CARIBBEAN FOOD CROPS SOCIETY

PROCEEDINGS

ELEVENTH ANNUAL MEETING

A GREENHOUSE TRIAL OF THE EFFICIENCY OF VITAMON D AND ENMAG AS SLOW RELEASE FERTILIZERS USING PANGOLA GRASS *(Digitaria decumbens)*[1]

by

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INTRODUCTION

There has been increasing interest in recent years in the development of fertilizers with the property of controlled, gradual release of nutrients, in the hope that they might provide a more efficient supply, especially of nitrogen and also reduce or eliminate the need for multiple applications during the season (Lunt *et al,* 1962). One approach to the problem has been to encapsulate the fertilizer grannule in some hydrophobic substance, thus reducing its rate of dissolution. Another approach has been the search for less soluble compounds that are only gradually broken down in the soil. (Army, 1963).

Tests of these new materials have met with varied success. (Dahnke, *et al,* 1963, Forbes, 1966 and Lunt, 1968). Best results appear to have been obtained on light soils, under crops responsive to high nitrogen fertilization, such as forage grasses and maize (Lunt, 1968, Mays and Terman, 1969). Efficient nitrogen supply to soils of the humid tropics has up to now been managed by frequent applications of fertilizer in order to reduce losses by leaching and denitrification. The use of controlled release fertilizers suggests itself as a possible alternative under certain circumstances.

[1] A paper prepared for the Eleventh Annual Meeting of the Caribbean Food Crops Society held in Barbados from 1st July to 7th July, 1973.

The present trial was set up to investigate the efficiency of two fertilizers of this type. Vitamon d is a polyvinyl chloride encapsulated compound fertilizer and Enmag a magnesium ammonium phosphate type. Pangola grass was selected as a good indicator of nitrogen supply as it is known to respond to heavy fertilization, both in the field (Vicente-Chandler et al, 1964) and pots (Eves, 1971).

MATERIALS AND METHODS

The work was carried out in an open sided greenhouse at St. Augustine. Pangola grass obtained from the University Field Station was planted as root sets, six per metal Mitscherlich pot containing about 6.2 kg of a dry loamy sand with an average composition of 0.1, 2.1 and 0.6 meq. of exchangeable K, Ca and Mg respectively, 64 pots arranged in a randomized complete block of 16 treatments included four replications. The 16 treatments comprised one control with no fertilizer added, and three levels each of the following fertilizer treatments:— normal compound fertilizer 13-7-13 plus 4% MgO (F); Vitamon d 13-7-13-4 mixed with the soil (v); Vitamon d applied to the surface (VS); Enmag 5-24-10-16.6 mixed with the soil (E) and Enmag applied to the surface (ES). Levels 1, 2 and 3 of each fertilizer supplied 0.26, 0.53 and 1.05GN per pot equivalent to 84, 168 and 336 KgN/per ha respectively. 300ml of tap water was supplied to the pots three times per week or more often as required from observation of the pots. The amounts of water added were calculated to approximate local rainfall rates.

Top growth of the grass was harvested every five weeks by cutting at 2.5 cms. above soil level. Fresh and dry weights were determined before the material was ground and ashed for analysis of the major nutrients.

The volumes of the leachate from the pots comprising one complete block were measured before submitting samples for chemical analysis. The grass was sprayed every 10–14 days with Malathion to protect against insect attack.

RESULTS

Fresh and Dry Weight Yields:

All tests of significance between means were made at the 5% level using the Duncan's Multiple Range Test. It will be seen from Tables 1 and 2 that maximum yields were obtained from harvest 2, the amount decreasing steadily in later harvests. Establishment was obviously not complete by harvest 1, no treatment being significantly greater than the control. It appeared as though the higher rates tended to show a depression of early growth. By the second harvest establishment was complete and growth was rapid, however, there was no significant difference between treatments or levels except between the control and all other treatments. Maximum yield was shown by E2S. Unfortunately no dry weight data were obtained for this harvest.

The 3rd harvest began to show up some differences between treatments although all mean yields had decreased relative to the 2nd harvest. On a fresh weight basis E3 showed maximum yield and significantly out-yielded F3, V3 and V3S. E3S also out-yielded these three treatments. All treatments except E1S were significantly greater than the control. On a dry weight basis, however, F3 showed maximum yield owing to a much higher per cent dry matter, but was only significantly greater than the control and the F2, V1, V1S, V2S, E1S and E2S treatments.

