QUEENSLAND DEPARTMENT OF PRIMARY INDUSTRIES
DIVISION OF PLANT INDUSTRY BULLETIN No. 605

OBSERVATIONS ON NUTRIENT DEFICIENCIES IN KIKUYU GRASS (PENNISETUM CLANDESTINUM)

By N. G. Cassidy, M.Sc.

SUMMARY

Kikuyu grass is apparently very sensitive to lack of phosphorus, potassium, sulphur, iron, magnesium, copper or manganese. It is influenced much less by lack of boron, molybdenum, calcium or zinc.

I. INTRODUCTION

Two conditions in kikuyu grass (*Pennisetum clandestinum* Hochst.)—yellow tip, and green and white striping—have been observed in the field in Queensland.

Yellow tip refers to the occurrence of a clear, pale yellow colour of the youngest, unfurled leaf in the terminal shoot. Occasionally the youngest two leaves may be involved. The yellow leaflet tends to be flaccid and the tip may bend over about a third of the way from the top. Eventually the yellow colour gives way to a reddish brown necrosis and there is some inward curling of the affected part. The leaf can easily be pulled out of the shoot. A brown rot may be found at the base of the detached leaflet, but this appears to be a secondary condition. Yellow tip occurs mostly in summer, but its occurrence is not related to amount of rainfall.

Green and white striping, consisting of a pattern of stripes running parallel with the midrib, occurs on young growing shoots, beginning with the youngest leaf but extending to the top two or three leaves. Slightly older shoots a few inches away may not be visibily affected. White clover, paspalum and thistles in the affected area show no symptoms. In the field, the symptoms may disappear within 6 weeks. Plants become normal when transferred to a complete nutrient culture in the glasshouse. There was no evidence of a virus disease (G. M. Behncken private communication).

A series of pot experiments was carried out in efforts to identify the two conditions with particular nutrient deficiencies.

Series I was designed to reproduce the field symptoms of yellow tip and determine their cause. Series II was designed to extend the findings of Series I, particularly in relation to leaf-striping effects. Series III was concerned with the effects of calcium deficiency.

II. MATERIALS AND METHODS

(a) Series I

There were no replications within the series because of the limited facilities for aeration of pots, but three consecutive trials were carried out.

The basic planting material consisted of offshoots taken from kikuyu stolons when at about the 5-leaf stage. The offshoots were rooted in a complete nutrient solution until roots and shoots were approximately the same length. At this stage, transplanting into plastic pots 5 in. square lined with intact polythene bags was done. "Alkathene" polyethylene granules were used to support the plants.

Each pot was aerated by means of a glass tube drawn out to a point and thrust under the alkathene granules, the tube being connected at the other end to an air-pump controlled by a time clock. The time cycle consisted of 5 min (later 3 min) of aeration in every 30 min, day and night. Under this system, the plants with complete nutrient supply remained healthy and vigorous, though growth slowed whenever a trial entered the colder period of the year. Glasshouse temperatures were moderated by an evaporative cooling system and were in the range 10-38°C, but even in winter the maximum usually reached 30°C.

The nutrient solutions used were based on those of Arnon and Hoagland (1940). A subtractive technique was used, so, except for the control, each nutrient solution had one plant food element missing.

The nutrients N, P, K, S, Ca and Mg were provided in stock solutions which required 100 times dilution before use. B, Mn, Zn, Cu, Mo and Fe were provided in stock solutions which required 600 times dilution.

The stock solutions used (m-equiv./litre) were:—

KNO_3	600*	$Na_2B_4O_7 . 10H_2O$	60*
$NaNO_3$ (Ca, K absent)	600*	$MnCl_2 . 4\,H_2O$	60*
$Ca(NO_3)_2 . 4\,H_2O$	800*	$ZnCl_2$	30
$MgSO_4 . 7\,H_2O$	400*	$Cu(NO_3)_2 . 4\,H_2O$	12
$CaSO_4$ (Mg absent)	800*	Na molybdate (33% Mo)	6
$MgCl_2 . 6\,H_2O$ (S absent)	400*		
$NH_4H_2PO_4$	100*		

* Analytical grade reagents

Ferric citrate 0·5% was applied to the nutrient solutions after a similar amount of dilution, twice weekly.

