THE EFFECT OF SEED RATE AND NITROGEN FERTILIZER ON THE YIELD OF SEED AND BY-PRODUCT LEAF OF WHITTET KIKUYU GRASS AT GRAFTON, NEW SOUTH WALES

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ABSTRACT

The yield of seed and by-product leaf of Whittet kikuyu was studied over two years at five sowing rates and four levels of nitrogen application. Rainfall distribution was favourable in the first but not the second year of the study.

In the first year, yields of seed and by-product leaf increased with sowing rate but in the second year the yields decreased.

Increasing the rate of nitrogen (from nil to 224 kg ha^{-1}) reduced seed yield but increased the yield of by-product leaf in both harvest years.

INTRODUCTION

The management of kikuyu grass (*Pennisetum clandestinum*) for seed production is different to that adopted for other grasses. Kikuyu grass swards are first mown short until flowering commences. Then the frequency of mowing is gradually increased and the cutting height is progressively raised to stimulate continued flowering. Seed at varying stages of development is accumulated in the sward during a protracted period and is later harvested by mowing as close to ground level as is practicable (Wilson 1970).

The kikuyu cultivar Whittet characteristically forms a very open sward (Barnard 1972). In pilot studies, a sward of cv. Whittet sown in rows 0.9 m apart and fertilized with 177 kg ha^{-1} N, 159 kg ha^{-1} P, 106 kg ha^{-1} K, 106 kg ha^{-1} S + Cu, Zn and Mo, produced 445 kg ha^{-1} of seed. Most of this was collected close to the sown rows where the seed-bearing culms were densest.

Increased seeding rates or nitrogen fertilizer or both would be expected to increase sward density and possibly seed yield. However, they would probably also increase the amount of by-product leaf (leaf) that should preferably be removed from the sward at each mowing. This would be a disadvantage unless the quantities produced were large enough to justify collecting them for animal feed.

This study sought to determine whether increased seeding rate or nitrogen fertilizer or both improved the yields of seed or by-product leaf.

MATERIALS AND METHODS

The experiment was conducted at the Department of Agriculture Research Station, Grafton, N.E. New South Wales (29° 38'S, 152° 57'E, altitude 18 m). The soil is a Krasnozemic red earth developed on a weathered Cenozoic terrace (Riddler personal communication), pH 5.2, classification UF 6.71 (Northcote 1971). *Glycine wightii* cv Clarence was grown for seed production on the site for five years until preparation of the seed bed was started in November, 1968.

Factorial combinations of the following rates of sowing and levels of fertilizer were compared in six randomised blocks in plots 1.22 x 7.62 m.

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Seeding Rate ($kg\ ha^{-1}$)	*Level of Nitrogen* ($kg\ ha^{-1}$)
5.6	No nitrogen fertilizer
11.2	56
22.4	112
44.8	224
89.6	

Seed and fertilizer

Seed and fertilizer were applied evenly by hand with the aid of a wire grid divided into 100 equally sized cells. The seed contained 365 pure live seeds g^{-1} and was sown on all plots at 89.6 $kg\ ha^{-1}$. The required sowing rates were achieved by mixing the required amount of dead seed with the viable seed. Seed was killed by heating it in a drying oven at 85°C for two days. Sowing took place on January 8, 1969 on a dry but well cultivated seed bed.

A basal dressing of nutrients of 9 $kg\ ha^{-1}$ N, 43 $kg\ ha^{-1}$ each of P, K, and S, 4.5 $kg\ ha^{-1}$ each of Cu and Zn and 0.15 $kg\ ha^{-1}$ Mo was applied before sowing and in February, 1970. Ammonium nitrate was applied annually as split dressings in April and July, 1969 and in February and June, 1970.

The plots were sprayed with 0.1% 2, 4–D sodium salt on April 29, 1969 to kill broad-leaf weeds.

Measurements

Establishment was determined from counts made three weeks after the first seedlings began to appear. A wire frame measuring 0.46 m x 6.4 m containing 9 strata, each having fourteen 15.2 cm^2 divisions was placed over the centre of each plot. Plants were counted in one 15.2 cm^2 division selected at random from each stratum.

TABLE 1

Date and cutting height of twenty-three leaf harvests of Whittet kikuyu

1969		1970	
Harvesting Date	Cutting Height (mm)	Harvesting Date	Cutting Height (mm)
May 5 ←	25	Jan 23	30
May 26	27	Feb 20	30
Jun 12	27	Mar 23 ←	30
Jul 14	27	Apr 13	30
Aug 11	27	Jun 3	45
Sep 1	27	Sep 25 ←	45
Sep 10	27	Oct 9	45
Oct 7	30	Oct 29	47
Oct 17	35	Nov 16	47
Oct 30	37	Dec 21	47
Nov 14	47		
Nov 20	65		
Nov 28	75		

← Nitrogen applied during this period.