By the 4th and 5th harvests the plants were showing successively poorer growth and some definite signs of nutritional deficiency. Fresh and dry weight yields of E3 were highest in the 4th harvest, and fresh weight yield of E3 was highest in the 5th harvest also; however V3 yielded slightly higher dry weight than E3 in this harvest. All level-3 treatments significantly out-yielded the control at the 4th harvest while only the highest levels of the slow release fertilizers V3, V3S, E3 and E3S were significantly greater at the 5th harvest. Fresh weight of E3 in the 4th and fresh and dry weights in the 5th harvest were significantly greater than F3. V3S also out-yielded F3 on both counts in the 5th harvest.

TABLE 1

Mean fresh weights of pangola grass tops (g/pot) after different fertilizer treatments

Treatment		HARVEST					
Fertilizer	N applied Kg/ha	1	2	3	4	5	Total
	Control	19.6	28.2	22.3	16.3	7.7	94.1
13-7-13	84	23.6	58.5	44.6	25.3	12.6	164.6
+4% Mg	168	13.8	63.4	40.3	20.9	9.5	147.9
	336	14.6	58.9	39.9	44.6	14.7	172.7
Vitamon d	84	19.6	63.6	39.1	28.4	9.7	160.4
mixed with soil	168	20.3	67.4	47.6	34.1	17.2	186.6
	336	17.5	64.8	38.0	51.2	19.5	191.0
Vitamon d	84	24.6	52.6	37.7	32.4	8.3	155.6
applied to	168	16.3	57.1	38.8	38.0	16.7	166.2
Surface	336	16.6	64.9	40.4	53.8	26.2	201.9
Enmag mixed	84	24.0	64.4	46.1	29.4	12.8	176.7
with Soil	168	16.2	62.6	39.9	41.9	14.8	175.4
	336	13.2	61.4	53.4	64.2	29.0	221.2
Enmag applied	84	19.5	63.1	27.7	21.3	8.0	139.6
to Surface	168	17.0	72.3	38.8	28.8	13.7	170.6
	336	9.6	61.6	52.6	45.7	21.3	190.8
Overall Mean		17.9	60.3	40.5	36.0	15.1	168.8

TABLE 2

Mean Dry Weights of Tops (g/pot)

Treatment	HARVEST				
	1	2	3	4	5
Control	2.7		4.0	2.5	1.4
F1	3.4		8.8	4.5	2.2
F2	2.3		8.1	3.7	1.8
F3	2.3		11.6	8.2	2.7
V1	2.8		7.3	4.7	1.7
V2	3.0		9.1	5.9	3.0
V3	2.7		8.8	8.1	3.8
V1S	3.5		7.3	5.1	1.6
V2S	2.5		7.8	6.2	2.8
V3S	2.5		10.0	8.6	4.5
E1	3.3		9.4	5.0	2.2
E2	2.6		11.0	7.4	2.6
E3	2.4		11.6	9.9	4.9
E1S	2.8		5.3	3.0	1.4
E2S	2.5		7.9	4.4	2.3
E3S	1.6		9.8	7.7	3.3
Average	2.7		8.6	5.9	2.6

Table 3

Tissue Analysis, Nitrogen (% ODM)

TREATMENT	HARVEST			
	1	2	3	4
0	2.86	1.46	1.16	1.23
F1	2.77	2.17	0.87	1.18
F2	2.93	1.82	1.12	1.24
F3	2.92	2.32	1.45	1.21
V1	2.90	1.87	1.05	1.40
V2	2.75	2.09	1.24	1.43
V3	2.92	2.46	1.80	1.78
V1S	2.91	1.40	1.02	1.37
V2S	3.05	1.89	1.10	1.56
V3S	2.97	2.33	1.49	1.34
E1	2.93	1.87	0.91	1.00
E2	2.83	2.45	1.04	0.99
E3	2.79	2.75	2.04	1.68
E1S	2.81	1.35	1.00	1.62
E2S	3.07	2.23	1.13	1.23
E3S	3.15	2.28	1.83	1.05
Average	2.91	2.05	1.27	1.33

Tissue Analysis: Data for harvests 1 through 4 only are available

NITROGEN

Nitrogen content of the tops decreased steadily from a maximum at the first harvest where the average overall treatments was 2.9% N. to 1.3% N at the 4th harvest (see table 3). Few significant differences were observed at the first harvest only E3S at 3.15% N showing significantly higher concentration than F1, V2 and E3.

