ESTABLISHMENT OF KIKUYU GRASS ON THE CLAY SOILS OF THE DARLING DOWNS, SOUTH-EASTERN QUEENSLAND

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SUMMARY

Trials were conducted to determine the relative influence of size of sprig, depth of planting and time of planting on the establishment of kikuyu grass. The trials extended from August to February and were conducted on a dark grey clay soil of the Irving-Purrawunda Soil Association.

The best establishment followed late winter planting. Establishment increased with size of sprig (from 3 nodes to 9 nodes) but decreased with increase in depth of planting from 2 in. to 6 in. The rate of surface colonization followed the pattern of establishment.

I. INTRODUCTION

One of the primary problems in the application of soil conservation measures is the provision of erosion-resistant vegetation. This is particularly the case in areas where concentrated flows of water occur.

On the Darling Downs, in south-eastern Queensland, the provision of water disposal channels or waterways is the first step in the establishment of the agricultural drainage pattern. These waterways are generally constructed on sites where run-off water accumulates naturally and are designed to carry water at velocities which exceed the maximum non-scouring velocities of bare soils. It is therefore necessary that these waterways be protected by an erosion-resistant cover of vegetation.

Since no further soil conservation earthworks can be constructed until the channel is stabilized, it is important that this be effected as rapidly as possible.

Experience has shown that for most areas of the Darling Downs kikuyu grass (*Pennisetum clandestinum* Hochst.) provides the most effective cover for these waterways.

Because there is no commercial supply of seed, the grass is established from vegetative material, either sprigs or turves. The labour involved in collecting, transporting and then hand-planting sprigs or turves is considerable. To mechanize planting, a kikuyu sprig planter has been developed by officers of the Department of Agriculture and Stock. The machine is a modification of the American Bermuda sprig planter. It plants two rows 45 in. apart, and approximately 4–5 ac can be planted in a normal working day.

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The sprig planting method is now extensively used for establishing waterway vegetation on the Darling Downs, but information has been lacking on the optimum size of sprig to plant, the depth to which sprigs should be planted, and the best time of the year to plant having regard to growth rate and soil conservation needs.

The sprig planter buries the whole of the sprig. This contrasts with the normal hand-planting method where approximately two-thirds of the sprig is buried and one-third is left protruding from the surface. However, it has been shown that complete establishment is possible on the Darling Downs where the whole sprig is buried to a depth of 2-3 in. provided moisture and temperature conditions are satisfactory.

The months of February and March would appear to offer the best conditions for the planting of vegetative material. Establishment is rapid provided follow-up rain occurs within a fortnight after planting. However, the high temperatures cause rapid drying of the disturbed soil with consequent desiccation and death of the sprig if this follow-up rain does not come. This occurs even with compaction of the soil immediately after planting. Consideration was given to the fact that the much lower evaporation losses in late winter might enable more reliable establishment provided the low temperatures did not inhibit establishment. At this time of the year establishment could proceed during a period when erosion-producing rains were infrequent and the risk of loss of planting material reduced. Further, surface cover from late-winter plantings should be sufficiently well developed to provide soil protection against the high-intensity rains of midsummer. This situation has much to recommend it from a soil conservation viewpoint.

II. EXPERIMENTAL

Trials based on size of planting material, depth of planting and time of planting were carried out.

(1) *Planting Material*.—Rhizomes were selected visually for uniformity and then cut to three sizes based on number of nodes rather than length, although material of both extremes of short and long internode length was discarded. Three-, 6- and 9-node material was used (Figure 1). Fifty sprigs were hand-planted in each plot approximately 1 ft apart.

(2) *Method and Depth of Planting*.—Sprigs of each length were planted by hand to depths of 2, 4 and 6 in. The 2 in. planting was in a furrow (Figure 2) opened to 2 in. by hand-mattocking. The 4 in. and 6 in. depths were obtaining by opening holes to the required depth using a 4 in. soil auger (Figure 3). Care was taken to cover the sprigs by returning the soil to the holes as close as practicable to its original location—i.e. the dry surface mulch (if present) was replaced on the surface after the moister lower soil levels were returned to their original positions. The soil was then compacted over the sprig by tramping.

