

### 5. IMPERATA CYLINDRICA (L.) BEAUV

- 19 -

5.i. Introduction

- -----

<u>I. cylindrica</u> variously known as lalang, cogon grass or spear grass is a widespread perennial particularly serious as a weed of rubber in Malaysia. There have, however, been few studies of its growth or of the rhizome system. The underground rhizomes branch freely and terminate in a very sharp structure of scale leaves which enclose the apex. Nodes occur at varying intervals along the rhizome, being two or three cm apart on mature sections. In pots, branching is observed to occur most frequently in the region of an apex which has begun to ascend vertically to form an aerial shoot.

Work on the regeneration of rhizome fragments has been recently conducted by Soerjani and Soemarwoto (1969). Rhizome which was collected in Indonesia was found to possess buds at every node in the region of the apex. Rhizome diameter and the position of the bud on the prepared fragment were factors found to have little or no influence on regeneration. Bud colour, considered an indication of age, was associated with the capacity of fragments to regenerate. Fragments with white buds germinated much better than those with dark brown buds, the latter presumed to be the older. Size also had an effect. While fragments 1 cm long regenerated well, fragments only 0.5 cm gave much poorer results. The resulting shoot length was found to be linearly related to the length of fragment; the longer the fragment, the longer the shoot.

These workers found light to stimulate bud germination but the increase over dark controls was only statistically significant (P=0.05) when fragments were placed with the bud facing the light. When the buds were placed facing downwards buried in the supporting agar media, a reduced regeneration resulted.

<u>I. cylindrica</u> may spread by seed. Santiago (1965) reports that 95% germination is possible for seed within a week of harvest. However, viability is retained for less than a year.

Work at WRO has been concerned with rhizome regeneration. Various factors thought likely to influence regeneration were studied. Preliminary studies concerned effects of substrate, fragment type, fragment size, season and the temperature at which stock plants were grown. The effects of season and plant age were assessed in an experiment of comparable design to that used for the other species.

5. ii. Preliminary studies on regeneration

Methods

A clone was established from rhizome material originally obtained from Malaysia. Stock plants for the experiments were produced by dividing existing plants using large portions of the rhizome system with attached aerial shoots. These portions were potted into John Innes potting (J.I.P.) compost No. 2 using 15 and 25 cm diameter pots for young and old plants respectively. The stock plants were grown at 21°C for a preliminary period to encourage rhizome production after which some were transferred to a lower temperature of 10°C. The dates of potting and the duration of the temperature periods are shown in Table IX. Where experiments did not involve comparisons of stock plant treatments the material was obtained from mature plants grown at 21°C.

Except for an initial experiment comparing fragment sizes, all fragments were 9 cm long and consisted either of a 9 cm length with an apex

	Table IX Treatment of <u>I. cylindrica</u> stock plants										
0	Time of potting	Months of growth at 21°C min	Months of growth at 10°C min	Description of material	Date of experiment						
	Oct. 1965	8 4	0 4	Old - warm Old - cool	June 1966						

- 20 -

Oct. 1965	12	0	Old - warm	Nov. 1966
June 1966	5	0	Young - warm	
Oct. 1965 Oct. 1965 Nov. 1966	16 4 4	0.12.0	01d - warm 01d - cool Young - warm	Feb. 1967
Oct. 1965	21	0	01d - warm	July 1967
Oct. 1965	4	17	01d - cool	
Feb. 1967	5	0	Young - warm	

(apical fragments) or a 9 cm. length taken 9 cm back from the apex (sub-apical fragments).

The fragments were planted 1.25 cm deep in 9.0 cm pots and placed in a glasshouse at 21°C minimum temperature. There were 10-15 fragments per treatment.

#### Results

In an initial experiment comparing one and two-node fragments (3 and 5 cm long) planted in October 1965 using JIP compost, all fragments failed to regenerate and succumbed to rotting. Larger fragments up to 15 cm taken in January 1966 grew and produced a variable number of shoots: of these fragment sizes, a length of about 9 cm was the smallest to regenerate well and provided the best opportunities for utilising the limited amount of material then available.

Substrate, fragment type, and the condition of the stock plant were investigated initially in a  $2 \ge 2 \ge 2$  factorial experiment in June 1966. The substrate type was the principal factor of interest at this stage. The results are shown in Table X.

The substrate type did not affect the number of pots in which plants were established.

Sand was included with the object of reducing the possibility of rotting but this did not appear an important factor. The greatest shoot number after 30 days occurred with JIP compost and the difference between sand and JIP had increased at 60 days when JIP had almost twice as many shoots as sand.

Apical fragments established much better than sub-apical fragments and produced approximately three times as many shoots.

There were only small differences due to stock plant temperature conditions, with the "warm" plants giving rise to approximately one third more shoots than "cool" plants. These differences were not significant.

sents as ditty discoult as 9 a 10 houristed either and then length with the

### Table X

- 21 -

Effects of substrate, fragment type and stock plant condition on the regeneration of <u>I. cylindrica</u> (three fragments per pot, five replicate pots per treatment)

			Sau	nd	L. Ig AL	J.I.P.			
	and charter in the second of	Number of pots with: plants established		Total shoot numbers per treatment		Number of pots with plants established		Total shoot number per treatment	
1 -	Number of days from planting		60	30*	60+	30	60	30*	60t
Stock	Apical fragments	5	5	13	19	4	4	. 16	26
plants cool	Sub-apical fragments	1	3	2	5	2	3	4	9
Stock	Apical fragments	5	5	10	16	5	5	15	40
plants warm	Sub-apical fragments	3	3	5	7	4	4	6	16

\* L.S.D. = 8.0 (P = 0.05) / L.S.D. = 9.0 (P = 0.05)

Apical and sub-apical fragments taken from stock plants of two ages, twelve and five months' old established in 25 cm and 15 cm diameter pots respectively were planted in November 1966 in J.I.P. compost. The results are shown in Table XI. Establishment was generally poor. Shoot numbers were low and showed a decrease from thirty to sixty days after planting. Many fragments rotted and root production on those fragments which survived was poor. The use of apical fragments again led to increased survival.

A DOUT A GUIRA HARDANIAN DE BERCHANNER

With old rhizome, apical fragments proved best, while all sub-apical fragments rotted. With young rhizome material apical fragments were poorer than sub-apical fragments.

The effects of stock plant age were not significant.

A factorial experiment involving apical and sub-apical fragments and three stock plant treatments was conducted in both the winter and in the summer to measure the effect of season on establishment, and on any interaction with the other factors. The results of the experiment which was non-orthogonal with respect to stock plant age and temperature treatments are shown in Table XII.

Of the main effects, fragment type proved the most important with apical fragments giving both increased regeneration and shoot production. The overall percentage of fragments regenerating was 78% and 23% for apical and sub-apical fragments respectively.

#### Table XI

- 22 -

Effects of stock plant age and fragment type on the regeneration of I. cylindrica (two fragments per pot, 10 replicate pots per treatment)

			Old pl	ants	i.sez	Young plants			
		Number of pots with plants established		Total shoot numbers per treatment		Number of pots with plants established		Total shoot numbers per treatment	
	Number of days from planting	30	60	30*	60t	30	60	30*	60t
	Apical fragments	8	7	10	7	3	2	3	3
	Sub-apical fragments	0	0	0	. 0	5	5	7	8

\* L.S.D. = 5.6 (P = 0.05)f L.S.D. = 6.2 (P = 0.05)

35

Season had a significant effect on aerial shoot numbers only, with summer production being more than double that of the winter.

Differences due to stock plant condition were not significant, although there were interactions with the other factors. During the summer sub-apical fragments gave a much reduced percentage regeneration and a low shoot number compared with apical fragments. Differences in the winter were small. and area (1900). A life Hi delet, and povell at fotosto crean alera destable

# Table XII

Effects of season, fragment type and stock plant condition on the regeneration of I. cylindrica

(one fragment per pot, 10 replicate pots per treatment)

		Win	ter (Fe	eb. 1967	).	Summer (July 1967)			
	Stock plant condition	Apic fragm		Sub-apical fragments		Apical fragments		Sub-apical fragments	
		*i	*ii	i	ii	i	ii	i	ii
	Old - cool	100	10	0	0	90	19	10	1
A. A. A.	Old - warm	40	4	0	0	90	23	40	7
	Young - warm	60	6	70	7	90	15	20	3

. .

