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EFFECT OF INCORPORATED PLANT MATERIALS ON GERMINATION, PERSISTENCE AND GROWTH OF LADINO WHITE CLOVER SEEDLINGS IN POTS

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SUMMARY

In a pot experiment the incorporation of the equivalent of 15·5 tonnes/ha of finely milled oven-dry aerial portions of three grass species in the top 2·5 cm of soil resulted in a number of distinct effects on the germination, persistence and subsequent growth of Ladino white clover (*Trifolium repens*) seedlings. The three species, *Paspalum dilatatum, Bromus unioloides* and Ronpha grass (*Phalaris* sp.), caused differing reductions in the speed of emergence, total emergence and persistence of emerged seedlings compared with no incorporated plant material. The seedlings which did persist showed eventual stimulation of growth which become apparent at differing times depending on the material incorporated.

I. INTRODUCTION

It has been shown by Cameron (1969) that the Ladino white clover (*Trifolium repens*) component of paspalum (*Paspalum dilatatum*)/clover pastures on the Theodore Irrigation Area in Central Queensland has a much slower winter growth rate than pure clover or clover-dominant stands at Biloela Research Station. Clover growth rates in spring, however, are equivalent or even superior at Theodore. When grown at Biloela with a small proportion of Ronpha grass (*Phalaris arundinacea* x *P. tuberosa*) in 200 litre drums, the clover growth rate was depressed throughout the year.

Cameron (1969) has also shown that application of fertilizers, containing variously N, P, K, S, Mo, Bo, Zn, Mn, to the pastures at Theodore failed to lift the winter production even though the paspalum growth was stimulated in late autumn by nitrogen application and the clover growth in spring by sulphur. He also found that, although early autumn renovation and overseeding led to a paspalum yield depression, these treatments failed to increase the yield of either the persistent or the oversown clover 5 months later.

These results prompted an investigation into the possibility of residual effects of the summer growth of paspalum depressing clover growth during winter. The experiment presented here describes the effects on winter germination and subsequent growth of clover seedlings of incorporating massive quantities of plant material in the surface soil.

II. MATERIALS AND METHODS

The experiment was conducted in 20 cm plastic flower pots. The hole in the bottom was covered with six layers of blotting paper and 5·8 kg of clay loam soil used, the last 1·5 kg being added separately. This formed a top 2·5 cm layer

to which was added 0·2 g Ladino white clover seed (50 kg/ha approx.). In the appropriate pots this layer also received a massive quantity, 50 g (approx. 15·3 tonnes/ha) of finely milled plant material.

A 4 x 8 randomized block design was used with treatments of:

(1) Nil vegetative material.

(2) Paspalum material collected Theodore, March 1966.

(3) Prairie grass material collected Biloela, March 1966.

(4) Ronpha material collected Biloela, June 1966.

The plant materials were oven-dried at 95°C following collection, stored, then milled through an 0·75 mm screen in a 20 cm C and N laboratory mill just prior to use. The paspalum was late-season leaf material with a small component of summer residues. The Ronpha and prairie grass were made up of leaf and lush stem from vigorous vegetative stands.

The clover seed was inoculated by mixing with a small quantity of soil dug from a vigorous clover area immediately prior to planting.

The pots were bulk-wetted in trays on July 5, 1966, and at regular intervals thereafter. Liberal sprinkler watering was used to keep the surface soil of all pots moist.

Emerging seedlings and those persisting were counted periodically over the first 21 days, while the performance of individual pots 41 and 78 days after planting was assessed by rating general growth on a 1–10 scale and noting the overall appearance of the pot. On September 29 (86 days) four replicates (A to D) were harvested. Oven-dry weight of tops and of roots (after washing) and the number of plants per pot were recorded, and observations were made on nodulation in each pot. The remaining four replicates were harvested on October 18 (105 days). Oven-dry weights of tops, roots and plant numbers were again recorded.

III. RESULTS

Emergence.—The seedling populations over the first 21 days are shown in Table 1. Two distinct effects are evident: (1) a considerable and differing reduction in the speed of emergence, with seedlings in pots containing milled Ronpha material emerging last, and (2) differences in the total number of seedlings emerging with paspalum material giving the least effect.

TABLE 1

EMERGED SEEDLINGS OF LADINO WHITE CLOVER (PLANTS/POT) FOLLOWING INCORPORATION OF MILLED GRASS IN THE TOP 2·5 CM OF SOIL

Treatment	Days from Planting			
	6	8	10	21
1. Nil material	22·6	55·6	150*	146
2. Paspalum	1·4	13·7	48·7	105
3. Prairie	0·4	3·7	13·9	47
4. Ronpha	Nil	1·3	5·9	43

* Count not accurate because of density in small pots.

Early growth.—The mean ratings and summarized comments on plant appearance 41 and 78 days after planting are shown in Table 2. Even as early as 41 days the seedlings were growing well in pots receiving prairie grass material, while many in the Ronpha-treated pots were weak and chlorotic. By 78 days plants in all treatments were growing well.

TABLE 2

EARLY GROWTH PERFORMANCE OF WHITE CLOVER SEEDLINGS FOLLOWING INCORPORATION OF MILLED GRASSES IN TOP 2·5 CM OF SOIL

Treatment	Mean Rating	Comments
41 days		
1. Nil	9·62	Thick stands; small but vigorous plants
2. Paspalum	6·75	Fairly thick. Small and fairly vigorous but some very unhealthy
3. Prairie	5·0	Sparse open stand; large well-grown plants
4. Ronpha	2·12	Few plants, mostly very small and very unhealthy, many chlorotic and dying
78 days		
1. Nil	3·5	Dense stand; small plants
2. Paspalum	6·62	Moderately dense; fairly well grown plants but somewhat variable
3. Prairie	8·0	Moderate stand; very well grown
4. Ronpha	6·12	Very few plants; growing well

Persistence.—Final emergence has been taken as the count 21 days after planting. The counts of plants at the harvests that concluded the trial and percentage persistence of these relative to their 21 day counts are shown in Table 3. Ronpha caused a markedly lower level of persistence of emerged seedlings. The plants that died did so over a period. No yellowing or death of seedlings was noted in the nil pots.