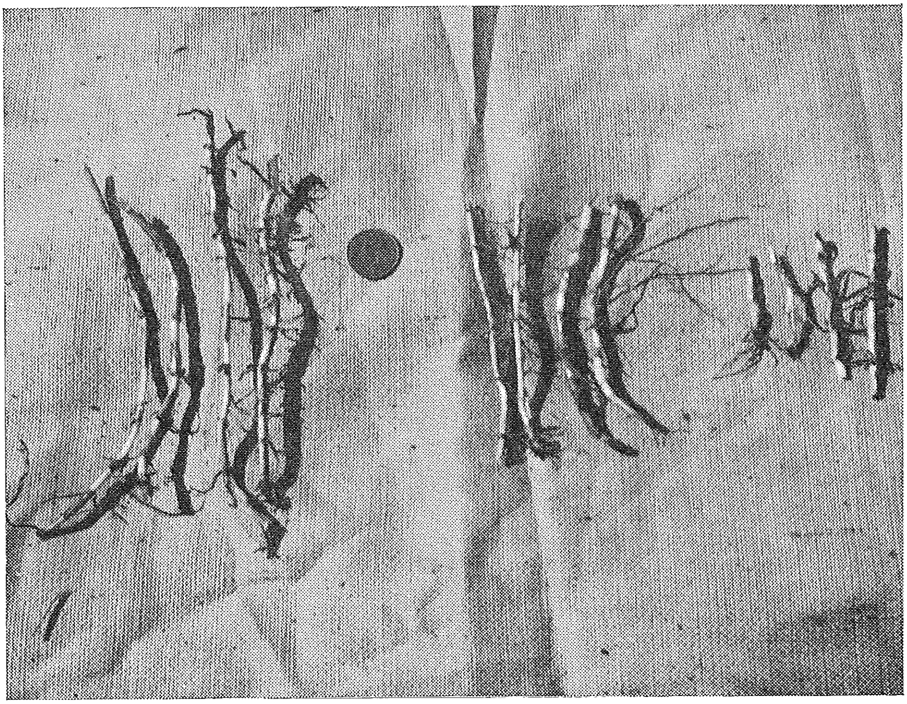

Fig. 1.—Typical planting material used in the trial. Left to right, 9-, 6- and 3-node rhizomes.

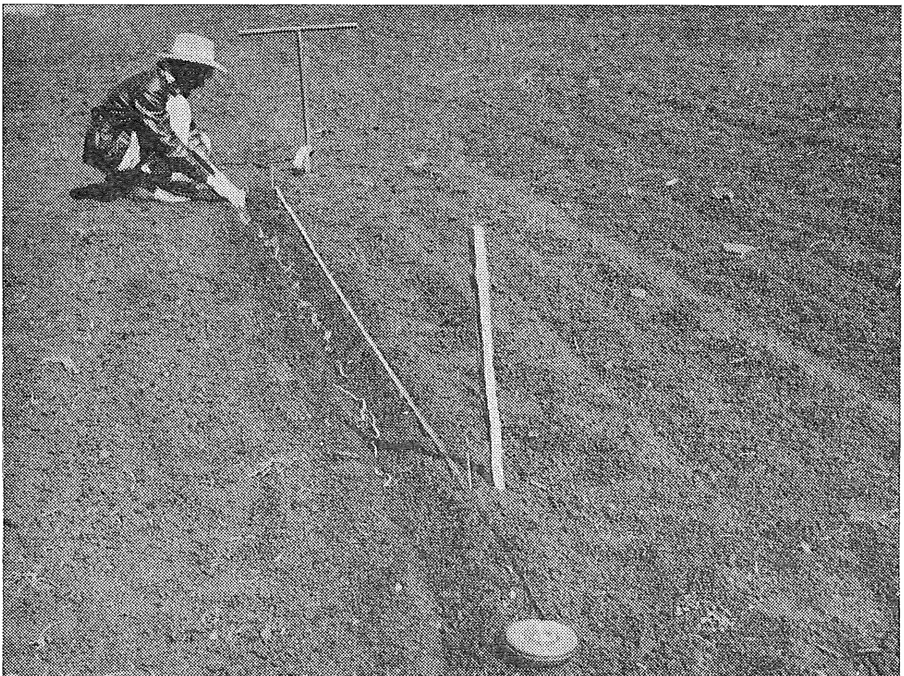

Fig. 2.—Planting sprigs to a depth of 2 in.

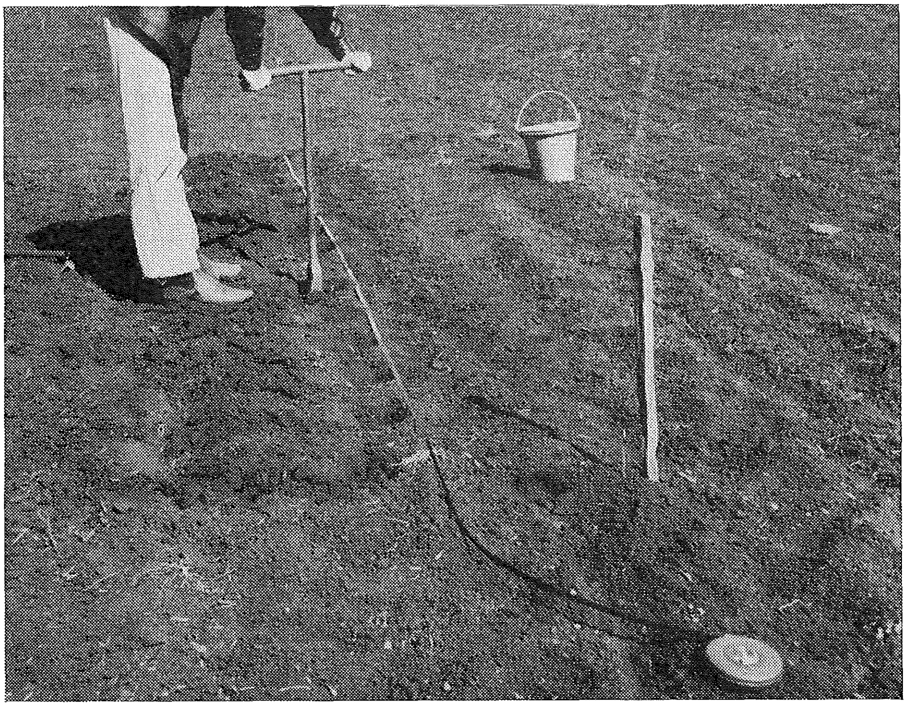

Fig. 3.—Preparing holes for sprig planting at 4 in. and 6 in. depths. Moist soil was replaced over the planted sprigs.