\* i % of fragments regeneration. L.S.D. = 32% (P = 0.05) \* ii total shoot number per treatment. L.S.D. = 7.5 (P = 0.05) Season had a significant effect on aerial shoot numbers only, with summer production being more than double that of the winter.

- 23 -

Differences due to stock plant condition were not significant, although there were interactions with the other factors. During the summer sub-apical fragments gave a much reduced percentage regeneration and a low shoot number compared with apical fragments. Differences in the winter were small.

There were only small differences resulting from the temperature treatment of old stock material with fragments planted in the summer, when the "warm" material did best. In the winter differences were greater and the "cool" material was the most satisfactory. Again all sub-apical fragments taken from both the old stock treatments completely failed to grow in the winter.

A small experiment in June 1966 compared establishment of rhizome fragments possessing an aerial shoot with that of apical and sub-apical fragments without such shoots. Eighteen days after planting, the original shoot, which had begun in most cases to die, was cut off leaving new shoots to develop. Establishment of such material was good, (Table XIII).

#### Table XIII

Effects of shoot retention on establishment of I. cylindrica rhizome fragments

(15 fragments per treatment)

Fragment type	Percentage of fragments regenerating	Mean shoot number per fragment planted		
Apical fragments plus aerial shoot	100	3.5		
Apical fragment minus aerial shoot	60	0.7		
Sub-apical fragment minus aerial shoot	30	0.3		

120

66.0

The state of the state

345

...

5. iii. Effects of season and plant age

on rhizome production and reproductive potential

#### Methods

DEW DIDELLYD GERMANN

witt + with

. 202.50 13

Insient en

-33 0015 2.8"

and further

. Taves

The methods of culture and design of the experiment were identical to those used for the other species apart from some differences in the method of fragment preparation and the assessment of rhizome growth and regeneration. Apical fragments 9.0 cm in length were used exclusively in testing regeneration and for the establishment of the stock plants. As the number of nodes on the rhizome was unrelated to the number of fragments obtainable from the plant this measure was not obtained when the rhizome was being assessed.

COLEMAN FINE STOR TRUNSPORT IN THE BUILDE

reliant beset findes were stored to the test the thirt

#### Results

The production of rhizome by I. cylindrica appears to be largely influenced by season. Data presented in Table XIV shows that there were fluctuations in the amount of rhizome, in both length and weight, which can be related to seasonal conditions. Except in the case of the June planting rhizome length reached a peak in September. There then followed a decline from September to December after which the amount of rhizome increased.

- 24 -

The most favourable three-month period for rhizome growth depended

somewhat on the time of planting (Table XV). Overall, June to September was most favourable while conditions between September and December were associated with a decline in the amount of rhizome.

The amount of aerial growth increased steadily with the age of the plant. The rhizome/aerial shoot weight ratio was seasonally dependant, being highest for June assessments and falling to a low level in December. The percentage of rhizome by weight was high compared to other species, the mean value for all treatments being 28.6%.

Regrowth of rhizome fragments was not found to occur readily on fibre-glass in the dark and so comparable tests were conducted also:

- on fibre-glass in the light; a)
- in pots in the light; b)
- in pots in the dark. c)

Fragments in pots (9.0 cm diameter) were inserted vertically, with the apex exposed in J.I. compost and were sub-irrigated by standing on fibre-glass. Due to slowness of growth a 40-days assessment period was used. Fragments tested were from plants of three ages. In all cases, fragment placed in the light in the glasshouse showed improved regeneration over those placed in the dark (Table XVI). In the glasshouse the fibre-glass technique gave better regeneration than pots. (The mean percentage regeneration improved also with plant age, from 32% for three months, to 39% for six, and 66% for nine month old plants). Any further tests were therefore conducted in the light on fibre-glass.

Results of the three-monthly assessments of regeneration are shown in Fig. 4. Regeneration showed a tendency to improve during the summer months and to decline in mid-winter. June-planted material however, did not follow this pattern. The number of apical fragments available was variable and not consistently related either to age or season. Regeneration was not related to rhizome weight per unit length.

#### 5. iv. Conclusions

Preliminary experiments have established that fragment type is one of the most important factors influencing regeneration. Apical fragments regenerate better than sub-apical fragments of comparable length from mature plants (8 - 12 months old). For younger plants (4 months old) apical fragments are best in the summer whilst sub-apical fragments give the best results in the winter.

Regeneration is benefited in the winter if stock plants are grown at a 10°C minimum temperature instead of 21°C. This may be a result of reducing the depletion of carbohydrate reserves. There is no advantage accruing from such treatment in the summer.

Month of planting	Plant age in months	Month of assess- ment	Rhizome length (cm/plt)	Rhizome fresh weight (g/plt)	Aerial shoot fresh weight (g/plt)	Rhizome fresh weight per cm length (mg)	Rhizome/shoot fresh weight ratio	Rhizome as a % by weight of rhizome plus aerial shoot
Sept. 1967	3 6 9 12	Dec. March June Sept.	46 559 2060 2463	- 3 35 182 160	7 45 285 349	61 63 88 65	0.39 0.79 0.64 0.46	30.0 39.9 39.0 31.4
Dec. 1967	3 6 9 12	March June Sept. Dec.	54 981 1896 1585	1 92 133 109	3 135 376 544	26 94 70 68	0.47 0.68 0.35 0.20	25.0 40.5 26.1 16.7
March 1968	3 6 9 12	June Sept. Dec. March	574 2302 1368 1445	50 140 104 84	61 287 441 391	87 61 76 58	0.81 0.49 0.24 0.22	45.1 32.8 24.0 17.7
June 1968	3 6 9 12	Sept. Dec. March June	678 625 1445 1734	36 24 67 157	97 199 252 361	53 38 46 90	0.37 0.12 0.26 0.43	27.1 10.8 21.0 30.3

etututs.

.

-

aveb or

22

the part of the part of the

Sta

18.23

.

\*

.

14

#### Table XIV

Rhizome and aerial shoot productivity of I. cylindrica (data are means of three plants)

.

The strength of the strength o

.

.

.

25 -

1

63.2

10.011

(33.0)

BR

# - 26 -

#### Table XV

Increments in rhizome length of <u>I. cylindrica</u> during three-monthly periods of growth (data are means of three plants)

	N	Nonth of plan	nting		
Period of growth	September	December	March	June	Total

			Le	ength in cm/r	plant		
September	-	December	46	-311	-934		-1252
December	-	March	513	54	77	820	1464
March	-	June	1501	927	574	289	3291
June	-	September	403	915	1728	678	3724

all have the state of the

- CA 65 1 V

#### Table XVI

The influence of incubation environment on the regeneration of 9.0 cm apical rhizome fragments of <u>I. cylindrica</u>

(means of three plants)

Age of Mean Mean fragments regenerating % of fragments regenerating regenerating

parent plant	Environment	fragment number	-	nd shoots	roots a	roots and shoots		
in months		tested	20 days	40 days	20 days	40 days		
	Pots: GH C.E.R.	5.7 5.7	1.7 0.7	·2.0 0.7	30 12	35 12		
3	Fibre-glass: GH C.E.R.	5.3	.2.7	4.3	51	81 0		
	Pots: GH C.E.R.	8.0	3.3	4.0 1.3	41 16	50 16		
6	Fibre-glass: GH C.E.R.	7.7 8.0	4.0	4.3 2.7	52 21	56 34		
	Pots: GH C.E.R.	19.3 19.3	12.7 4.0	14.7 4.7	66 21	76 24		
9	Fibre-glass: GH C.E.R.	19.7 19.7	17.3 10.0	18.7 13.0	88 51	95 66		

GH = glasshouse (20 - 27°C) C.E.R. = dark constant environment room (23°C)

## Fig. 4. Reproductive potential of rhizome of Imperata cylindrica

Brand - Budder Parts

-

Labora - 5- 5- But Bold- 54

. . .

6. 1. 8.

1.2

ander vie staden mit

and the second second

. .

5 1 5

and the state is the state of the state

.......

4. 1

4.4.4

\*.

· Alexandri

4. 4

1 T T

net work of 1

1.16

But May 1 12 Martin 14 11-1

4 4 ...

4.0

1.1

14.223

5 . . \*\*\*\*\*

Liberton Acardonicaio

1

.

