	117
Fine roots	12 "	18	1.57	27	-	-	-	-	-	-
Coarse roots	12 "	23	2.21	45	-	-	-	-	-	-
Tops & roots	24 seeds	41	3.42	69	78	4.20	122	131	3.17	126
Roots only	24 "	24	1.65	32	45	3.29	71	93	2.77	85
Tops only	24 "	41	2.91	80	95	5.08	179	160	2.52	124
Fine roots	24 "	19	1.41	26	-	-	-	-	-	-
Coarse roots	25 "	31	2.49	50	-	-	-	-	-	-
Nil	Nil	26	2.08	47	76	4.48	152	138	2.30	111

* Mineral N is the NH_4^+ + NO_3^- produced after 2 weeks aerobic incubation.

Comments:

- The clover roots have decreased mineral N, yield and N uptake in most treatments. This implies immobilization of nitrogen is occurring; due to the lower N content of the roots.
- The fine roots on the Wongan Hills soil have the largest effect on the variables.

2. THE EFFECT OF ORGANIC MATTER AND TIME ON PLANT GROWTH

81GH2

A pot trial had four treatments [clover (= 4% N), wheat straw (= 1% N) and a mixture of the clover and wheat straw (= 2% N) applied at 4000 kg/ha equivalent, and a Nil] on a nitrogen deficient Wongan Hills loamy sand. The pots were seeded to wheat and harvested at 2, 3, 4, 5, 6, 8 and 12 weeks after emergence.

From the top yield (weeks after emergence graph, Fig 1) the clover tops have a lot better growth and wheat straws worse growth than the Nil organic matter addition treatment. The organic material with 2% N, shows that temporary immobilization has occurred up to 5 or 6 weeks, after which some mineralization occurs.

The root weights were also measured, and followed a similar pattern to the top weights. However, the root weight curves levelled out more than the top weights with time.

In the wheat belt, many clover/grass pastures have nitrogen contents of 2% N or less. Therefore, very little nitrogen would be released to the following wheat crop when the pastures are ploughed in, and especially when the pastures produce less than 4000 kg/ha.