(3) *Condition of Soil.*—All trials were conducted on an area of a dark grey clay soil (self-mulching Irving-Purrawunda Soil Association) (Figure 4). The area was bare fallowed during the summer of 1957-58. It was in good tilth and held good subsoil moisture at each planting.

(4) *Time of Trial Initiation.*—Six 9 x 3 randomized block trials were conducted with planting times as follows: August 1-2, 1958; September 4-5, 1958; October 9-10, 1958; December 3-4, 1958; January 6-7, 1959; and February 10-13, 1959.

(5) *Method of Assessment.*—Plant counts were taken at intervals and a final count was made approximately four months after planting. After this period, differentiation of individual plants became impracticable due to surface spread. In cases where good initial establishment was obtained and rapid growth followed, a complete cover resulted in less than four months. Counts were therefore discontinued at this stage or at four months in the case of the backward treatments.

(6) *Colonization Data.*—Colonization data were not collected in detail but were recorded at important stages in some trials (Figure 5). Data for the August planting are presented in Table 8.

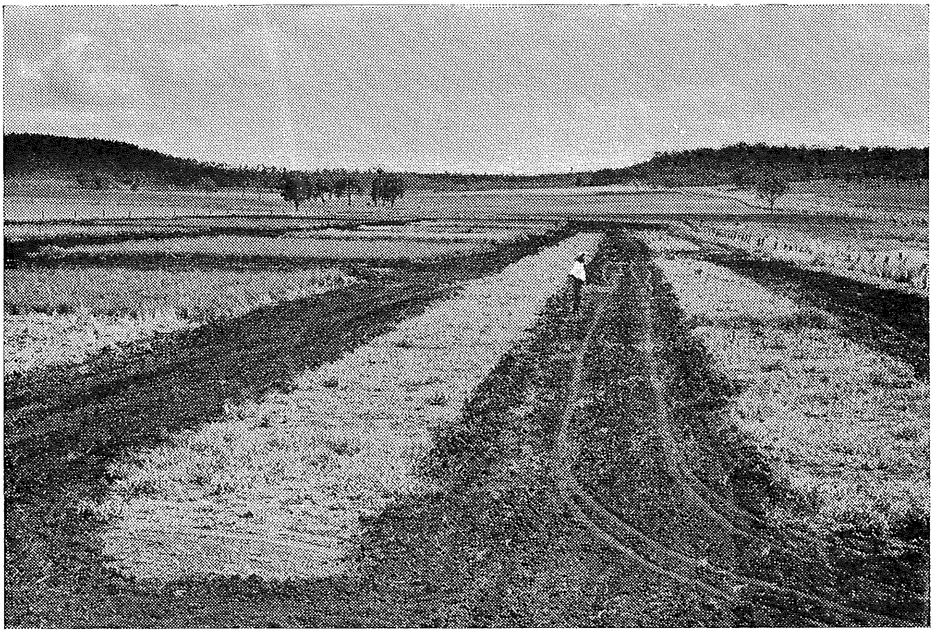

Fig. 4.—General view of the area on which the trials were conducted.

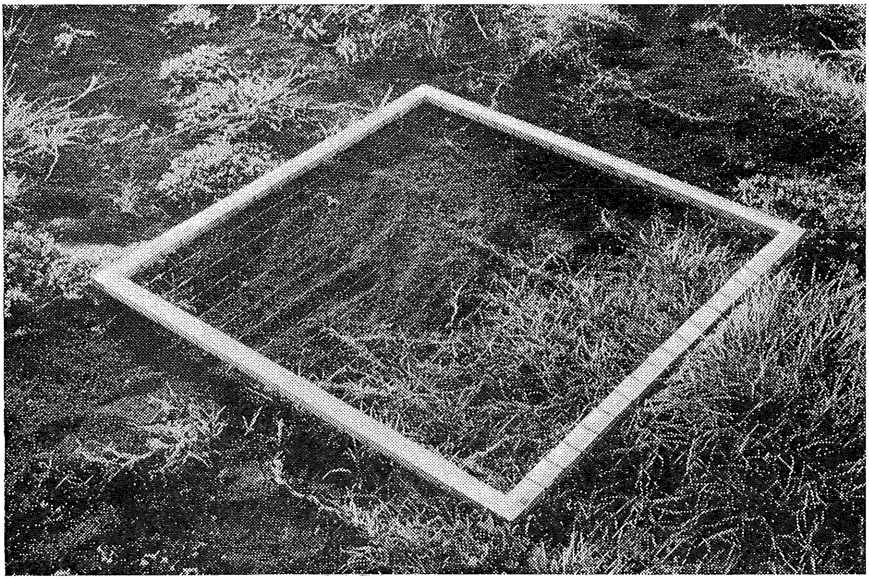

Fig. 5.—Quadrat used for collecting colonization data. Quadrat 36 in. square divided into 324 squares.