.

and a manufacture of the second

they all the last sign at a trap of the

Brite aler

1. 16 - C - F - F

4.

ing to shall -

the at the second out any the to the

4. 4.

1 4 9 4

1.800

. .

「あってんちょうない 日本ないのでいう

8 8 7

4 5 5

Andrew and in Surgerson a. W. Har

a series - 1.10

- 10 B

8 - -

.

.

10 m m

and a series and the star and

- Destropendenter

2 ...

a series and

. . .

- - - -

. . 2 · · \* ·

1 5 6

and with the month

- + -

and the strength of

Number of apical fragments selected as suitable for あるいあいる 来のあい いうないない かち あいち regenerating 1 2 2 4 2

1 1 1

1. 1.

The Bridge Bridge Bridge Bridge Bridge

- - 4

-----

. . . . .

1 2 3 4 5 1 4 .

-- ----

1 4 5 4

. . . . . .

---

4 1 4

1 4 1 8

- - - -

......

4 8 4 8

4.5

1 8 -

1 1

434 4 2

· · · · ·

............

.......

114-11-148

1.16 .111 4444-1--

.........

. . . . . . . .

1 .......

........

and the state is dealer that

+ \* + + 1 + 4 -

. . .

2 4 4

1 4 8 - 8 × 1 X 1 8 7 8 3 \* 3

1 the star week - Sector the of - But af - good - b - book - 16

......

- + - 5

1 4 4

4 6 4 1 4

1 4 4 4 9

.....

24.45.427

\* 2 4 - 2 7 - - -

4. 4 -

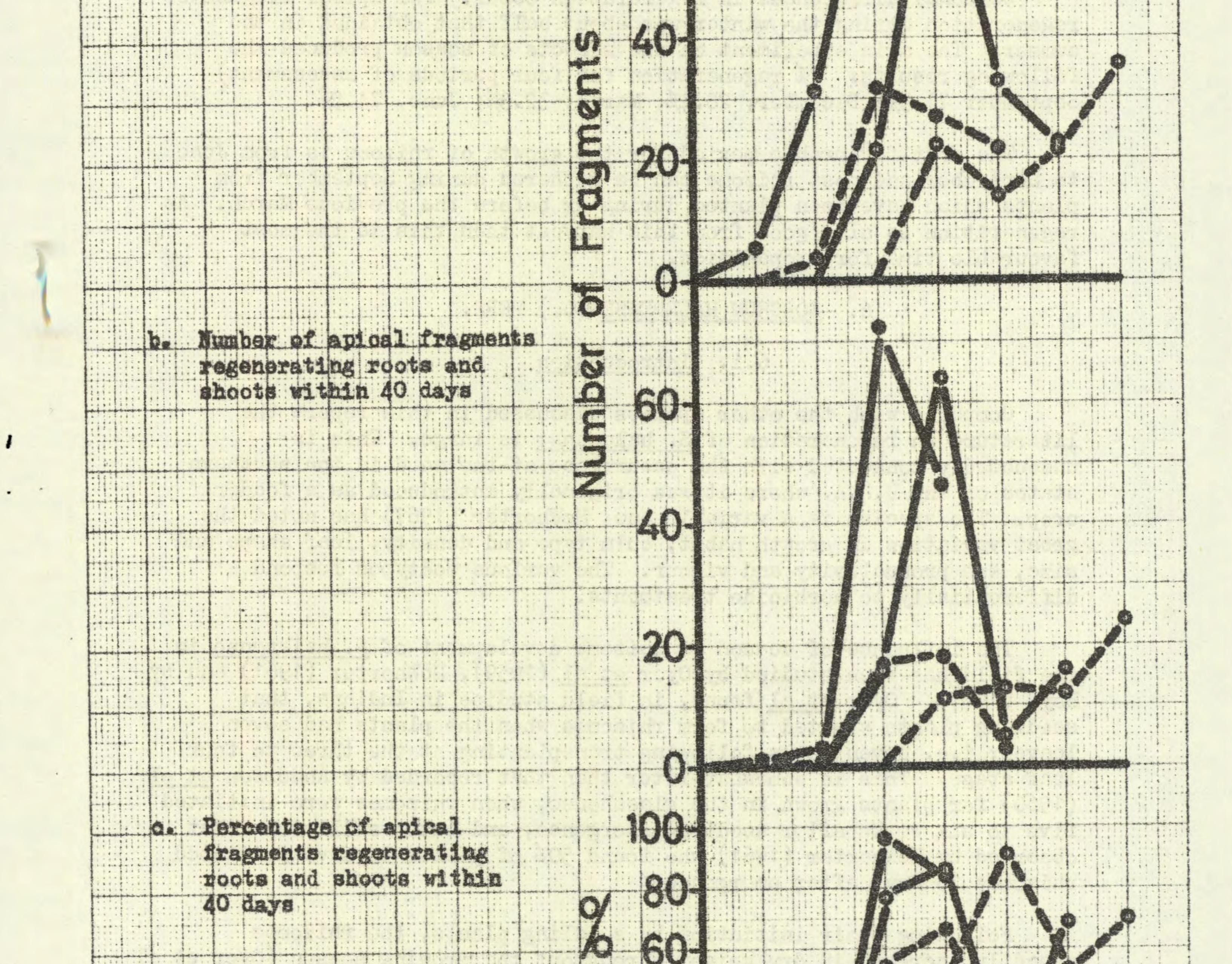
. .

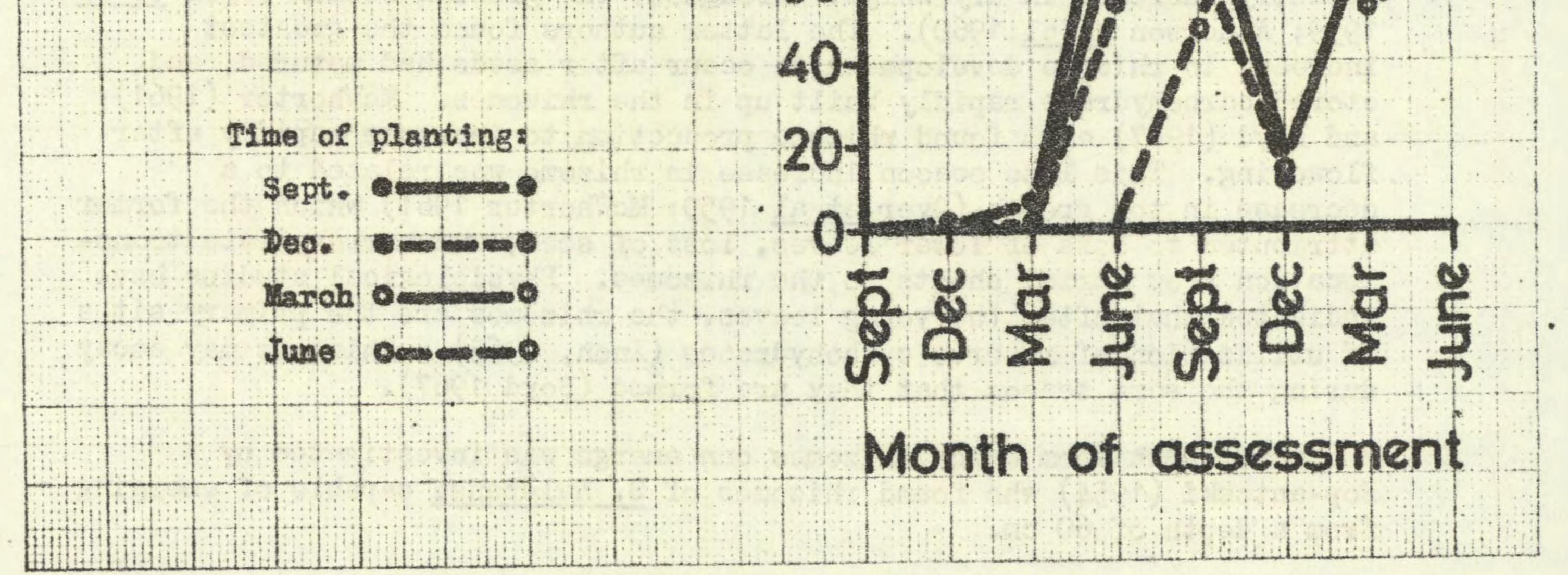
. .

unin linned Bo

and rear and real some of a standard and and reason

1 4. 4





Division remains an alternative technique to the use of fragments. Establishment of apical fragments is aided if the shoot has already developed from the apex and if this is retained when planting.