E3S was again highest at the second harvest with an N concentration at 2.04% N, a significantly higher concentration than was obtained from either F3 or V3S treatments; E3S was also significantly greater than these two treatments. V3, but not V3S, was also significantly higher than F3. All slow release fertilizer treatments at the highest level gave N concentrations significantly greater than either their low or middle levels. F3 was significantly higher than F1 but not F2.

By the 4th harvest the pattern had changed somewhat, V3 providing the highest N concentration of 1.8%, with E3 slightly less, both treatments yielding concentrations significantly greater than F3, V3S and E3S. The poor growth of E1S was evidently not related to low N concentration in the tissues as this treatment ranked next below V3 and E3 at 1.6%.

OTHER ELEMENTS

Owing to the fact that fertilizer compositions were different except in the case of Vitamon d and the mixed fertilizer, amounts of the elements other than nitrogen added to the pots at corresponding levels of the different treatments were not the same. Therefore, consideration is restricted to the comparisons of the mixed fertilizer and Vitamon d treatments:

(a) Phosphate – Concentrations averaged over all treatments ranged from 0.32% P to 0.16% in the 1st and 4th harvests respectively. No very significant pattern was observed except that higher fertilizer levels generally produced greater concentrations in the plant tissues. There was a slight tendency for F treatments to yield greater tissue concentrations than V or VS treatments at the same level.

(b) Potassium – At the 1st harvest, concentrations of potassium were high, averaging 4.0% but decreased steadily to 2.2% by the 4th harvest. In all except the 2nd harvest, V3 supplied higher concentrations of K than F3 but differences were not significant except in the 4th harvest. There was no observable difference between VS and V treatments.

(c) Calcium – The average calcium content decreased from 0.47% at the 1st harvest to 0.33% at the second, after which it remained fairly constant at about 0.37%. In the first harvest only, calcium levels were significantly higher in all V and VS treatments than in F1 and F2 treatments. Differences between F3 treatments were not significant. In later harvests few significant differences between F and V or VS treatments were observed.

(d) Magnesium – Average magnesium levels decreased steadily from 0.39% in the 1st harvest to 0.26% in the 4th. No consistent pattern of any significant differences between levels of Mg obtained by any of the three sources F, V or VS could be detected.

Leachate Analysis

Results obtained from analysis of the leachate at intervals during the 25 week; period produced some indication of the concentration of the nutrients being lost from the pots by this route. However, results were rather variable and no duplication of samples was possible. Results obtained indicated that there was a heavy initial loss of N in the leachate collected from F treatments, increasing markedly with the level of fertilizer applied (see tables 4 and 5) reaching almost 2000 ppm

N from the F3 treatment, a level 7 to 20 times the concentration from the slow release treatments at similar levels.

This high initial concentration decreased rapidly in the first few weeks and by week 8 had dropped in all treatments to 10 ppm or less, and to less than 5 ppm from most treatments by week 11. The loss of nitrogen in the first 3 weeks amounted to approximately 80% of that added in F3 treatment, and only 2–3% for the VS and V3S treatments. Enmag behaved similarly.

Increasing levels of nitrogen supplied in the slow release fertilizers did not cause any marked increase in the concentration of N in the leachate in contrast with the results observed for the three F treatments.

Surface application of the fertilizer did appear to reduce slightly the initial loss of N but this tendency was not maintained in subsequent samples.

Recovery Data

Nitrogen recovery data were estimated for the second harvest on the basis of an assumed mean dry weight percentage of 16% fresh weight. The overall recovery figures for the first four harvests are shown in table 6. Consistently high recovery figures for the lowest level treatments were observed and in all cases, percent recovery decreased as rates of nitrogen increased. At 336 kg, N/ha recoveries ranged from 51 to 70%.

Table 4

Concentration of Nitrogen in leachate (ppm)

Period ending Week	TREATMENT					
	0	F3	V3	V3S	E3	E3S
3	72	1870	76	68	324	58
6	40	292	34	36	64	82
8	7.8	6.6	2.6	1.6	1.6	2.0
11	4.8	4.4	4.4	1.6	1.8	3.2

Table 5

Cumulative amounts of Nitrogen lost in leachate (mg N)[1]

Period ending Week	TREATMENT					
	0	F3	V3	V3S	E3	E3S
3	37.8	842.0	21.3	29.9	128.0	28.4
6	53.6	972.0	34.9	28.4	162.2	65.8
8	59.0	974.7	36.4	49.0	162.9	67.0
11	65.1	974.9	37.4	49.1	163.4	68.9