(7) *Rainfall.*—Details of rainfall over the period of the trial are as follows:—

Month	No. of Falls	Largest Fall (in.)	Total (in.)
1958			
July	3	0·61	0·69
August	6	0·54	1·37
September	4	0·54	0·95
October	5	1·58	3·62
November	5	0·20	0·37
December	10	0·66	2·70
1959			
January	12	1·78	4·51
February	7	2·75	3·62
March	6	1·53	2·93
April	6	0·55	1·45
May	5	0·84	1·29
June	2	0·12	0·17

III. RESULTS

The results are summarized in Tables 1–9 and Figures 6–10.

(a) Size of Planting Material

In all trials the 9-node rhizome establishment exceeded the 3-node rhizome establishment at the 1% level of significance. In the October and January series the 9-node rhizome establishment exceeded the 6-node rhizome establishment at the 1% level and in the August and December series at the 5% level. In the August, September, October, December and January trials the 6-node rhizome establishment exceeded that of the 3-node rhizomes at the 1% level and in February at the 5% level.

TABLE 1

Analysis of Rhizome Establishment—August Planting

Summary of Mean Values

No. of Nodes	$\sqrt{x + \frac{1}{2}}$ for Depth				Equivalent No. for Depth			
	2 in.	4 in.	6 in.	Mean	2 in.	4 in.	6 in.	Mean
9	6·38	6·60	5·95	6·31	40·2	43·1	34·9	39·3
6	6·04	5·52	5·04	5·53	36·0	30·0	24·9	30·1
3	5·33	4·42	2·96	4·24	27·9	19·0	8·3	17·5
Mean	5·92	5·51	4·65	5·36	34·5	29·9	21·1	28·2

	S.E.	Nec. Diff. 5%	Nec. Diff. 1%		
Individual	·361	1·08	1·49	9> 6>>3	No. of nodes
Marginal	·208	·62	·86	2, 4>> 6	Depth

Further analysis shows that in every trial month and at every depth, 9-node rhizomes were equal to or better than 6-node rhizomes, and except in the February planting, at the 6 in. depth, were significantly better than 3-node rhizomes.

TABLE 2

Analysis of Rhizome Establishment—September Planting
Summary of Mean Values

No. of Nodes	$\sqrt{x + \frac{1}{2}}$ for Depth				Equivalent No. for Depth			
	2 in.	4 in.	6 in.	Mean	2 in.	4 in.	6 in.	Mean
9	3·96	4·59	3·61	4·05	15·2	20·6	12·5	15·9
6	2·87	4·60	3·05	3·51	7·7	20·7	8·8	11·8
3	2·50	2·08	1·43	2·00	5·8	3·8	1·5	3·5
Mean	3·11	3·76	2·69	3·19	9·2	13·6	6·7	9·7

	S.E.	Nec. Diff. 5%	Nec. Diff. 1%		
Individual	·399	1·20	1·65	9, 6>> 3	No. of nodes
Marginal	·230	·69	·95	4 >> 6	Depth

TABLE 3

Analysis of Rhizome Establishment—October Planting
Summary of Mean Values

No. of Nodes	$\sqrt{x + \frac{1}{2}}$ for Depth				Equivalent No. for Depth			
	2 in.	4 in.	6 in.	Mean	2 in.	4 in.	6 in.	Mean
9	5·22	3·93	3·36	4·17	26·7	14.9	10·8	16·9
6	4·99	3·28	1·87	3·38	24·4	10·3	3·0	10·9
3	2·91	1·46	1·05	1·81	8·0	1·6	0·6	2·8
Mean	4·37	2·89	2·09	3·12	18·6	7·9	3·9	9·2

	S.E.	Nec. Diff. 5%	Nec. Diff. 1%		
Individual	·099	·99	1·36	9>> 6>> 3	No. of nodes
Marginal	·057	·57	·79	2>> 4>> 6	Depth

(b) Depth of Planting

At the 1% level of significance the strike at the 2 in. depth of planting significantly exceeded that at the 4 in. and 6 in. depths in the October and January trials and that at the 6 in. depth in the August, October, December, January and February trials. The 4 in. depth of planting significantly exceeded the 6 in. depth at the 1% level in the August, September, October, January and February trials.