- 28 -

A loam-based compost proved initially to be a suitable incubation medium and was found to sustain more shoot production than did sand. Moist fibre-glass matting did however give results superior to the compost. Light was found to be highly beneficial to regeneration. Few fragments regenerate if kept in the dark.

Seasonal differences in regeneration occur. For apical fragments regeneration during the winter was about half that obtained in the summer. The main experiment on the effects of season produced the following results: (% regeneration for four periods of assessment) September 71.3%; December, 28.4%; March, 32.3%; June, 74.5%.

The most favourable period for the growth of rhizome is from June to September and most rhizome can be gathered during September from plants which have been planted during or before the previous March. As regeneration is also good from this harvest then this is the most favourable time for propagation.

6. SORGHUM HALEPENSE (L.) PERS.

#### 6.i. Introduction

Compared with the other species discussed in this report the literature on regeneration of <u>S. halepense</u> is large. This is undoubtedly connected with the occurrence of the weed in the southern states of the U.S.A. where it was originally introduced as a fodder crop. The species is a variable one; McWhorter (1967) has noted the great variation in growth habit, culm type and density, leaf shape and size, see productivity and vigour. The various ecotypes respond differentially to herbicide treatments.

The influence of season on rhizome development of <u>S. halepense</u> in the field has been studied by Oyer <u>et al</u> (1959), McWhorter (1961) and by Boyd (1967). Oyer <u>et al</u> found, in field studies in Indiana, that seedling plants started to form rhizomes when the plants had seven leaves; i.e. seven weeks following transplanting at the three to four leaf stage. This is somewhat later than that recorded by Anderson <u>et al</u> (1960) for plants grown in the glasshouse, when rhizomes were initiated five to six weeks after seedling emergence, and later still than that observed by McWhorter (1961) who found 50% of plants to have initiated rhizomes 18 days after emergence.

Following their initiation by seedling plants, the rhizomes steadily increase in dry weight throughout the growing season (Oyer <u>et al</u> 1959; Anderson <u>et al</u> 1960). The latter authors found the greatest increase in rhizome development to occur after seeds had matured, and stored carbohydrate rapidly built up in the rhizomes. McWhorter (1961) and Boyd (1967) also found rhizome production to increase rapidly after flowering. This late season increase in rhizome was related to a decrease in top growth (Oyer <u>et al</u> 1959; McWhorter 1961) which the former attributed to loss of lower leaves, loss of seed, and carbohydrate translocation from aerial shoots to the rhizomes. Physiological studies have indicated that after the young leaves, the rhizomes are the primary sites of utilization of reserve carbohydrates (Anon, 1965). Rhizomes may decay during the same season that they are formed (Boyd 1967).

The depth from which rhizomes can emerge was investigated by Pop-antoski (1954) who found rhizomes of <u>S. halepense</u> capable of emerging from a depth of 60 cm. Both Oyer <u>et al</u> (1959) and McWhorter (1961) found plant development from single-node rhizomes to be similar to that of seedlings although plants from rhizomes were generally slower growing than from seed (McWhorter 1961).

- 29 -

The quantity of rhizome produced was found by Anderson <u>et al</u> (1960) to be exemplified by an internode number exceeding 5,200 for a 4.5 month old plant. McWhorter (1961) reports that after approximately five months growth a mean of 8070 g and 212 linear feet of rhizome was produced per plant. Stamper (1957) estimated, on the basis that ten milesof rhizome weighs one ton, that 15 tons or 150 miles of rhizome could be produced

the stand of the

per acre. Individual rhizome could be up to 7 - 9 ft long. This indicates the tremendous development the rhizome system can undergo.

Regeneration of one-node rhizome fragments was found, by Ingle and Rogers (1957), to be favoured by darkness and high temperatures. At a given temperature the percentage of fragments sprouting decreased as the photoperiod increased. At 16°C less than 25% of fragments sprouted while at 32°C over 80% sprouted. Hull (1966) also found 15°C to be too low to induce bud germination. The response to temperature, which had a greater effect than light, was later found to differ according to the source of the material (Ingle and Rogers 1961); rhizomes from Michigan showed a greater response at low temperatures than rhizomes from Indiana.

It was noted (Ingle and Rogers 1961) that rhizome buds always gave rise to aerial shoots and never to rhizomes. Adventitious roots appeared at the base of these shoots but their appearance was not general within the 14 days duration of the experiments.

Boyd (1967) found there to be no differences between herbaceous and woody rhizomes in either their ability to regenerate roots and shoots or in their carbodyrate content. Carbohydrate content did however vary seasonally; soluble sugars were found to increase during the winter. A seasonal variation in the regeneration of fragments also occurred. Rhizomes when tested early in the year gave 100% regrowth decreasing to 70% in late summer and rising to 100% again in the autumn and winter. This is coincident with the "late-summer dormancy", a normal phenomenon in the field. This dormancy has been considered by Hull (1966) to be controlled by apical dominance (bud activity declines once shoots have emerged); also being influenced by the supra-optimal temperatures which prevail. Hull found that rhizome pieces with apical meristems produced aerial shoots by development of the meristem in 100% of cases while only 67% of basal buds developed and such development was normally delayed. The number of buds developing decreased along the rhizome in the direction of the apex.

Competition between nodes of multi-node fragments without apices does not appear to occur according to results of Anderson <u>et al</u> (1960). The total number of shoots produced was found to be much the same whether the rhizome were cut into 8-internode pieces or further fragmented into onenode pieces; indeed slightly more shoots were produced when the rhizome pieces were left intact.

.lecours evidence enditioners

In a study of the effect of desiccation on rhizome regrowth it has been found that drying to 40% of the original weight represented the critical limit below which few shoots developed (Anderson <u>et al</u> 1960).

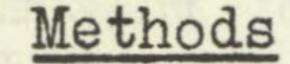
Inhibitors have recently been found in rhizome extracts as well as in those of the leaf (Abdul-Wahab 1967). This is possibly an additional factor favouring establishment at the expense of other species.

Thus, much is known of the growth and regenerative behaviour of this species in the field. Investigations described below were restricted to studying the effects of age and season on the growth and regeneration of pot-grown material. 

6. ii. Effects of season and plant age on rhizome production and reproductive potential 

- 30 -

Jasmyo arab thing Bandol (1991) that to hand ban (1991) Is but on toyo ditos



Stock plants of S. halepense were established from material imported from Israel. The experiment was conducted in a manner identical to that for C. dactylon and D. scalarum. Rhizome fragments were, however, given 40 days in which to regenerate as their progress was slow compared to the other two species under the same conditions. 

state tot for the state state what a total a total total total total a state whether the

Shotertet in increased. 1966 the stereins hotertet

#### Results at 3200 ever 50 a openied. 1981 (3366) slant de 1990 to 1990 to 1990 to

Rhizome and aerial shoot growth records are shown in Table XVII. Rhizome growth increased steadily with age; planting in December giving the greatest quantity. The most productive period for rhizome growth proved to be from March to June while a reduction in amount of rhizome occurred during September - December (Table XVIII).

Aerial shoot weights continued to increase during the life of the plants. The rhizome/shoot weight ratio showed a dependence on season, being greatest for June and September and low for December and March.

The percentage of prepared fragments which regenerated generally increased steadily with age although there was some decline for older plants. Regeneration was not dependent on the time of harvest (Fig. 5b). Also, regeneration was not related to variations in the fresh weight of rhizome per node. September planting gave the highest percentages of regeneration. Planting in December, however, gave the greatest number of regenerating fragments as more fragments were available for testing from these plants (Fig. 5a); a mean of 81.8 compared to 44.9, 35.1 and 45.7 for March, June and September respectively was obtained.

#### 6.iii. Conclusions ACTOM LIDIGS HILLS SOCIE PROXIME FORT THE SPICE WEETS

Work in the USA has shown that S. halepense produces much rhizome in the field and has a relatively rapid rate of spread. The rhizome is active in regenerating new shoots but may enter a period of dormancy in the late summer. Laboratory studies indicate that regeneration of rhizome fragments is both a light and a temperature sensitive process. Regeneration is favoured by darkness and by high temperatures.