Solutions were made up with distilled water; the third trial of the series was begun on a de-ionized water supply, but at the first renewal of nutrient solutions the plants appeared to be getting traces of some of the excluded elements and it was decided to revert to distilled water.

The third trial included some dual deficiencies such as Mg and S.

The plants were examined from time to time for visual symptoms of nutrient deficiency. Observations were also made in one trial on the number of shoots developed and on the formation of adventitious roots. Dry weights were also taken. In the last trial the plants were shaken free from the granules, washed, and their root systems observed and dried for determination of dry weight.

(b) Series II

This was a Zn x Cu x Fe x Mg x S factorial trial with two replications. The planting material and the soil used in the pots were taken from the field where green and white leaf striping had first been observed. Phosphorus and potassium levels in the soil were adequate; nitrogen as urea was given as a basal nutrient as required.

(c) Series III

This trial was a factorial arrangement of calcium (0 and 8 m-equiv./litre) x height of cut (short and long), with four replications. As the minus-calcium plots had to be kept separate in one block to guard against contamination, randomization was not perfect and statistical analyses of the minus-calcium and the plus-calcium blocks were made separately.

Potting was in "Alkathene" granules. During establishment the minus-calcium plants were subjected briefly to full nutrient, after which the roots and stems were washed and the plants returned to the appropriate nutrient solution.

Several cuts were made at the 2 in. and 6 in. levels and calcium and magnesium determinations made on the dry matter.

The tri-weekly additions of water needed to bring the substrates to a given level were recorded as evapotranspiration.

III. RESULTS AND DISCUSSION

(a) Series I

The condition of plants, leaves and roots in the absence of particular elements from the nutrient solutions is summarized in Tables 1 and 2.

TABLE 1

DEFICIENCY SYMPTOMS IN KIKUYU GRASS

Deficiency	Overall Appearance	Leaves	Roots
Phosphorus ..	Runt	Small, pointed, dark leaves	Fair
Potassium ..	Runt	Yellowing of top leaves; older ones green but necrotic at tips; small, oval, reddish spots.	Very poor
Sulphur ..	Runt .. .. (Stems and ligules pink)	Yellowing of tip of shoot, but from base of individual leaves upwards.	Very Fair
Magnesium ..	Runt	Yellow striping of leaves, longitudinally	Fair
(Mg and S) ..	Runt	Top leaves yellowish (striping)	Fair
Copper ..	Very poor ..	Light green	Poor
Manganese ..	Fair growth (red coloration on stem)	Tips of leaves tender; one month later tips were dead	..
Iron ..	Very poor growth	Yellow to whitish striping, interveinally ..	Fair–poor
Zinc ..	Good growth ..	Young leaves yellow to white at tips ..	Large Fibrous
Molybdenum ..	Good growth ..	Some yellowing at leaf tips	..
Calcium ..	Fair growth ..	Characteristic yellowing, and then collapse (from mid-lamina) of youngest leaf	Good
Boron ..	Very good growth	Normal	Good

Table 1 is not to be regarded as a key for the diagnosis of nutrient deficiencies in kikuyu grass. Visual symptoms in this plant are not sufficient in themselves for diagnostic purposes, particularly as conditions such as yellowing may accompany deficiency of various elements. The reaction accompanying lack of calcium is clearer than that noted with lack of other elements, but even here a diagnosis without the support of chemical data would be inconclusive.

It was observed that the primary clear yellow stage which persists for several weeks in the field was of short duration in the glasshouse trial.

It will be noted from Table 1 that the condition of the roots (that is, their abundance and general health) does not always agree with the assessment of aboveground parts.

It was observed that the production of a large number of secondary shoots was a prerequisite for good growth. The number of primary shoots (that is, those arising from ground level) was of little importance. (No cutting regimen was imposed in this trial.)