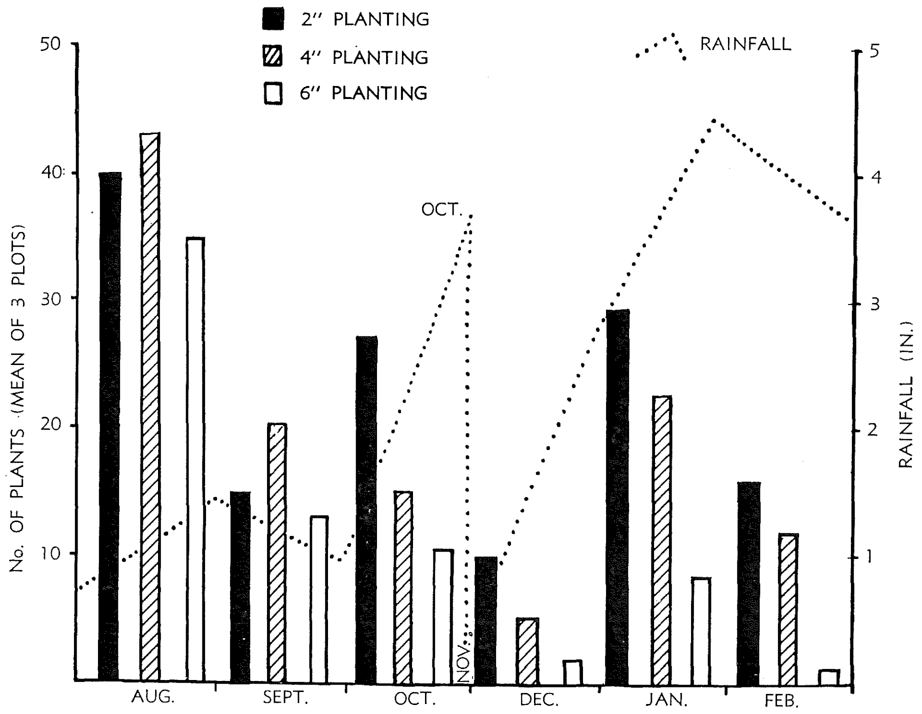

Fig. 6.—Establishment from 9-node rhizomes.

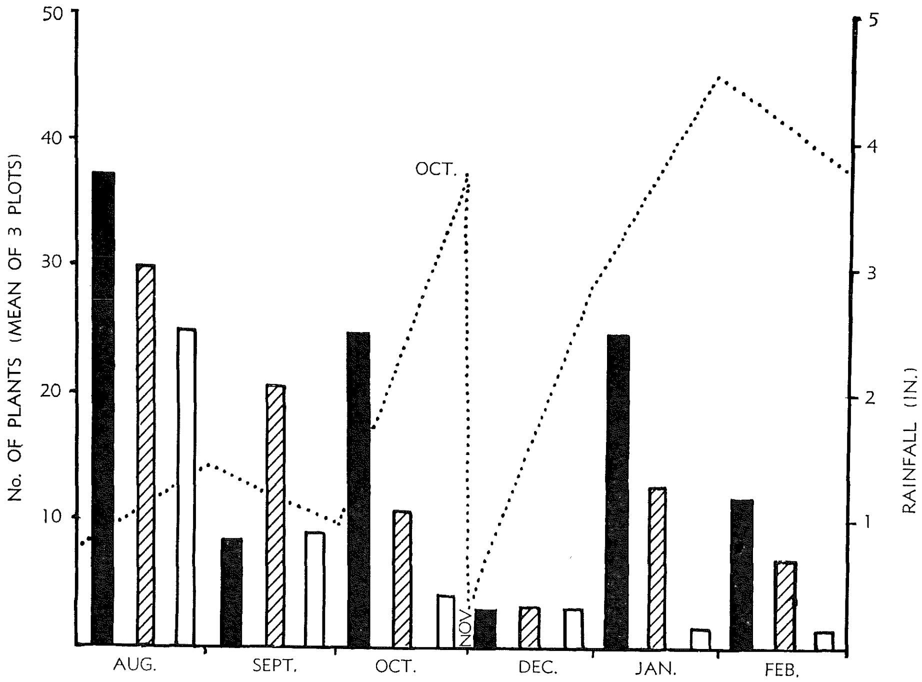

Fig. 7.—Establishment from 6-node rhizomes. (Legend as in Fig. 6.)

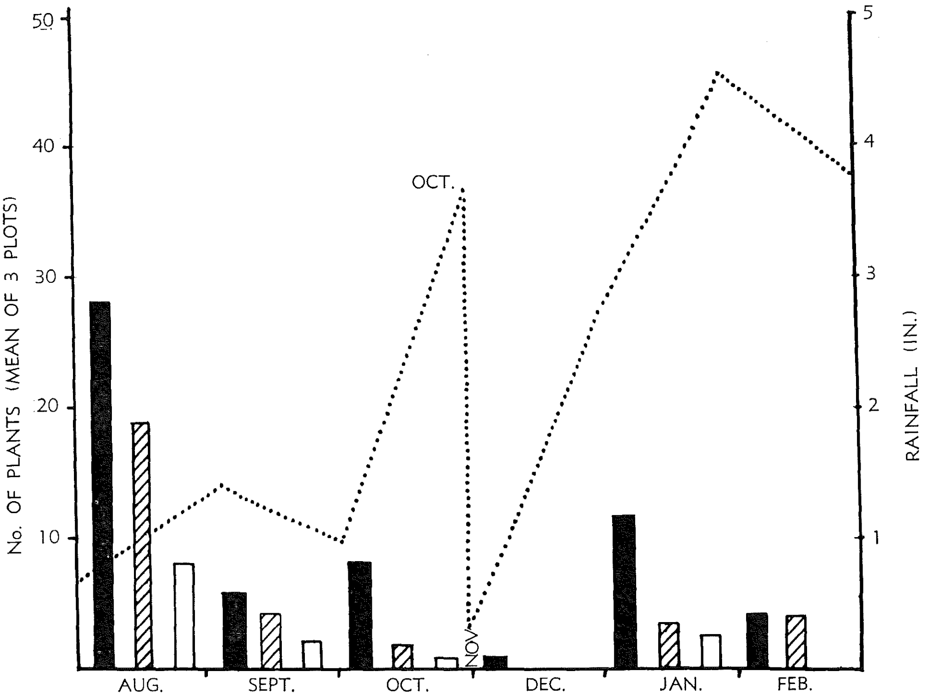

Fig. 8.—Establishment from 3-node rhizomes. (Legend as in Fig. 6.)

