THE SEEDING AND SUPERPHOSPHATE RATES FOR THE ESTABLISHMENT OF *DESMODIUM UNCINATUM* (JACQ.) DC. BY OVERSOWING IN UNCULTIVATED GRASSLANDS OF WESTERN KENYA

N. C. O. KEYA and D. W. KALANGI*

ABSTRACT

Desmodium uncinatum *was oversown in the* Hyparrhenia *grasslands of Western Kenya at* 4 *seeding rates* (0, 5, 10 *and* 15 *kg/ha) and topdressed with* 4 *levels of single superphosphate* (0, 250, 500 *and* 750 *kg/ha*).

When topdressed with superphosphate the legume established and significantly increased the dry matter and nitrogen yields of grassland. The optimum superphosphate rate was 500 *kg/ha. There was no apparent advantage to use more than* 5 *kg/ha seed. Without superphosphate, the legume failed to establish, regardless of the seeding rates used. Superphosphate alone had no significant effect on the productivity of grassland by the end of* 2 *years.*

INTRODUCTION

Preliminary results indicate that *Desmodium uncinatum* and *D. intortum* can be used for improving uncultivated grasslands of Western Kenya by oversowing (Keya, Olsen and Holliday, 1971a). Superphosphate is essential for successful establishment of such oversown legumes (Keya, Olsen and Holliday, 1971b). The desmodiums can also be established in the uncultivated grasslands by planting root splits (Keya, Olsen and Holliday, 1972a). Of the two desmodiums, *D. uncinatum* is commercially produced in Western Kenya and is available to farmers. It has been observed that oversown *D. uncinatum* can establish irrespective of grassland pre-treatment but as a result of economic considerations Keya, Olsen and Holliday (1972b) recommended that where grassland was not too tall and/or dense, the grassland should remain untreated before oversowing. Where possible the grassland may either be grazed or burned prior to oversowing.

The survival rate of surface sown seed is usually low (Keya, Olsen and Holliday, 1971a) and generally, the heavier the sowing rates, the better the strike and the more rapid the sward improvement (Suckling, 1965).

A trial was initiated to determine the seeding and superphosphate rates for the successful establishment of *D. uncinatum* oversown in uncultivated grasslands of Western Kenya.

MATERIALS AND METHODS

Botanical composition at experiment site

Originally, the experiment site was under a woodland dominated by *Combretum gueinzii.* In 1956, the trees and bush were cleared and stumped with only a few trees left for shade (Bogdan and Kidner, 1967). From 1962 to the initiation of the trial, the site was closely grazed at frequent intervals and as a result the top soil was fairly compact. The botanical cover at the site of the experiment prior to oversowing was analysed using the inclined Point Quadrat Method as described by Tinney, Aamodt and Ahlgren (1937). The grass cover was dominated by *Hyparrhenia* spp. Other grasses included *Loudetia kagerensis, Digitaria* spp., *Eragrostis* spp., *Setaria trinervia, Themeda triandra, Brachiaria* spp. and *Sporobolus pyramidalis.* Herbs, mainly *Commelina bengalensis,* formed the undergrowth.

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* National Agricultural Research Station, Kitale, Kenya.

TABLE 1

Rainfall (mm) at Kitale during the period of the trial and monthly means over a ten year period.

Year	J	F	M	A	M	J	J	A	S	O	N	D	Total
1970	106	9	226	199	136	63	177	214	86	83	32	14	1345
1971	9	—	21	148	119	204	181	167	75	171	60	57	1212
1958 to 1967	24	48	84	149	152	113	150	180	108	127	98	51	1284

TABLE 3

Percentage botanical ground cover of Desmodium uncinatum *oversown at several seeding rates in uncultivated grassland topdressed with various rates of superphosphate.*

Months from oversowing	Seeding and superphosphate rates (kg/ha)								
	Seed				Superphosphate				
	5	10	15	$S\overline{X}$	0	250	500	750	$S\overline{X}$
4	8B*	10B	19A	±0.08	6C	20A	11AB	13B	±0.11
8	20c	27b	35a	±0.02	6b	30a	30a	34a	±0.03
16	30b	36ab	39a	±0.03	9b	25a	25a	27a	±0.04
23	35B	54A	48A	±0.06	3b	37a	40a	44a	±0.08

* Means followed by the same superscript letter in the same column across the table do not differ significantly according to Duncan's multiple range test; capital and small letters denote probability levels of 5 and 1%, respectively.

$S\overline{X}$ = Standard error of the mean.