The formation of adventitious roots was, in general, associated with good growth. In fact, the treatments fell naturally into two groups: those that were associated with the production of adventitious roots and those in which there was an absence of adventitious roots. The segregation of the groups is shown in Figure 1.

There is a non-significant difference between the X coefficients of the regression equation relating dry weight to number of secondary shoots, and a highly significant difference between the intercepts on the dry weight (Y) axis.

Table 2 shows the relationships between treatment, production of adventitious roots and production of primary and secondary shoots.

TABLE 2

Production of Primary and Secondary Shoots in Relation to Presence of Adventitious Roots

Nutrient	Primary Shoots (no.)	Secondary Shoots (no.)	Dry Weight (cg)
	Adventitious Roots Present		
Complete	18	18	255
−Ca	9	15	238
−Zn	5	19	210
−Mo	10	26	270
−B	5	29	314
	Adventitious Roots Absent		
−(Mg+S)	2	1	11
−S	6	2	10
−P	2	3	2
−K	4	3	30
−Mg	12	4	56
−Cu	8	7	40
−Mn	11	12	86

It appears from Table 2 that kikuyu grass is very sensitive to lack of P, K, S, Mg, Cu or Mn. It is influenced much less by lack of B, Mo, Ca or Zn.

It appears also that the initiation of root buds is a sign of a high potential for growth, and that the formation of many secondary shoots is an important factor in the realization of strong growth.

The lack of particular elements apparently exercises a control over these processes.