In pots under glass in UK rhizome growth is greatest if planting is done in December. Also, December planted material yields the greatest number of regenerating fragments even though the percentage of regenerating fragments is greater with September plantings.

Regeneration appears to be related to age with the more mature rhizome having the better chance of regrowth than rhizome from very THE OFFICE AND A DEPARTMENT OF A young plants.

Inditate have recently hear found in whither extracts existent and is in those of the last (Ardul-Medrob 1967). This is possibly an additional - 1010son 19nfe 10 panets the the transfillers as to to it to the the total of the the transfer of the total

Month of planting	Plant age in months	Month of assess- ment	Rhizome length (cm/plt)	Rhizome fresh weight (g/plt)	Aerial shoot fresh weight (g/plt)	Number of distinct nodes on rhizome (per plant)	Rhizome fresh weight per cm length (mg)		Rhizome/shoot fresh weight ratio	Rhizome as a % by weight of rhizome plus aerial shoot
Sept. 1967	3 6 9 12	Dec. March June Sept.	10 155 484 708	3 52 145 179	163 259 357 467	7 93 332 661	262 330 300 253	1.5 1.7 1.5 1.1	0.02 0.20 0.41 0.38	1.8 16.7 28.9 27.7
Dec. 1967	3 6 9 12	March June Sept. Dec.	2 576 1029 923	-1 137 239 177	123 354 541 492	2 253 536 452	200 238 232 192	1.2 2.3 1.9 2.0	0.01 0.39 0.44 0.36	0.8 27.9 30.6 26.5
March 1968	3 6 9 12	June Sept. Dec. March	94 398 369 411	32 117 84 96	326 352 423 490	52 220 253 205	341 295 227 233	1.8 1.8 1.5 2.0	0.10 0.33 0.20 0.20	8.9 25.0 16.6 16.4
June 1968	3 6 9 12	Sept. Dec. March June	166 112 331 877	-32 -32 -76 -261	264 339 372 472	90 90 200 586	194 287 228 298	1.8 1.2 1.7 1.5	0.12 0.10 0.20 0.55	10.8 8.6 17.0 35.6

**e**)

. .

.

.

Rhizome and aerial shoot productivity of S. halepense (data are means of three plants)

### Table XVII

.

.

Sorghum hale Reproductive potential OL

-

1.2

1 12 19 19 19

1.1.1

-

5 5 4

4 - - 4

and the second second second

A ....

. 14

1 m.

and the state of the

.....

3 - - -

4 . . .

And the state of the state of the state

and the second second second

2.7

. . . . . . . .

1.0

2 4 4 2 -

2 . . . .

5 × 1 + 1 + 1

\* 2...

margine the state of a

4414 - 4

Number of fragments suitable selected as regenerating.

- 4 -

2 . .

..........

and has a head a first start and a set of a

· Side Bearing

.

1 4 6.

patrice and drive drank & spate such

A. 100

15 10 B 10 12 1 B

-----

. .

.......

......

1 +1 -

1.1.2 4

and a stand and a stand of the

4. 4 4 1 4

......

.......

. . . . .

. . . . . .

- 6. \*

. . .

A ALLENDA STATUT LAND

\* \* \* \* \* \* \* \*

. . .

n. H. .

....

4.4 -

....

And the state of the

...

. . . .

. . . .

...........

111.4.8.9.8.4.9

T + 3 + 4 - 1

4. 4. 1

..... E. . . . 4.4 . . . . . . .

\* 5. -. . . .

. . . 1 - E

. . . . 4

. .

1 1 4

. .

4 5 1

6.41.0

......

. . .

11. 1

ne wergenterfing an at a to a

----

\*\*\*\*\*\*\*\*

the new sector and the

..........

- 114

1 × + + + + +

\* \* \* \*

a select react party fam. . . . . . . . . . ....

电子子子 医

\*\*\*\*\*\*\*

4 1 1 1 4 1 4 1

3 - - + + + - + +

.......

- the apple - Ball - Ball - Ball

...........

....

. . . . .

5 4 4 1

\* \* \* \*

...

. . .

8 + X + 8

しゅうしち もうちしょう あいまる もいをき ちちも

.......

1 . . .

# 4

.

10.

sample monatting and the

C. Hutering ...... Andrew in Anoral prate 4.4. 8 ....... ........ 5 ..... . . . .... ---8 . . . . . . . 1.4 -1 8. . 9. そのもを書いてをや書す ショー キル 1 1 F # . . . . . あるちゃくなるるい うちのあいに きんきい \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\* -----...... 4 4 4 A allege to a state a st . apar in first indered fries a read from the property of the property of the property of the second description of the and a spirit and a sector but and and agreed the production of a design of a far for you to and when the are a specific to a stand of -----.....

£ . . . - 1 - - - -66000 arest alighter are are are are are are are are and a state 4 . . . 4 - 2 こうちを書いていて夢をもうときしたかの オートングタント 第一日の オントレーネント しょうちょう 83.5 -\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\* service and and the set of the set . . . . . . . . and the state of t ふちましまし ないないのちゃういい ちちょう an a desta provide to a second desta de la seconda de seconda 4 5 8 1 a c a 1 - - -. . the state state the state the state state state and the state st . . . . . あんちのなるをある、「スタンのない」を見てきたのです。 ないたちまたのでの · · · · · · · · -----1 4 9 energy and the constant of the stand of the 1.4.5.8.4.6. 2 

A REAL PROPERTY AND A REAL PROPERTY A REAL オレシュ・キキ ....... Sea Plantal ..... alageras from the construction of the \*\*\*\* 198 ... 1 1 4 1 \* \* \* \* 6 . . . . . してもちないので、「 シン・シーム・シーム アイン あまっちしょう \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\* Lassing and a far a set mass of a bank for a set ..... . ... . . . . . . and a second and a province and a second and a second and and a second a second and a second and a second and and the second of the seco . . . 4454141 1 4 5 4 1 8 9 1 ...... 1.2.7 1 - - - -

「う」を書きます「「ちょう」」」」を見てきますのないできますのです。 I take garage & to a new set of the state of a . . . . . 2----ARTERS ANTERS 1 . . . ...... the series substants a state the state and CLASSICAL PROD - tam it - good and - boot - and and shoots within forty days. a die the state and a strait of a

1 + + 1 . . . . . . . . . . ......... 1 . . . .

the second secon .... 15 ..... 「「「」」」、「」、「」、「」、」、「」、、」、、」、、」、 - and a first of the second and the second of the second o . . . .... \$ \$ \$14.4 × + ----

「ちょう」 してももえる . . . - ber manuferburgers of many and 1 1 4 4 4 4 Cariban an farma harris when the party of the state of B . . . . . . . .... 1 1 1 . . . . . . . . 1 4 4 1 + 2 + 2 3 - 2 8 2 4 4 4 1. 1. 1 

- -18 1 1 2 1 1 4 2 1 1 2-5 ...... 4.8 1 4 4 . . . . . . Simmer & Arrange Sec. 4 . 5 . 4 . 4 2 1 2 these budget and a state of a state on today is a new provide the service of the servic and since 1.5 4 . F + + + + + -. . . . 8 - - - -. 「「山を見て」とをます 1 4 3 3 ... - - - - -11. . . . . 8 8144 and the second BOALLE BARRAGE IN. the same state and any x + 5 + - - -. . . wanter and a second and 1-7. And with programmer a. 

1 2 ----

.

しいち ほう あい かいかい

S. 100

A 10 B

4 5 4

1-46-1

4 .....

1 . .

and in the man

1.5

1.0

10.4

.

- ÷

Destance Section +

4 5 4

.

La Lago

.

. .

2 4 5

-augusta

. . .

2 3 4 7 2 4 8

そうちょう かん あっかう さっちのな かうちょうちょうかい

. .

. . .

1 A 4 -

Acamer Brange and the second in 197

- Loger Ser Surgerale.

......

4. 1. 1. 1

summer present

. 2

1

.

- Ar J. Star 14 74

- 40

ふいきっ と、長のやいまたこ

· · ·

コスタンウーンシス 第二 とののあまりのかう

1.5

1. 1

.

19.1

.

3 8

------

10 1 mar 10 1 + 10 - 10

the sea sector to the sector

. . . . . .