Experimental procedures

A 4 × 4 factorial experiment in a randomized complete block design replicated 4 times was used. The plot size was 3 × 5 m^2. The treatments consisted of combinations of 4 seeding rates (0, 5, 10 and 15 kg/ha) of pure germinating seed (p.g.s.) and 4 single superphosphate rates (0, 250, 500 and 750 kg/ha) at the start of the trial. Single superphosphate (21% P_2O_5, 10% S) was re-applied in April 1971 at the start of the long rains. The experiment was established on March 24, 1970. Planting procedure was as described by Keya, Olsen and Holliday (1971a).

Legume establishment

Seedling counts were taken one week after oversowing using the Frame Quadrat Method as described by Keya, Olsen and Holliday (1971a). Only seedlings that had at least two open leaflets were counted. The seedling counts were terminated 12 weeks after oversowing. For 1970, the long rains started rather early and it was generally wet from March to October. An average of 5 mm per day fell for a week following planting. However, there was a severe drought at the start of 1971. (See Table 1).

Apart from seedling counts, legume establishment was assessed by analysing the botanical changes based on legume cover at specified intervals. The first and last botanical analyses were carried out 4 and 23 months after oversowing. Legume establishment was finally assessed by estimating the dry matter (DM) and nitrogen (N) yields of the oversown grassland. Four harvests were taken and in the final cut, the phosphate (P) content in the plant tops was determined. The crude protein (CP) content of the DM was also calculated. The sampling procedure, DM estimation and CP calculation have been described by Keya, Olsen and Holliday (1971a).

RESULTS

Seedling survival

The legume seedling numbers are presented in Table 2. In general, higher seedling rates resulted in significantly more seedlings. The highest number of seedlings was recorded 6 weeks after oversowing and thereafter there was a general decline. There was no significant interaction between superphosphate and seeding rate. The seedling survival 12 weeks after oversowing was 18.5% of the viable seed oversown.

TABLE 2

Seedling numbers of Desmodium uncinatum *oversown in natural grassland at various seeding rates.*

Seeding rates (kg/ha p.g.s.)	Seedlings/m^2				
	Weeks from planting				
	1	4	6	8	12
5	10C*	23B	26C	22C	20B
10	20B	34B	44D	32B	33B
15	36A	72A	73A	60A	60A
Mean	22	43	48	38	38
S.E. of the mean ±	2.2	3.3	2.8	2.2	6.3

* Means followed by the same superscript letter down the column do not differ significantly at 5% according to Duncan's multiple range test.

Botanical cover

The changes in the botanical cover of the oversown legume during the period of the trial are presented in Table 3. Higher seeding rates in the treatments receiving superphosphate generally resulted in significantly greater legume cover which increased with time. However, 10 months after oversowing, there was a big drop in the legume cover possibly because of the severe drought at the time. However, at the conclusion of the trial, *D. uncinatum* constituted 35 to 54% of the total botanical species cover in the superphosphate plots, and only 3% in the plots not receiving phosphate. Although superphosphate significantly increased the cover of *D. uncinatum*, there was no significant advantage in applying more than 250 kg/ha of superphosphate. The interaction between superphosphate and seeding rates did not reach a significant level.

Dry matter production

The dry matter yields of individual cuts as well as the total DM for the 4 harvests are presented in Table 4. At the first sampling (8 months after oversowing) there were no significant differences in yield between treatments. A severe drought after the first cut delayed sampling for 6 months. By this time the oversown legume at the highest seeding rate increased the DM significantly over the control. However, there were no significant differences among the 5, 10 and 15 kg/ha seeding rates. Superphosphate significantly increased the DM yields in the legume plots in the second and third harvests but there were no significant differences among the 250, 500 and 750 kg/ha superphosphate rates. However, superphosphate at 500 kg/ha tended to result in optimum yields. In the initial harvest application of over 500 kg/ha superphosphate led to a decline in total DM yield.

There was a significant interaction between superphosphate and seeding rates in the third cut. In the plots receiving 250 and 500 kg/ha superphosphate, the highest DM yields were obtained in the plots sown with legume seed at a seeding rate of 5 kg/ha. However, in the plots receiving 750 kg/ha superphosphate, the highest DM yields were obtained when the legume was sown at a seeding rate of 10 kg/ha.