These results show the inferiority of the 6 in. depth of planting to the 4 in. depths. If the 9-node rhizome is accepted as the best planting material, then for this length we find that the 2 in. depth was better than the 4 in. in three months and equal to 4 in. in the other three months.

The relationship between the depth of planting and the size of material planted is shown in Figure 9.

TABLE 4

ANALYSIS OF RHIZOME ESTABLISHMENT—DECEMBER PLANTING
SUMMARY OF MEAN VALUES

No. of Nodes	$\sqrt{x + \frac{1}{2}}$ for Depth				Equivalent No. for Depth			
	2 in.	4 in.	6 in.	Mean	2 in.	4 in.	6 in.	Mean
9	3·16	2·26	1·39	2·27	9·5	4·6	1·4	4·7
6	1·76	1·74	1·65	1·72	2·6	2·5	2·2	2·4
3	1·22	0·88	0·88	0·99	1·0	0·3	0·3	0·5
Mean	2·05	1·63	1·31	..	3·7	2·1	1·2	..
		S.E.	Nec. Diff. 5%	Nec. Diff. 1%				
Individual		·263	0·79	1·09	9> 6>> 3		No. of nodes	
Marginal		·152	0·46	0·63	2 >> 6		Depth	

TABLE 5

Analysis of Rhizome Establishment—January Planting

Summary of Mean Values

No. of Nodes	$\sqrt{x + \frac{1}{2}}$ for Depth				Equivalent No. for Depth			
	2 in.	4 in.	6 in.	Mean	2 in.	4 in.	6 in.	Mean
9	5·47	4·81	2·96	4·41	29·4	22·7	8·2	19·0
6	4·99	3·67	1·56	3·41	24·4	13·0	1·9	11·1
3	3·51	1·68	1·46	2·22	11·8	2·3	1·6	4·4
Mean	4·66	3·39	1·99	..	21·2	11·0	3·5	..

	S.E.	Nec. Diff. 5%	Nec. Diff. 1%		
Individual	·312	0·93	1·29	9>> 6 >> 3	No. of nodes
Marginal	·180	0·54	0·74	2 >> 4 >> 6	Depth

TABLE 6

Analysis of Rhizome Establishment—February Planting

Summary of Mean Values

No. of Nodes	$\sqrt{x + \frac{1}{2}}$ for Depth				Equivalent No. for Depth			
	2 in.	4 in.	6 in.	Mean	2 in.	4 in.	6 in.	Mean
9	4·05	3·47	1·00	2·85	16·2	11·5	0·5	7·6
6	3·43	2·74	1·32	2·50	11·3	7·0	1·3	5·7
3	2·16	1·87	0·71	1·58	4·2	3·0	0·0	2·0
Mean	3·23	2·69	1·01	..	9·9	6·7	0·5	..

	S.E.	Nec. Diff. 5%	Nec. Diff. 1%		
Individual	·411	1·23	1·70	9 >> 3 ; 6 > 3	No. of nodes
Marginal	·237	0·71	0·98	2, 4 >> 6	Depth

TABLE 7

Analysis of Rhizome Establishment—Average over Six Plantings

Summary of Mean Values

No. of Nodes	$\sqrt{x + \frac{1}{2}}$ for Depth				Equivalent No. for Depth			
	2 in.	4 in.	6 in.	Mean	2 in.	4 in.	6 in.	Mean
9	4·71	4·28	3·04	4·01	21·7	17·8	8·8	15·6
6	4·01	3·59	2·41	3·34	15·6	12·4	5·3	10·7
3	2·94	2·06	1·41	2·14	8·1	3·8	1·5	4·1
Mean	3·89	3·31	2·29	..	14·6	10·5	4·7	..

	S.E.	Nec. Diff. 5%	Nec. Diff. 1%		
Individual	·214	0·67	0·96	9 >> 6 >> 3	No. of nodes
Marginal	·104	0·33	0·47	2, 4 >> 6	Depth