TABLE 3

PLANTS OF LADINO WHITE CLOVER PER POT AT EACH HARVEST AND PERCENTAGE PERSISTENCE

Treatment	Mean Plants/Pot†		Mean % Persistence	
	86 days	105 days	86 days	105 days
1. Nil material	167	150	114·2*	105·5*
2. Paspalum	89	78	77·6	77·5
3. Prairie	31	45	96·5	91·3
4. Ronpha	9	21	34·8	41·7
Significance	1>2 1 & 2≫3 & 4 3≫4	1≫2, 3 & 4 273 2 & 3≫4	1>2 1, 2, & 3≫4	1≫4 2>4

* 21-day count not accurate because of density in small pots.

† Log transformation used for analysis of data.

Yields.—The adverse effects noted for the various incorporated materials disappeared at differing times, this being first noticeable in the pots that had received prairie grass material. Subsequently when the adverse effects disappeared there was a marked stimulation of the remaining plants, as shown in Table 4, where yields at each harvest are presented.

TABLE 4

YIELDS OF TOPS AND ROOTS OF WHITE CLOVER (G/POT ODM) FOLLOWING INCORPORATION OF MILLED GRASSES IN THE TOP 2·5CM OF SOIL

Treatment	Tops			Roots		
	86 days	105 days	Mean	86 days	105 days	Mean
1. Nil material	4·25	8·08	6·16	7·88	13·45	10·66
2. Paspalum	8·80	16·75	12·77	7·50	17·27	12·39
3. Prairie ..	9·70	23·12	16·41	12·80	38·47	25·64
4. Ronpha ..	4·88	22·10	13·49	5·83	30·20	18·01
L.S.D. 1% ..	2·41	9·19	5·89	2·99	14·52	9·75
Significance	2 & 3≫1 & 4	3 & 4≫ 1	2, 3 & 4≫1	3≫1, 2 & 4	3≫1 & 2 4≫1	3≫1 & 2

The relative proportions of roots to tops at each harvest are shown in Table 5. The lower proportion of roots for all treated pots compared with the control at the 86-day harvest is noticeable. Nineteen days later there were much more even proportions of roots to tops, only paspalum having significantly less than any of the other treatments.

TABLE 5

PROPORTIONS OF ROOTS TO TOPS OF WHITE CLOVER PLANTS AT EACH HARVEST

Treatment	86 days	105 days	Mean
1. Nil material	1·85	1·63	1·74
2. Paspalum	0·86	1·06	0·96
3. Prairie	1·34	1·64	1·49
4. Ronpha	1·23	1·39	1·31
L.S.D. 5%	0·25	0·57	..
L.S.D. 1%	0·36	0·82	0·40
Significance	1≫2, 3 & 4 3 & 4≫2	3<2	1≫2 & 4 3≫2 4<2

Nodulation.—Observation suggested that nodulation was satisfactory in all pots.

IV. DISCUSSION

The incorporation of milled plant materials in the surface soil had a number of distinct effects. These included differing reductions in the speed and number of clover seedlings emerging and differing levels of persistence of the seedlings that did emerge. As well, the adverse effects disappeared at different times for the different plant materials incorporated and were replaced by a marked stimulation of the remaining plants.

A study of the literature suggests several sources of these effects. Grant and Sallans (1964) and Hoveland (1964) tested aqueous extracts of aerial and root portions of a number of grasses and legumes on germinating seeds of a range of species. They found that there were differing effects from these extracts on germination and more particularly radicle and shoot growth of the seedlings from species to species. Pedersen (1965) more specifically laid the blame for reduced germination and again more particularly reduced rates of radicle elongation of cotton seedlings on saponins extracted from lucerne meal. On the other hand, workers in southern Australia (Anon. 1967) suggest that stunted growth and poor emergence of wheat planted in stubble land may be caused by toxins produced by micro-organisms associated with the breakdown of stubble rather than materials directly extractable from the stubble. Kimber (1967) indicated that these toxins could usually only be extracted from wheat straw rotted less than 10 days although there was evidence of toxin production sometimes occurring for at least 42 days; different varieties of wheat gave different toxicities in the extract.

When the straw was completely decomposed Anon. (1967) indicated a net gain in nitrogen possibly due to the activities of the bacteria *Klebsiella* which fix atmospheric nitrogen.

Results of the present experiment match those of southern Australia with wheat straw, with initially adverse effects and later stimulation of the remaining plants. This in part is what happens in the field at Theodore and the present experiment has helped to explain why it has not been possible to stimulate winter growth of Ladino white clover. By spring all previous season's trash and residues of paspalum have been rotted and this enables the clover to grow particularly well for a while. In the present experiment the paspalum effect was not as marked as for the other two species but this may be explained in terms of the different stages in the plants' growing seasons when the collections were made.

From the results obtained in this experiment there appears little likelihood of being able to stimulate the winter clover growth in the mixed stands at Theodore by the use of fertilizers. It may, however, be possible to utilize some form of soil sterilization such as that described by Beggs (1964) to get earlier vigorous growth from the clover in winter. This remains to be tested.

V. ACKNOWLEDGMENTS

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