By-product leaf was harvested by cutting a strip 0.46 m wide and 6.4 m long at the heights and on the dates shown in Table 1. Mowing height on each occasion was based on a visual assessment of the lowest height at which the tallest growth could safely be cut without severing potential seed bearing material. The leaf samples were oven dried at 80°C for 16 hours and dry matter yields recorded. A composite sample taken from all treatments on October 17, 1969 was pelletted (without additives) in a commercial plant and pellets were analysed for crude protein, crude fibre, crude fat, phosphorus and moisture.

Seed was harvested on November 28, 1969 and December 21, 1970 by cutting a strip 0.46 m wide and 6.4 m long to ground level, with a 0.46 m wide rotary lawn mower and catcher. The sample was air dried, threshed three times through a hammer mill (4.8 mm mesh screen) at 1255 R.P.M. and cleaned through conventional sieving, winnowing and gravity separation equipment.

RESULTS AND DISCUSSION

Temperature and rainfall during the experimental period are given in Figure 1.

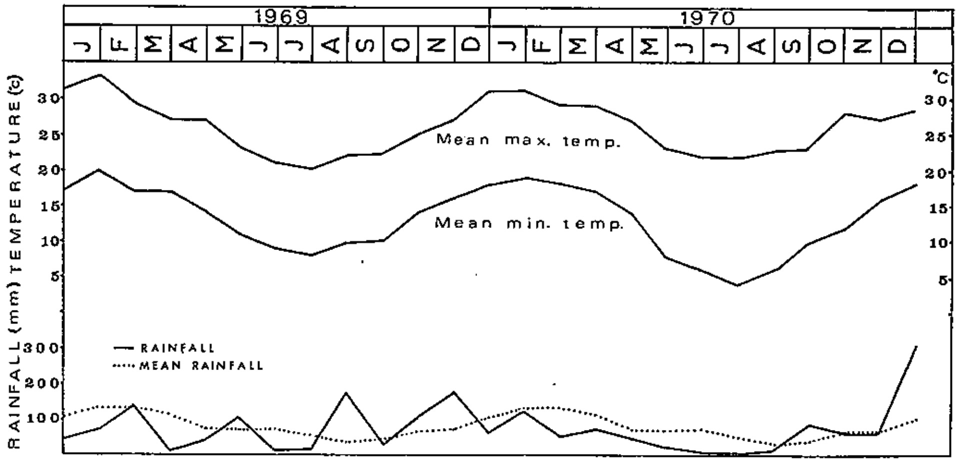

FIGURE 1

Mean maximum and minimum temperatures, rainfall and mean rainfall at Grafton Research Station during 1969 and 1970.

Establishment

Because the range in the number of plants m^{-2} was large, all data was transformed to Log_{10} before analysis. The number of plants established increased as sowing rate increased but percentage establishment decreased significantly ($P < 0.001$) as sowing rate was increased (Table 2). The low establishment percentages which occurred are attributed to lack of moisture during the month after sowing. Because of this, an optimum sowing rate could not be selected from the experimental results. However, from an examination of the results in both years it is suggested that an initial plant population of approximately 190 plants m^{-2} is near the optimum for seed production purposes at Grafton.

Seed production

Seed yields increased with increased sowing rate in the first year and decreased in the second year (Table 3). High seeding rates were observed to produce erect culms whose growing points were removed with a high degree of uniformity at each

TABLE 2

Mean density and % establishment of Whittet kikuyu for five sowing rates

Sowing rate kg ha^{-1}	$\log_{10}$ (Plants m^{-2}) 3 weeks after emergence	Percentage Establishment
5.6	1.721 (52.6)+	26.7
11.2	1.967 (92.7)	23.9
22.4	2.276 (188.8)	23.6
44.8	2.541 (347.5)	21.8
89.6	2.779 (601.2)	19.1
S.E. of mean 110 dF	±0.024	±1.2

+Retransformed means.

mowing. This stimulated the development of many flowering branches. Low seeding rates produced many decumbent and procumbent culms which could not be uniformly defoliated and so remained sparsely branched (Figure 2). The low seed yield in the second year, particularly of the two highest seed rate treatments, is attributable to moisture stress before and during flowering, causing reduced seed setting.