......

a colorador de colorador por entitación

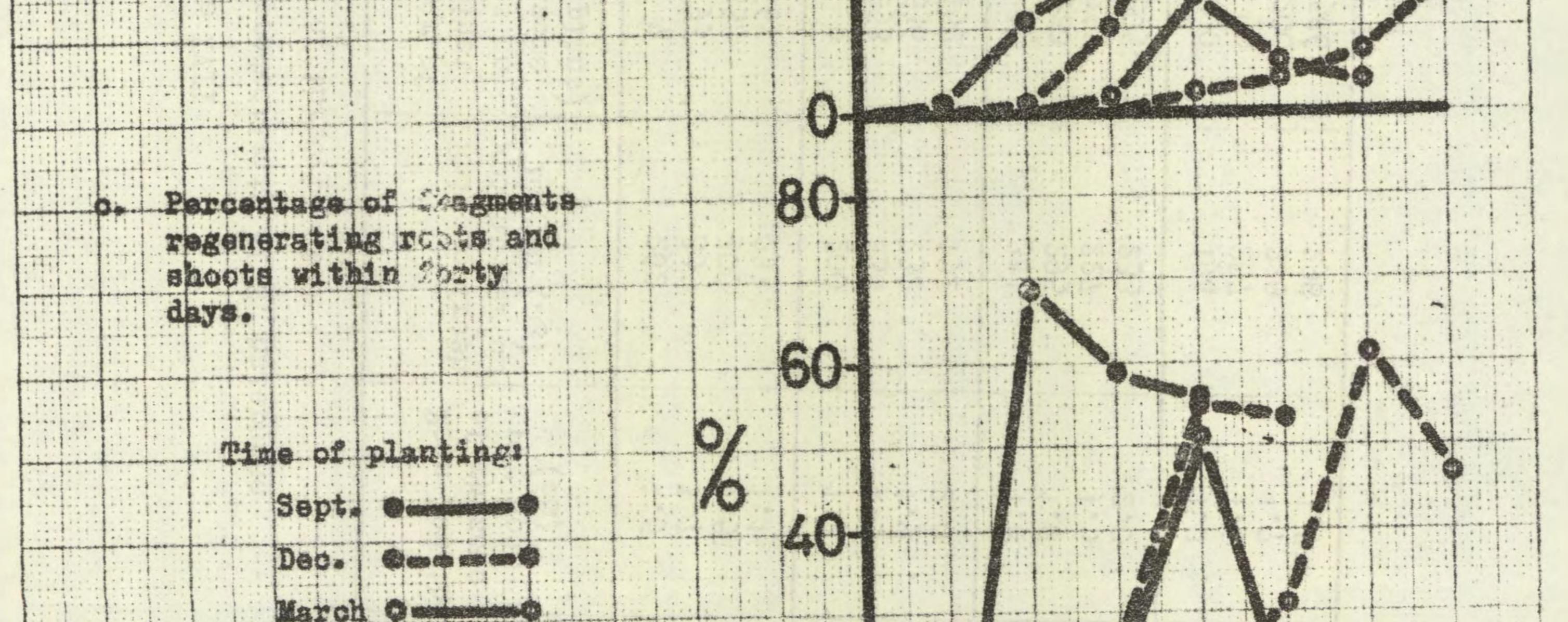
2. 4 . 4 . 7

. . . . \* \* \* \* \* \* 1 4 2 3 \* \* . ..... 111.111. 1. 2. 新聞 4. 6. 4. 1 \* \* \* \* \* \* And ...... ....... · · · · · · · 8-6--8---6 豪王 (おもちーと) 豪王王王 ちょう ....... And the state of the second state of the secon .....

5 6 8 5 4 -. . . . . - R. W. \*\*\*\*\*\*\*\* · - + - + + - - - + + \*\*\*\*\*\*\*\*\*\*\*\*\* a . a this to the a had a h · · · · · そのうきかもの 计单位表 机输出关系 A + A | = { - 1 + + + \$ 2 4 8 4 7 4 8 S . 4 -----\* 16114 ---· · · · · · · · and another of starts to the form - 22 - some the a north the in state of the same ' - a an appropriate and the second wine or fine month Executions to develop and the marting as a state \$ x x 4 1 -· · · · 1 + + + ----. . . . AAAAAA ABARAAAA Ver & Vel 1 ..... 1 1 4 8 \* 2 . 2 8 . . . Later in the state in the state in the Tel States ------Sec. 1.61 かたくまたいたとき、多いあっ

11. 11. 11. 11. 11. 1 BU AT I S A - x + 0 「キャモッチャッチャンン 1 1 1 \* \* 1 + 5 + 4 1 1 2 2 2 3 4 3 5 1 1 4 . . . . . . 1 X L E I Y e 1 at it is the part of the second at the second of the second secon 2 4 2 1 いちいち といろいたいころもこ いいま たいいちからいち ちょうちょう 1 8 4 and a standard and the standard and \*\*\*\*\* ....... 1.4.6 2 . . . . . . ------......... 29125 3 1 1 1 K 1 K L . . . . . . . . . 4 . . . . . 2 . . . . . . - + 5 i I ....................... . . . . . . . . . 1 . . . . . . . 1 4 4 5 5 1 4 1 -1 1 1 1 1 a - a 1 £ 1222 4× an calar a six and a relie & and a polyage are a factor - and and a set a man as a re-

このあいろい うち ちとうしち しこうちょうしい していちょう ちちしかい ちいち いうち いうちょう ちっち しろう ちょう ちょう ちょうちょう ちょうちょうちょう ちょうちょうちょう internet without 1 + + 5 -. . .



2. 2

1.1

1 - F

1.1

1.4

4 1 4 4

4 - 10 - 10 - 10

2 + 2 -

. .

. .

1 . . . .



wer and the second and a series and Electronic and and a street in and at an an a for which and a for a second at and - so a set a set 4 7 7 . . . 1 6 2 4 1 3 4 . 1. 1. 1. 1 2 1 . . .

1 - 21 . . . . A . . . . . . . . . . . . . . . 4 2.0 . . . .

. . - E . . and a second a second and the second as the second second and a second + 7

distant thinks a mapine to per-

proversition a real of the sport starting

.....

1 - + 4 - + 8

-4 4 5 5 1 - - -- 1 ×. . . \* E 2.0

. an a second to the second a grant as the second the production of the second o and because property and · - · . 4

. . 1.2 . .... 111 4 . . . . . . . 2 2 -. 3.14 「ちゃ、チーンルの島としたと見たくとの思え、中に多く、とら書として、シャー ......... N. P. \* . . .

5.8 . . \* \* 1 . . . . 1 4 4 1 . 4 . . . . . . 10 10 Aug - 10 1 1 - 10 1 preservation a proprietable to a designed in the same and an and the second あっちした、 一年にかったの、かいかいかいないないないないないないか いろう 1 1 . . . . .

\*\*\* \* \*\*\* \*\*\* \* 1 4 1 X X X 0.00 - - F - -1 1 1 4 1 . . . . . . . . . -11 1 「マスチをないりょくまんとうしき」 しゃ オイノスカネイススクロス -----4 1 2 1 4 4 4 1 C # . . . . . . · 4 · 1

· . . . . . . . . . 1 4 4 4 1 19-1 18 1-1.1.8. 2.8 -1 4 8 4 ware a complete the fore - compare and the doct my an a photos for the me ing the surp of surprise of The ARRONAL CAR

and they 1 . . . 4. 6. 6. 6. 1 2 . . . . 5 ...... 1 . 4 . . . 1 1 . . . 2 2 - 3 . . . . 2.2 日月二月月日 1 . . . . . . . \*\*\*\*\*\*\*\* まちらりをます。 ちまちととうち 1 8 8 - 11 - 8 .... . . . . . . . . . 6 . . . . . . 41111 . . . . . \*\*\*\*\*\* fersigte that there there a . . . ......... 2.1.2. ...... しょしんがんからう 書のをもっきり アイ . . I A I B A M I . . . . . . . . . . . . . . . . . 二善生义 医单子肉皮 11 11 1 . ++++ \* 1 1 ± r . . . . . . 1 2 2 2 3 - 2. h. and the second of the state of the second ...... ----A reason is a representation of the \*\*\*\*\*\* THE COMPANY . . . . . to a war a get a get the to be to be a get a ÷ K ............................... . . . . . .... ..... 