[1] Initial soil nitrogen was 5,600 mg N/pot.
1,050 mg N was added as fertilizers to all pots except control (0)

Table 6

Estimated nitrogen recovery by pangola grass from soil given various fertilizer dressings

Treatment	Harvest mg N/pot 1	2	3	4	Total N Recovered mg N/pot	% N Recovered
0	77.2	68.8	46.2	30.3	222.5	–
FI	93.9	203.0	77.2	53.1	427.2	164
F2	67.3	185.6	90.9	45.2	389.0	73
F3	67.1	218.0	167.7	98.8	551.6	53
VI	81.6	190.2	76.5	65.6	413.9	159
V2	83.7	225.5	113.2	84.1	506.5	96
V3	78.5	255.0	158.9	144.6	637.0	61
VIS	101.4	117.8	74.5	69.6	363.3	140
V2S	75.2	172.7	85.9	97.0	430.8	81
V3S	75.6	242.0	148.2	114.7	580.5	55
EI	98.0	203.4	85.2	49.9	436.5	168
E2	72.0	244.8	114.2	73.0	504.0	95
E3	65.6	270.0	235.1	165.7	736.4	70
EIS	78.1	136.9	53.0	48.7	316.7	122
E2S	75.2	258.0	88.6	53.4	475.2	90
E3S	50.9	225.0	179.3	81.2	536.4	51

DISCUSSION AND CONCLUSIONS

The results indicate that both Vitamon d and Enmag fertilizers were capable of producing greater fresh and dry weight yields of Pangola grass than the controls under the conditions of the trial. The effect was significant at the highest levels of fertilization after 20 weeks of growth. Enmag appeared to be somewhat more effective than Vitamon at the highest rate. More clear cut results would probably have been obtained had a slightly more fertile soil been used. There were signs of micro-nutrient deficiency symptoms in some treatments in later harvests, especially in the re-growth following harvesting. High soil temperatures – 89° to 90° were measured in several pots under normal weather conditions. At these temperatures, dissolution of the nutrients from the slow release fertilizers is expected to be considerably more rapid than at temperate soil temperatures (Lunt, 1962).

Results of yields, tissue nitrogen concentrations and leachate nitrogen indicate that at least some slow release of nitrogen was maintained by these fertilizers. Nitrogen recovery data, though approximate, do not indicate any striking correlation with the slow release fertilizer treatments. Figures are comparable to those of conventional fertilizers obtained by other workers in both greenhouse (Eves, 1971) and field experiments (Whitney and Green, 1969). Surface placement, particularly of Enmag, does not appear to be as satisfactory as incorporation with the soil.

These results agree with successful tests of other coated fertilizers tested under Trinidad conditions (Ahmad and Whiteman, 1969; Shand, 1973), and suggest that further testing of a variety of slow release fertilizer types in the field and greenhouse with a variety of crops could be well worthwhile.

SUMMARY

Vitamon d, 13-7-13-4, and Enmag, 5-24-10-16.6 were compared with a normal fertilizer mixture as nitrogen sources in a pot experiment

on a loamy sand soil in a randomized block design. A control and three levels of each fertilizer supplying the equivalent of 84,168 and 336 Kg N/ha were combined with mixed and surface placement treatments in four replications. Yields of Pangola grass *(Digitaria decumbens)* were obtained at five week intervals. Tissue analyses of the tops for N, P, K, Ca and Mg were carried out, along with the analysis of samples of leachate collected from a selection of pots.

Despite much variability and poor growth of the grass after the 15th week, at the highest rates tested, Enmag showed significantly greater yields (at the 5% level) at the 20th and 25th weeks, and Vitamon at the 25th. Tissue analysis confirmed a greater uptake of N from slow release sources at the 15th week. Rapid loss of N in the leachate from the normal fertilizer treatments was observed. Losses were considerably less from the slow release fertilizers.

Further evaluation is necessary to determine the economic importance of these fertilizers.

ACKNOWLEDGEMENTS

This study was carried out while the author was the recipient of an Internship from the Foreign Area Fellowship Program, an affiliate of the Ford Foundation and the work was assisted by a grant from Ruhr Stickstoff A. G., Bochum, W. Germany. The Central Analytical Laboratory and the Biometrics Department, The University of the West Indies are thanked for their help with the chemical and statistical analyses.

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