3. SEEDING RATE OF CLOVER

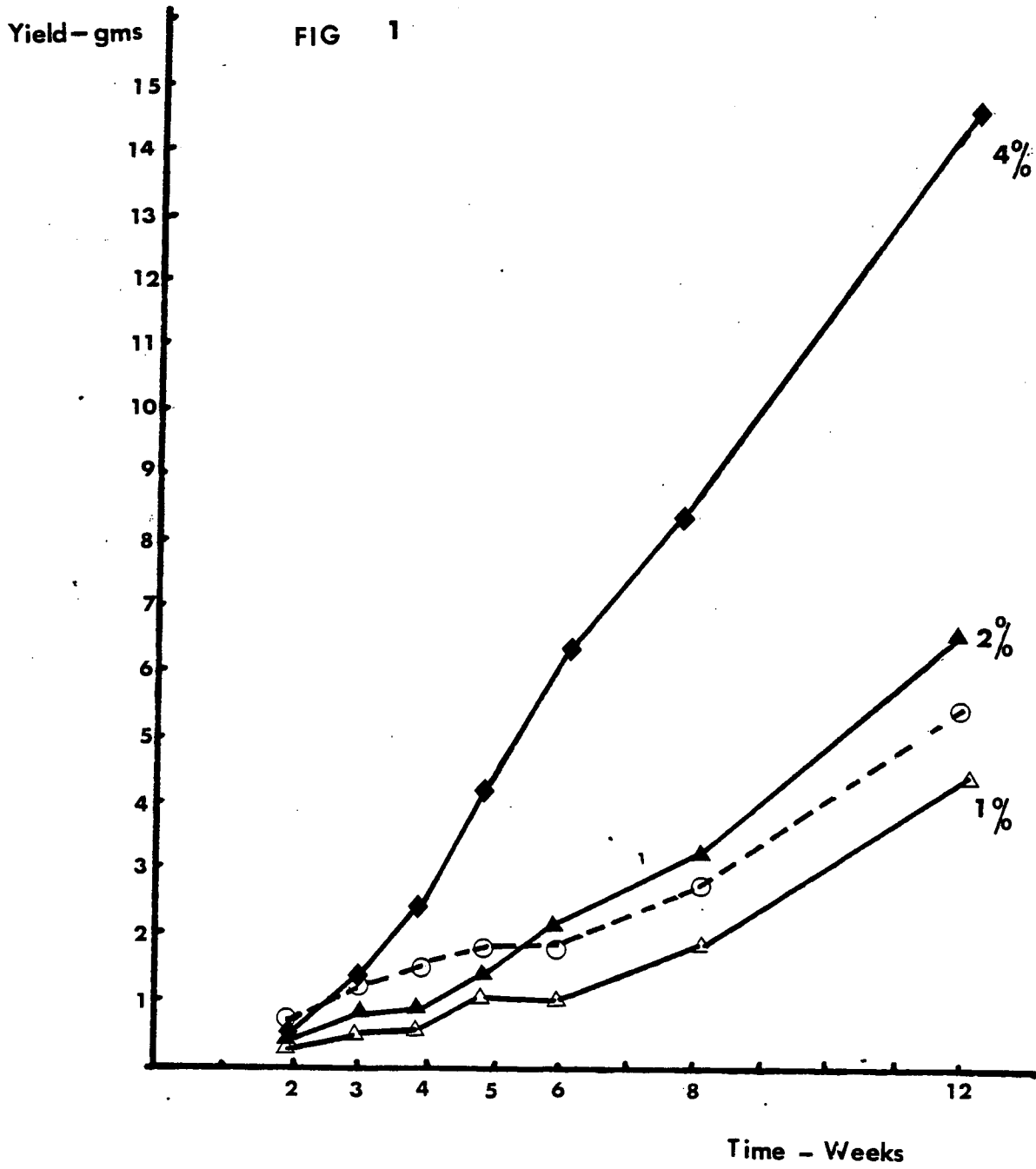
80WH5i) Over summer losses

The trial was planted in 1980, with 5 seeding rates of Nungarin clover. Large losses in the amount of dry matter present occurred during the summer period. As the trial was not grazed, the losses are probably due to physical breakdown and/or erosion losses.

TABLE 3

Seeding Rate & Dates	5 kg/ha				80 kg/ha			
	22/9/80	22/4/81	change	% change	22/9/80	22/4/81	change	% change
Dry wt kg/ha	1353	791	-562	-42%	1672	740	-932	-55%
% N	1.38	1.42	+0.04		2.03	1.99	-0.04	
kg N/ha	18.6	11.3	-7.3	-39%	33.8	14.7	-19.1	-56%
C/N ratio	31.9	26.2	-5.7		21.2	18.4	-2.8	

Substantial losses of nitrogen may occur due to over summer weathering. The losses are mainly due to losses of dry matter rather than changes in the amount of nitrogen present in the dry matter.



3. SEEDING RATE OF CLOVER (cont.)

ii) Effect on Mineral Nitrogen and Yield

The effect of clover on the mineral nitrogen and plant yield has been measured and compared to Agran additions. Very little difference occurred between the different clover seeding rates, therefore clover seeded at 20 kg/ha will be considered.

TABLE 4

Treatment Measurement	Clover 20 kg/ha	Nil	Agran 50 kg/ha	Agran 100 kg/ha
*Inc N 12/3/81 ¹	27	25	-	-
" " 12/3/81 ²	32	29	-	-
" " 16/7/81 ¹	19	19	-	-
Plant DW 18/8/81	710 kg/ha	653 kg/ha	971 kg/ha	1116 kg/ha
" " 28/9/81	2280 "	1867 "	2810 "	3308 "
" " 2/11/81	4480 "	4035 "	4220 "	4510 "
Total Dry Wt				
Grain Yield	2033 "	1960 "	2224 "	2055 "
Harvest Index				

* Inc N - $\text{NH}_4 + \text{NO}_3$ produced after incubation (2 wks, 30°C)

1 Total soil

2 < 2 mm soil

The soil test figures only show a very small increase in incubatable nitrogen due to the growing of clover at the early incubation. The removal of the < 2 mm fraction increased the incubatable N, which suggests the < 2 mm fraction was immobilizing the inorganic nitrogen. Early plant weights indicate the clover was worth between Nil and 50 kg/ha Agran. Later dry weights indicate slightly higher values.