........... 12" .... ききゅうりょうなき きっとちゃきょう イ 1 m 2 11 2 .... \$ 2 . + 2 3 5 - C 4.4.4 ちをとましたと考慮するとしませんで ........ 1 + 5 6-4 1 5 1 . . . . 1 - 1 -2.4.2. . . . 1 2 -5911 2 . . . . 113 7 2 8 4 - 4

a get any and a set of the set of a set \* + - # · · · # # = 18 -1 . . . .

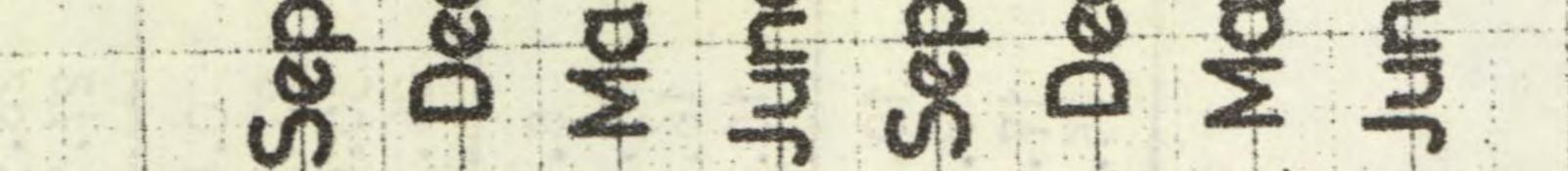
. . .

+---

. . .

and the stand attack of





. . . . the first sugar and the stand of a country we t -Paster a. . ..... -----Constant - E-Ecology with ·ちゅう、んちま かん かうういたかかかうろう . 1 1 1 . . . . . . . . Month of assessment .... . . . . · 1

and the second second 2 . . . 5-2- - - -1 . . . . . . . . . 1 1 1 4.6 1 1 4 4 4 . . - - - - I. 1 . 2 . 11.14 - - - -. . . . ...... ...... 4 .... . . . . . . . . . . . Sec. 11

11.11 2 .... 20 4

#### Table XVIII

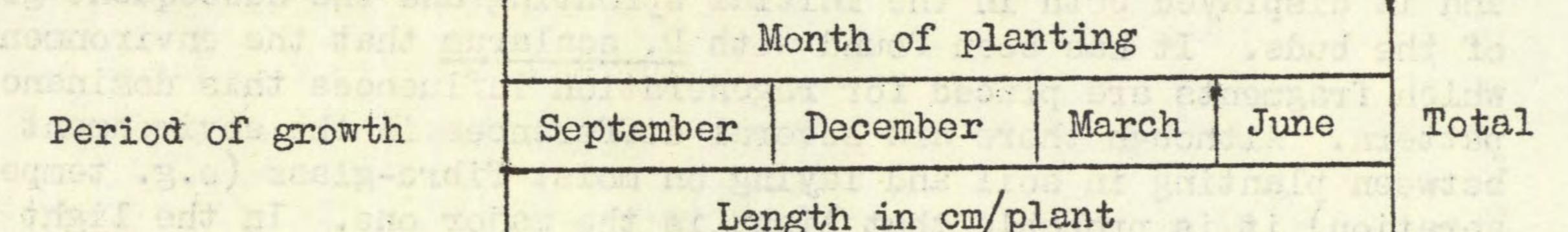
- 33 -

Increments in rhizome length of <u>S. halepense</u> during three-monthly periods of growth (data are means of three plants)

-----

1 ....

.



September - December	10	-106	-29	-54	-179		
December - March	145	2 .	42	219	408		
March - June	329	574	92	546	1543		
June - September	224	453	304	166	1147		

are of obvious significance in the physic legy of regionerizing a support of to see

you's teding? internew bracerissie

#### 7. GENERAL DISCUSSION

to past shit is the bit tak to we stren

Rhizomes are very efficient as perennating and reproductive organs. Their subterranean origin places them in a physically protective environment while their diageotropic growth habit maintains this and serves to extend laterally the plant's domain. Their regenerative ability is displayed both in the intact plant by the emergence of new shoots, often some distance away from the original stock, and more dramatically in the fragmented plant by the stimulation of sprouting of buds on detached fragments. Regeneration of detached fragments is dependent on physiological factors, largely unknown but which presumably include the status of bulk food reserves in the rhizome. The aerial assimilatory parts of the plant determine rhizome growth, condition, and hence ability to regenerate both when intact and fragmented. Rhizome growth and regeneration may thus be related to the general metabolic processes, in particular the photosynthetic efficiency and growth-substance status of the aerial shoots.

Of the four species studied here three have shown a similarity in pattern of rhizome growth and reproduction, whilst that of the fourth, <u>I. cylindrica</u>, differs somewhat from the others. While two and even one-node fragments of <u>D. scalarum</u> and <u>S. halepense</u> readily regrow, multi-node fragments containing an apex are required to achieve comparable success in the case of <u>I. cylindrica</u>. It is the apex which continues the growth of fragments of this species. Sub-apical buds are seldom encouraged to sprout in the absence of the continued growth of the apex. This contrasts directly to the behaviour of the other

species.

Photosynthetic tissue is quickly produced when apical fragments of <u>I. cylindrica</u> are incubated in the light, and light appears to be necessary if roots are to be initiated and the fragment is to survive. Also if a fragment already has an established green shoot then chances of survival are increased further (Table XIII). In the dark the leaf tissue underlying the other scale leaves of the apex may not expand or only slightly expand and of course will remain without chlorophyll.

Once the apex of <u>I. cylindrica</u> rhizome has resumed growth some of the sub-apical buds may begin to grow so that the fragment establishes several shoots. This is similar to the behaviour of the intact plant where branching occurs just behind an upturned apex of the rhizome with the buds at the position of a "bend" producing new shoots. Buds lower down the rhizome do, however, remain dormant. This is a dominance system in reverse to the usual pattern such as is found with e.g. D. scalarum fragments. Here the common pattern of apical dominance occurs with the most distal bud of a fragment inhibiting the growth of the proximal bud(s). This is consistent with the concept of polar flow and is displayed both in the initial sprouting and the subsequent growth of the buds. It has been found with D. scalarum that the environment in which fragments are placed for regeneration influences this dominance pattern. Although there are several differences in the environment between planting in soil and laying on moist fibre-glass (e.g. temperature, aeration) it is probable that light is the major one. In the light both proximal and distal buds sprout equally and the shoots they produce appear equal on casual observation. This tendency for both buds to sprout in light has also been observed with stolon fragments of Agrostis stolonifera L. (Henson, 1969). However, further measurement of D. scalarum has shown that in terms of shoot fresh weight the distal node is still dominant. These modifications by light and possibly other factors of the growth and expression of dominance in fragments of I. cylindrica and D. scalarum are of obvious significance in the physiology of regeneration of these species and warrant further study.

- 34 -

The position from which fragments are taken did not, in the case of D. scalarum, effect greatly their capacity to regenerate. Only the apical fragments too immature and too small to possess adequate reserves, failed to grow. Apart from this instance variation in the bulk of rhizome, as measured by its fresh weight, did not influence the regenerative capacity of the bud, for buds with the greatest bulk of rhizome associated with them did not necessarily give the best regeneration. The physiological state of the tissue was therefore of more importance.

The rate at which fragments regenerated differed, being rapid for C. dactylon and D. scalarum and slow for I. cylindrica and S. halepense (Fig. 6). It is probable, from the work of Ingle and Rogers (1957), that for S. halepense temperatures used were sub-optimal for most rapid regeneration.

The state of the rhizome and its suitability for propagation may be influenced by age and/or season. The experiments designed to determine the importance of these factors high-lighted interesting differences between the species. The regeneration of D. scalarum fragments was governed largely by seasonal influences and regeneration was poor in mid-winter. This was generally the case also with C. dactylon and I. cylindrica. S. halepense was less influenced by the time of year and age appeared a more important factor. Fragments from young plants often gave poor results.

The manner in which season affects the ability of the rhizome to

regenerate is not known but presumably the conditions governing photosynthesis play a large part. Light and temperature are the major varying factors and an effect of temperature on the capacity for regeneration by I. cylindrica stock material has been mentioned. If plants are grown cool (at 10°C) during the winter, regeneration of the fragments prepared subsequently is improved. This may be the result of ensuring a more favourable balance between photosynthesis and respiration under the low light intensity of the English winter; this increases the quantity of assimalates available for fragment regrowth. There is no advantage of such a treatment with plants during the summer when light intensity is increased.