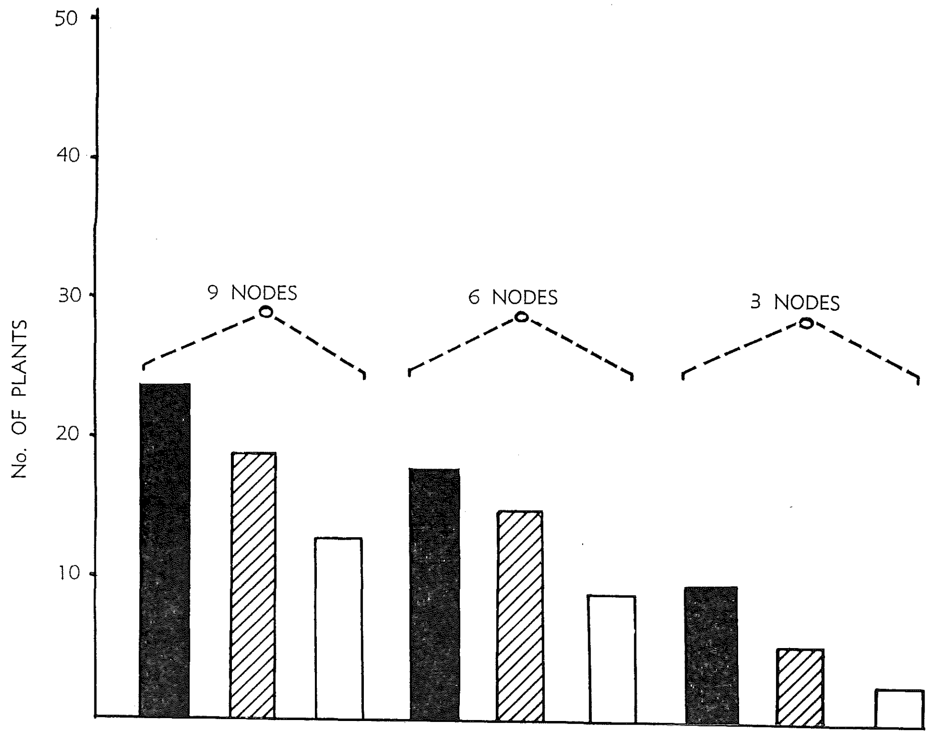

Fig. 9.—Mean establishment of six trial plantings. (Legend as in Fig. 6.)

(c) Time of Planting

Figures 6–8 show the relationship of size of rhizome and depth of planting for the six trials, with the rainfall plotted on a monthly total basis. The July and August rainfalls were the lowest monthly totals over the trial period other than for November.

The establishment rate in August was highest in all the treatments. This is considered to be due to the low soil moisture evaporation rate of July and August and a corresponding higher soil moisture level at the depth of sprig establishment. In contrast is the poor establishment in the December and February trials under conditions of high soil moisture evaporation lossess and inadequate moisture replacement from rainfall during the critical period of viability of the rhizomes.

From the trial results it appears that the establishment of kikuyu grass on the Darling Downs during the late winter months is practicable. The results obtained under higher rainfall conditions during the midsummer months of January and February were significantly inferior to the August results. In August the establishment resulted from soil moisture retained in the upper profile due to low seasonal evaporation and was not dependent on increment in moisture from rainfall. It is generally possible by prior fallowing to provide this moisture for a June-July-August planting and correspondingly on the trial evidence to establish kikuyu grass sprigs with a minimum danger of plant mortality without follow-up rain. This cannot be done in the summer months.

(d) Rate of Colonization

Colonization data collected from the August trial 18 weeks after planting showed that the surface growth of the 9-node rhizomes significantly exceeded that of the 6-node rhizomes at the 1% level of significance for the 4 in. depth of planting and at the 5% level for the 6 in. depth of planting. The surface growth for the 3-node rhizomes were markedly inferior and was not included in the analysis. The difference in surface cover decreased with time.

TABLE 8

COLONIZATION RATES AT 18 WEEKS—AUGUST PLANTING

No. of Nodes	Mean Cover (%)		
	2 in.	4 in.	6 in.
9	47	43	12
6	47	12	5
3	17	3	0

Analysis of Variance (log. trans)—Summary of Mean Values

No. of Nodes	log.				Equivalent %			
	2 in.	4 in.	6 in.	Mean	2 in.	4 in.	6 in.	Mean
9	1·65	1·62	1·06	1·45	45	42	11	28
6	1·64	1·02	0·70	1·12	44	10	5	13
Mean	1·65	1·32	0·88	1·28	44	21	8	19

	S.E.	Nec. Diff. 5%	Nec. Diff. 1%	
Individual	·099	·31	·44	9 >> 6 at 4 in.
Marginal	·057	·18	·26	9 > 6 at 6 in.

(e) Establishment

The general relationship between size of sprig, depth of planting, time of planting and establishment is shown in Figure 10 and Table 9. The time of emergence of shoots from the planted rhizomes is directly related to planting depth and size of material. The larger the planted material the quicker the emergence, and conversely the deeper the planting (from 2 in. to 6 in.) the slower the emergence. The factor of emergence is reflected in the initial colonization rate and is important in soil erosion control.