N yields and P uptake

The total N yields for the 4 harvests are presented in Table 5. There was a significant interaction between seeding and superphosphate rates. There was no significant increase in N yields in grassland alone when fertilized with 250 to 750 kg/ha superphosphate. The oversown legume plots topdressed with superphosphate increased the N yields of uncultivated grassland significantly. However, applying more than 250 kg/ha did not lead to significant increases in N yields. There was a tendency for N yields to increase with sowing rates but differences were not at a significant level. Oversown legume topdressed with superphosphate at 0, 250, 500 and 750 kg/ha resulted in CP contents of 6.8, 10.0, 10.1 and 10.2%, respectively, in the total DM at the conclusion of the trial. The CP content (DM basis) of the legume component receiving 250, 500 and 750 kg/ha superphosphate was 22.3, 23.6 and 23.5%, respectively, in the last cut. The legume in the superphosphate plots contained 0.19% P on a DM basis. The P content of total herbage was increased significantly from 0.16 to 0.19% (on DM basis) when superphosphate was applied to oversown grassland.

DISCUSSION

The results of this trial confirmed earlier findings of Keya, Olsen and Holliday (1971b) that superphosphate is essential for successful establishment of *D. uncinatum* by oversowing on uncultivated grassland. The results also indicated that it might not be necessary to use more than 500 kg/ha superphosphate. Since there were no significant differences among 250, 500 and 750 kg/ha superphosphate rates, 250 kg/ha superphosphate could be used for economic reasons. In view of the high cost of *D. uncinatum* seed, an important finding was that there was no apparent

TABLE 4

The dry matter production of an uncultivated grassland topdressed with different levels of superphosphate and oversown with Desmodium uncinatum *at varying seeding rates.*

(Tonnes/ha)

Date of harvesting	Seeding rate (kg/ha)				Superphosphate rate (kg/ha)				
	0	5	10	15	0	250	500	750	$S\bar{X}$
4/12/70	1.94	1.88	1.76	2.10	1.96	1.71	2.34	1.78	±0.18
2/6/71	1.97b*	2.17ab	2.22ab	2.40a	1.91b	2.33a	2.32a	2.19ab	±0.09
15/9/71	2.51B	2.90A	2.93A	2.92A	2.29b	2.89a	2.88a	3.20a	±0.11
4/1/72	0.63	0.74	0.76	0.92	0.47c	0.81b	0.95a	0.82b	±0.02
Total dry matter (4 cuts)	7.05b	7.69ab	7.67ab	8.34a	6.53b	7.74a	8.49a	7.99a	±0.22

* Means followed by the same superscript letter for seeds or superphosphate rates for any harvest do not differ significantly according to Duncan's multiple range test. Capital and small letters denote probability levels of 5 and 1%, respectively.

TABLE 5

The total nitrogen production of an uncultivated grassland topdressed with different levels of superphosphate and oversown with Desmodium uncinatum *at varying seeding rates.*

(kg/ha)

Superphosphate rates (kg/ha)	Seeding rates (kg/ha)				
	0	5	10	15	Mean
0	90b*	76b	74b	82b	81b
250	87b	144ab	151a	161a	136a
500	99b	149ab	154a	165a	142a
750	105b	155a	168a	189a	153a
Mean	95b	131a	137a	148a	

S.E. of the mean for treatments = ±5.3.

* Means bearing the same superscript letter do not differ significantly at 1% according to Duncan's multiple range test.

advantage in using a seeding rate in excess of 5 kg/ha p.g.s. Further tests with a wide range of environmental conditions are required before firm conclusions are drawn. McWilliams and Dowling (1970) have illustrated the importance, for radicle penetration, of anything that places restraint on the upward movement of surface sown seed during germination. It is possible that establishment of *D. uncinatum* by sod-seeding may lead to a further reduction in seeding rates and lead to a better total germination and early seedling survival. However, oversowing cannot be dismissed in favour of sod-seeding because the former is faster and cheaper and particularly when on country that is too steep for machinery (Janson and White, 1971a). In this trial superphosphate did not increase the DM and N yields of grassland alone significantly and this is in contrast with earlier findings of Keya (in press).

The total DM and N yields of *Hyparrhenia* grassland oversown with *D. uncinatum* were lower than reported earlier (Keya, Olsen and Holliday, 1971a, 1971b, 1972b) most probably due to the severe drought between December 1970 and March 1971. Frequent grazing for a period of 10 years prior to the initiation of the trial resulted in a fairly compacted soil which could have also impaired root penetration of the oversown legume. The low productivity could also have been due to a potash deficiency. It has been generally observed that tropical legumes including *D. uncinatum* decline in yield under a close and frequent defoliation (Whiteman, 1969; Whitney and Green, 1969). The harvesting intervals in this study might have favoured DM production but the CP content of the total DM never exceeded 10.2% possibly because the herbage was mature and rank when cuts were taken.

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