TABLE 3

Effect of sowing rate and nitrogen fertilizer on mean yield of seed of Whittet kikuyu for five sowing rates and four levels of nitrogen during two years

Treatment		Yield of Seed (kg ha^{-1})		Yield of Leaf (kg ha^{-1})	
		1969	1970	1969	1970
Sowing rate (kg ha^{-1})	5.6	507	105	4956	5222
	11.2	580	104	5217	5020
	22.4	639	103	5349	4706
	44.8	673	88	5599	4365
	89.6	702	86	5872	4095
LSD ($P = 0.05$)		37	10	287	220
Nitrogen rate (kg ha^{-1})	0	652	114	4830	3621
	56	639	110	5323	4621
	112	614	100	5448	4927
	224	576	65	5994	5795
LSD ($P = 0.05$)		34	9	260	200

Seed yield declined with increasing nitrogen rates in both harvest years (Table 3). Nitrogen fertilizer has increased the seed yields of some tropical grass species (Cameron and Mullaly 1969, Grof 1969, Chadhokar and Humphreys 1970, Hacker and Jones 1971). However, tropical grasses are normally harvested toward the middle or end of the growing season. Growth is not mechanically controlled to the same extent as with kikuyu which is partially defoliated at frequent intervals before and during the flowering period. Kikuyu is capable of producing high yields of seed at the beginning of the growing season.

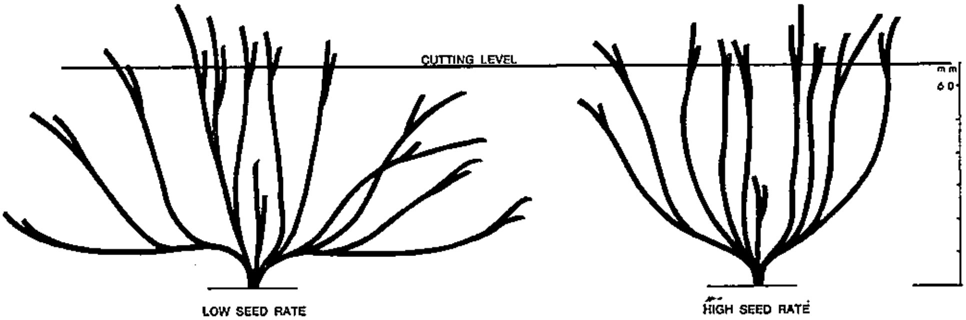

FIGURE 2

Schematic diagram prepared from photographs of culms taken from the low (5.6 kg ha^{-1}) and high (89.6 kg ha^{-1}) seed rate treatments before mowing on Nov. 28, 1969. Culms in the high seed rate treatment are more erect and more uniformly defoliated than culms in the low seed rate treatment.

This study does not explain the negative seed yield response to the higher rates of nitrogen application. However, nitrogen treatments appeared to produce fewer flowers. In a greenhouse study, Carr and Eng (1956) induced kikuyu to flower by repeated defoliation and later observed "as growth was resumed by the production of unbranched stolons from the crown, flowering became more and more sparse". They suggested that auxins flowing from leader shoots may be responsible for the suppression of flower primordia. Autumn-winter applications of nitrogen may stimulate the development of new crown growth during August-September which may explain the reduced flowering. There is an obvious need for investigation of the effects of time of application of nitrogen fertilizer on the growth and yield of seed of kikuyu grass.

Leaf production

In the establishment year, total dry matter yield of leaf increased with increased sowing rate. The differences were highly significant for the first seven harvests but as growth proceeded and sward density increased, the differences became less pronounced. Yield was significantly reduced with increased sowing rate at the final 1969 harvest and the majority of 1970 harvests (Table 3).

Yield of leaf increased significantly ($P < 0.001$) with increasing nitrogen rate in both harvest years. This also applied to the individual harvests ($P < 0.01$) excepting those of May 5, 26 and Sept 10, 1969 which did not respond. There was no significant interaction between nitrogen rate and sowing rate.

Pellets produced from dehydrated leaf were analysed and found to contain 24% crude protein, 17.64% crude fibre, 7.17% crude fat, 0.34% phosphorus and 9.8% moisture. The analysis indicates the apparent high animal feed value of the material. However, leaf yields from individual harvests were generally low, ranging from 138 kg ha^{-1} to 1452 kg ha^{-1} in 1969 and from 36 kg ha^{-1} to 1757 kg ha^{-1} in 1970. It is doubtful if the yields from the majority of mowings are high enough to justify collection either for processing into pellets or for use as green chop. Autumn-winter applications of nitrogen increased the yield of leaf and reduced seed yields and so could not be recommended.

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