4. PASTURE SPECIES/SEEDING RATE TRIALS

i) 81GE4 : Tenindewa

Three clover species, four medic species and one rose clover species were planted to evaluate dry matter production. In the second year, the effect of the species on the available nitrogen production is to be evaluated. Nungarin and Harbinger were sown at 7.5, 15, 30 and 90 kg/ha, while the other varieties were sown at 15 kg/ha. All varieties were seeded with 200 kg/ha superphosphate. The trial was ungrazed.

TABLE 5

Variety	Seeding Rate	Establishment plant counts	Dry Matter kg/ha	Roots 0-10cm kg/ha	Roots 10-20cm kg/ha	Total Roots kg/ha	% Roots	Top/root ratio
Nungarin	90 kg/ha	543/m ²	1170	1506	130	1636	92	0.71
	30 "	258/m ²	1090	1080	76	1156	93	0.94
	15 "	160/m ²	630	760	76	816	93	0.77
	7.5 "	85/m ²	508	680	66	746	91	0.68
Harbinger	90 kg/ha	580/m ²	2580	1682	119	1801	93	1.43
	30 "	258/m ²	2140	1305	122	1417	91	1.49
	15 "	158/m ²	1160	1212	142	1354	89	0.85
	7.5 "	98/m ²	1190	1297	124	1421	91	0.83
Northam	15 kg/ha	85/m ²	590	1000	58	1058	94	0.55
Kondinin Rose	15 kg/ha	161/m ²	740	771	216	987	78	0.74
Tornafield	15 kg/ha	80/m ²	608	1100	66	1166	94	0.52
Geraldton	15 kg/ha	123/m ²	391					
Swani	15 kg/ha	133/m ²	508					
Serena	15 kg/ha	65/m ²	280					

4. PASTURE SPECIES/SEEDING RATE TRIALS (cont.)

- ii) 81GE2 : Canna
81MO4 : West Wubin

These two trials evaluated the dry matter produced after seeding several varieties at different rates.

TABLE 6

81GE2

Variety	Seeding Rate	Dry Matter kg/ha
Nungarin	7.5 kg/ha	541
	15 "	616
	30 "	700
	90 "	900
Kondinin Rose	7.5 kg/ha	383
	30 "	483
Swani	7.5 kg/ha	125
	30 "	242
Geraldton	7.5 kg/ha	292
	30 "	608
Northam	7.5 kg/ha	458
	30 "	608

81MO4

Variety	Seeding Rate	Dry Matter kg/ha
Nungarin	5 kg/ha	660
	10 "	990
	20 "	1020
	100 "	1290
Kondinin Rose	5 kg/ha	300
	10 "	430
	20 "	460
	100 "	540
Geraldton	10 kg/ha	1040
Swani	10 kg/ha	370
Harbinger	10 kg/ha	520
Tornafield	10 kg/ha	360
Northam	10 kg/ha	710

5. THE EFFECT OF ORGANIC MATTER, RATE OF ADDITION, SOIL TYPE
AND TIME ON THE MINERAL NITROGEN PRODUCED AFTER INCUBATION

81LAB1

An incubation trial was designed to measure the effect of five organic matter compositions at three rates of addition over time on two soil types on the mineral nitrogen produced. Organic materials were added directly to incubation vials, the soil and water added and the vial incubated for the required period of time.

A multiple linear regression was fitted to the data such that

$$\begin{aligned} \text{Mineral N} = & a + b (\%N) + c (\text{Time}) + d (\text{Amount added}) \\ & + e (\text{Amount added} \times \text{time}) + f (\text{Amount added} \times \%N) \end{aligned}$$

On the Avondale soil (high N), the regression accounted for 94% of the variation.

On the Wongan Hills soil (low N), the regression accounted for 97% of the variation.

Further trials have commenced to examine each of the varying factors separately.

The complete multiple linear regression, which included all combinations of the input variables, did not significantly improve the variance accounted for over the multiple regression used.

FIG 2: Multiple linear regression as a function of amount added, %N of the organic matter and time

8000 kg/ha
4000 kg/ha
2000 kg/ha

8 weeks
4 weeks
2 weeks

Avondale Soil

Wongan Hills Soil

MINERAL
NITROGEN
(ppm)

180
160
140
120
100
80
60
40
20

1 2 3 4

% NITROGEN of ORGANIC MATTER