TABLE 9

MEAN OF PLANT COUNTS—AUGUST PLANTING

Treatment	Date of Plant Counts			
	26.viii.58	4.ix.58	10.x.58	9.xii.58
2-node rhizomes at 2 in.	18·7	22·5	23·7	28
3-node rhizomes at 4 in.	1·3	5·7	11	19
3-node rhizomes at 6 in.	0·3	0	1	8
6-node rhizomes at 2 in.	28·0	33·3	34	37
6-node rhizomes at 4 in.	4·3	16·3	22·5	30
6-node rhizomes at 6 in.	1·0	5	13·5	25
9-node rhizomes at 2 in.	30·7	38	38·5	40
9-node rhizomes at 4 in.	8·3	25·3	36·5	43
9-node rhizomes at 6 in.	0	5·7	13·5	35

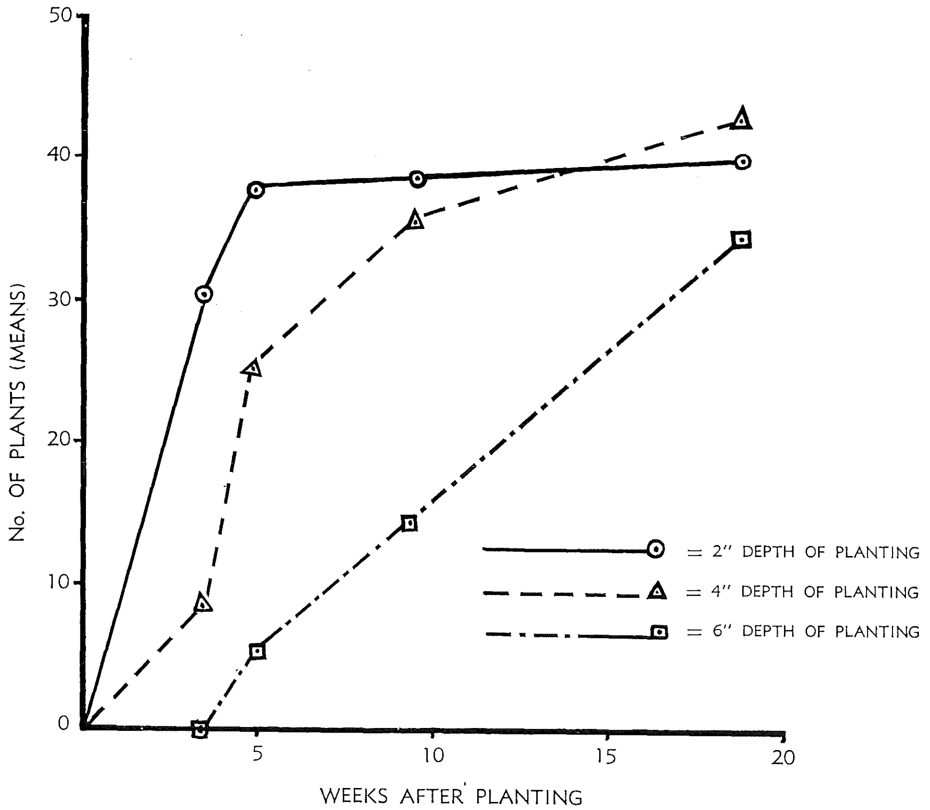

Fig. 10.—Rate of establishment of 9-node rhizomes for various planting depths (August planting).

IV. DISCUSSION

These investigations have provided data enabling certain conclusions to be drawn which are of importance in the Darling Downs soil conservation programme. These are:—

(1) The planting of kikuyu grass on soil moisture resulting from late winter or early spring rains is quite practicable and results in satisfactory plant establishment. The lower temperatures result in a slower growth rate than is the case with a midsummer planting but there is less risk of erosion-producing rains damaging the soil before surface cover is developed to a degree sufficient to provide protection against erosion.

(2) Kikuyu grass sprigs should not be planted to a depth greater than 4 in. This is important where the grass is planted mechanically either by ploughing-in or by the use of the kikuyu sprig planter.

(3) It is desirable to plant as large a piece of vegetative material as is practicable. The planting of turves is desirable but is usually impracticable for larger areas because of the quantity of material involved and labour required. The 9-node rhizome was selected as the type of sprig considered practical for delivery from a sprig planting machine.

The finding that the sprigs under nine nodes gave a much lower percentage establishment led to modification of the current model sprig planter. This involved alteration of the drum mechanism which teases out the sod into sprigs. The number of fingers on the drums was reduced by half, which resulted in the kikuyu grass sod being broken down to material of a size approaching the 9-node rhizomes used in the trial. The unmodified drum delivered a fair percentage of material approximating the 3-node size range.

These trials suggest that the following procedure should be adopted for the establishment of vegetation in soil conservation waterways on those parts of the Darling Downs where growth of kikuyu grass is satisfactory:

(1) Construct the waterway following summer rains, i.e. in autumn. When the waterway has been shaped, the section to be planted should be ripped to a depth of 6 in., leaving the surface in an open cloddy condition.

(2) Fallow the waterway during the winter.

(3) Plant kikuyu grass. The sprig planter should be set so that there will be 2–3 in. of compacted soil above the sprigs. The planted rows should be compacted by rolling with the rear wheel of a normal farm tractor. Other trials have indicated that compaction of the loose soil covering the kikuyu sprigs may considerably increase the percentage strike where soil moisture is at a doubtful level for establishment.

V. ACKNOWLEDGEMENTS

It is desired to acknowledge the assistance given by Messrs. G. and T. Wall, Rocky Creek, Pittsworth, in the conduct of these trials. Field assistance was given also by Messrs. M. H. Roberts, G. A. Bass and N. A. Rowlands. Mr. P. B. McGovern (Senior Biometrician) analysed the trial data.

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