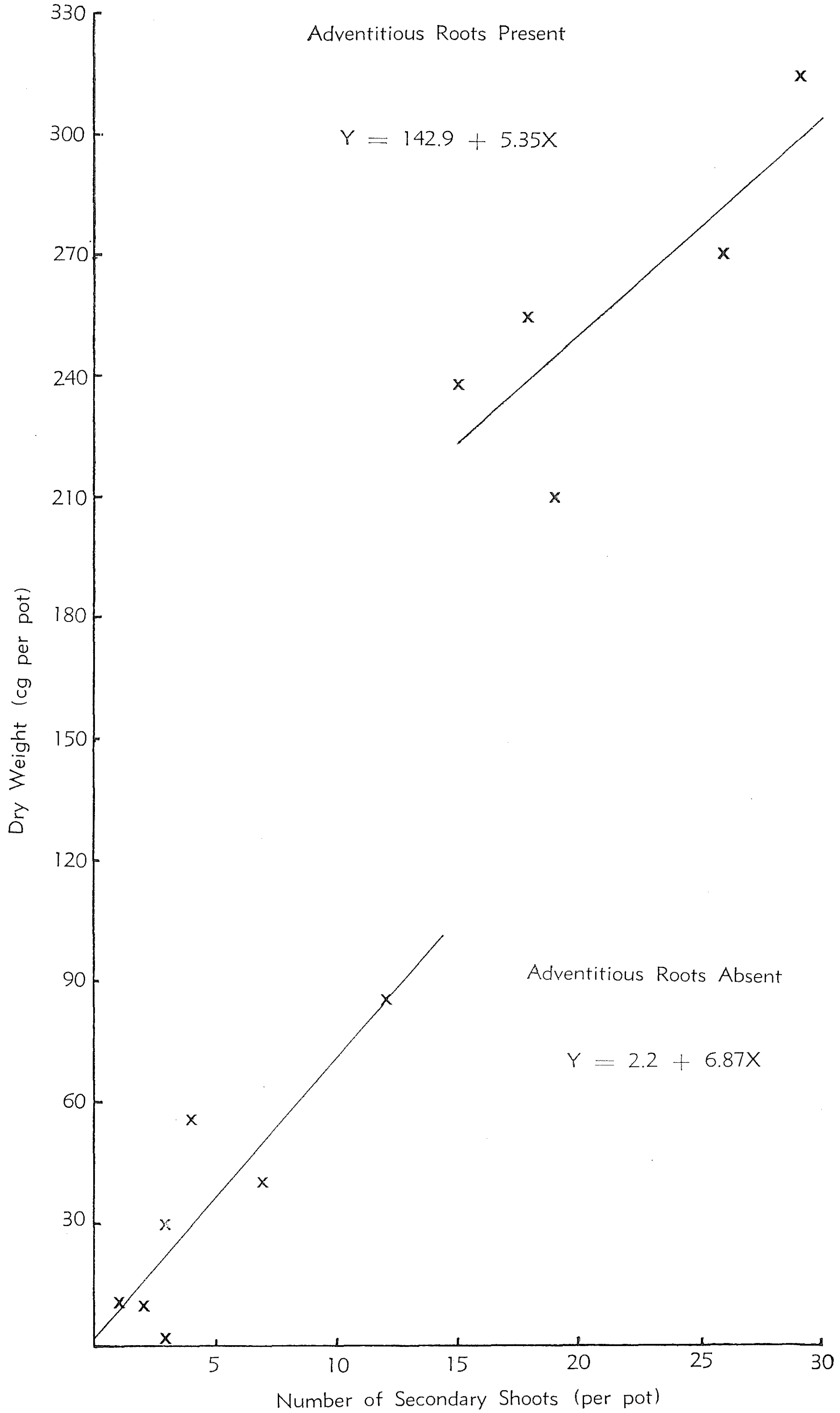

Fig. 1.—Relation between presence of adventitious roots and dry-matter production of kikuyu grass.

(b) Series II

The plants grown in pots failed to develop the field symptoms of leaf striping shown by the source material.

A significant yield response to magnesium and sulphur in combination, but not alone, was obtained (Table 3). Zinc and copper alone had no influence on yield and together appeared to depress yield.

TABLE 3

YIELD RESPONSE TO SULPHUR AND MAGNESIUM ALONE AND IN COMBINATION. MEAN DRY MATTER, g per pot

		Magnesium		Significance
		Absent	Present	
Sulphur	Absent	2·535	2·582	1% 0·412
	Present	2·613	3·046	5% 0·307

The field leaf striping described earlier is similar to the symptoms of magnesium deficiency in various gramineous plants, and it is suggested that a dual deficiency of magnesium and sulphur existed at the affected site. Sulphur deficiency has been shown to occur from time to time on the krasnozem soils concerned.

(c) Series III

Table 4 shows that the application or the withholding of calcium had no significant effect on the dry-matter yield of either short-cut or long-cut grass.

There was a highly significant difference in evapotranspiration between cutting short and cutting long under both calcium treatments. A long pasture might be expected to use about twice as much water as one that is maintained in short condition.

TABLE 4

RELATION BETWEEN CALCIUM APPLICATION AND CUTTING TREATMENT

Parameter	Treatment			
	Calcium Witheld		Calcium Applied	
	Cut Short	Cut Long	Cut Short	Cut Long
Mean dry matter (cg/pot)	1,160	1,341	2,310	2,000
Evapotranspiration (ml/pot for 21 days)	2,105	4,601**	2,776	5,584**
Calcium in plant tissue (% dry weight) . .	0·10	0·08	0·24	0·25
Magnesium in plant tissue (% dry weight)	0·44	0·31*	0·27	0·26

Analysis for calcium in the material collected from the third to the sixth cuts showed no significant difference between short-cut and long-cut grass whether calcium was applied or withheld. Magnesium in the same material was significantly higher in short-cut material only when calcium had been withheld, suggesting that in the absence of calcium there may be an attempt by the plant to substitute magnesium for calcium.

The analytical data could also be interpreted to show the likelihood that 0·25% calcium and 0·25% magnesium in kikuyu grass tops would represent a sufficiency of these elements, whereas 0·1% calcium could be regarded as a deficiency of that element.

The krasnozem soils on which incipient calcium deficiency has apparently developed usually contain 5 m-equiv. exchangeable calcium per 100 g of soil. This would indicate a high calcium requirement for kikuyu grass even though the limited data appear to show only a small depression of yield.

REFERENCES

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(Received for publication May 26, 1971)

The author (now retired) was an officer of Agricultural Chemical Laboratory Branch, Queensland Department of Primary Industries.