Growth of rhizome is also under the dual influence of plant age and seasonal environmental variations. The quantity of rhizome continued to Fig. 6. The rate of regeneration of rhizome marghent. E. a. E 8 8 -

1 4 5

~ \*

1 the work into the same working

. . .

-

5

1. P

.

. . . . . .

A & A

Sector and a

\*\* .....

1.6

. . .

4-4-1

A LANK & ALAR

and the second

- -----

have not a super a set and a set of a granter of many horizon bound to a set a s

3-

1 1 1 1

taken from 12-month old plants あっている いちのないあるし ちのう とう あみをまし Reversent. 6. 10

> June

.

- - -

.....

-

I some sale as replaced

2. 8 . . .

· - 4 1 - - 4

4 10

Contraction of the state of the

4 4 4 5

1 .

.

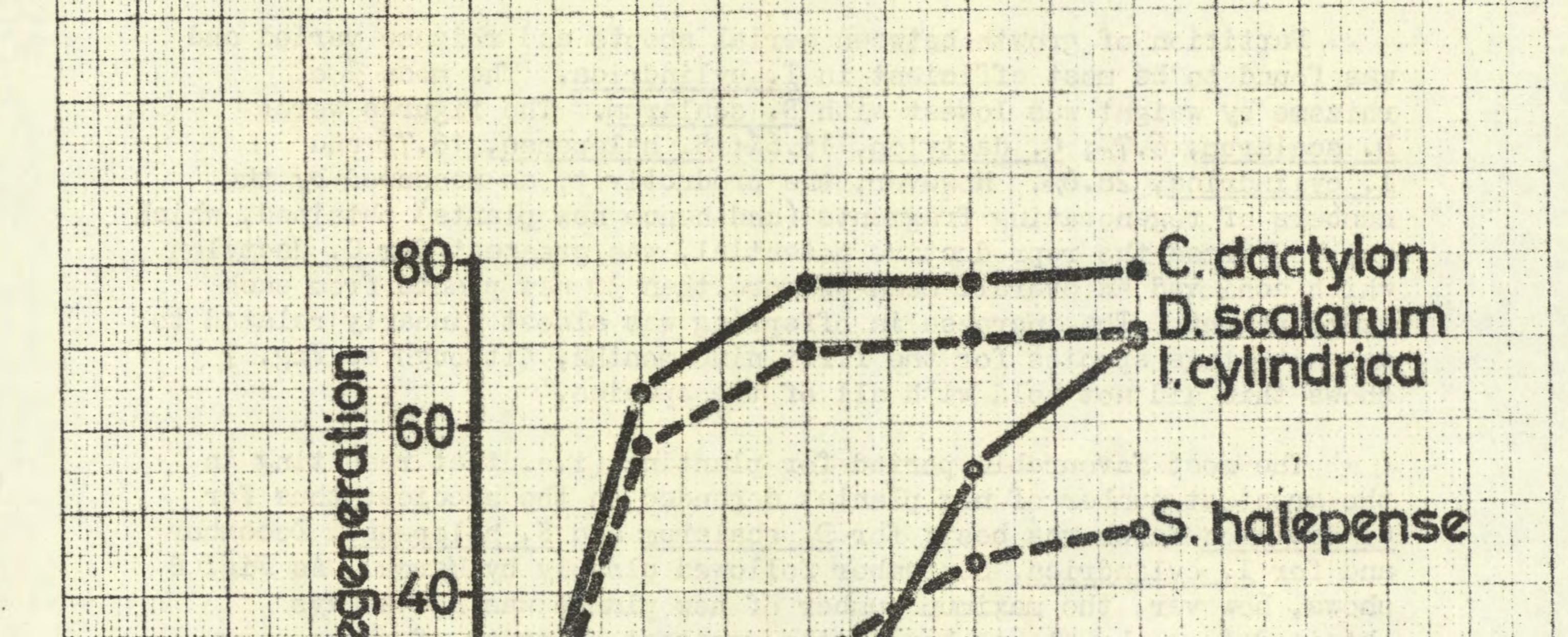
+

and the second s

are and a set of the

-1 - 1 - 1

ころう あんかない ちょう しょう あいち あいまい アイアンガインガイント 小かう



4. 1. 1. A. A. 4. And - 4 \*\*\*\*\*\*\* .......... ......... 

\*\*\*\*\*\*\*\*\*

a deal grades dealer dia my applying income of agent

. . . .

1 . . .

\* \*

. .

. . . . .

. . . . . .

4 8 4 4 1

- 4 3 3

. . .

......

書をちまも言うとう

\* \* \* \* \* \* \*

. .......

to the design of the state of a state of the state of the

\* \* \* \* \* \*

. . . . .

. . . . . . .

. 7 . . .

10.1

.

Capacity Martin - 4 and the Brits M. Martin Service and

.............

and want inserver a strange to some name

..................

· • • 1

\* 1 + + \$ 7 + \* + \* \* \* \* \* \* \* \* \* \* \* \* \*

「「ちちまちよももまち」もうまとう」う

· · · · · · · · · · · · ·

4 4 5 7 4 4 4

11 6198

.....

\*\*\*\*\*

144.55

1 4 4 4

. . .

.....

1 2 4 1

. . . .

· · · ·

2 h T

2. -

........

. . . . . .

1 - 1 - - -

あったみちも にての

22 8 2 ....

----

. . . . . . . . . .

上ますことうかい 1 44-4-1

きょうときもうとく

.........

5 + 1 4 5 + + + 5

. . . . . . . . . . .

. . . . . . .

8114

.

1

- -

1 1 1

1. . . .

1

· · · ·

and markly dealer at 1 th

11 A 14

.

1 4 4 7

1 \$ - 1 +

ちょうとうりきく きょうきょきょう

. . .

A. 1 3 - 2 8 4 - 1

. . . . . . . . .

. . . . . . . .

the and have a fragment of a serie of the series a series of a series of the series of

「そうを言え」とも書く しともう しとうと言くともっち ともうとうちょう うきをうとう

the second

. . .

2. . . . .

8 4 ....

. . .

1.112 11-1

11 11 1.3

--- **\$4** -+**\$**1

しくしきをとうから書きとして多く うちろい

The standard of a state of the state of the

- 1 E 1 - A

4 . . . .

----

4

1.5 6 10

1 1.

-----

...

111 ...

- 大法になる ちゅうようしき

1 - 2 - 2 - 2 - 2

1 - 2 3 9 4 4 4

I'M BOLV AND WELL AND ADAL MANAGER AND ADDRESS OF ADAL ADDRESS OF

. . .

and a stand of the second stand and the stand of the second stand of the

1 + 2 5 - 2 4 - 2 - 4

while and she do

and the second second as

. . . .

and the boys design - 10-

1.0

+ 1 - 2 +

1 4.2

- N N -

we is hit was a for this of water and

mill blattigents +

. 1

7 . . . .

1 47 4 -

- -

. . .

A 400 10 10 1 100

.

Company and a state of a state of a

· - - ?

- -

. . .

Action Accord & Accord

1.4 4 + +

· \* \*

シュート しんち ちかっとう あいましたかい してもないしたいかいましたいものあたいないたいで

3.4

8842111 . . . . . . . . . .......... \*\*\*\*\*\*\* . . . . . . . . . 52 18 24 4. 4. 9 . 4 . 4 . 4 . . \* \*\*\*\*\*\*\*\* Auto in an an an an a and a second and a second seco to go a shall be stored and 1 . . . . . . . . . . - - - -.......... いまえられる おおちをちゃく ちちち ウスー 2 . . . A . . . . . . . . . . . . . . . 2 . . . . . . . \* \* 7 8. . ......... .......... ......... a starting a starting and mind the for a serie of the property have a property dech

1.14 2645344 . . . . . . . . . ......... ...... 2 3 4 4 5 4 7 4 7 4 ····· . . . . . . . . . . \* \* \* \* 1.1.5.2.8 4 5 + 5 4 + 5 -. . . . . . . . . .......... . . . . . . . . . ......... anonita thinks a subcorrent 1 . . . . . . - - - - - - -. . . 2. 1 . . . . . . \* \* \* \* \* \* \* \* \* \* ...... 1 + i - 1 + + 2 - + 1

8.07 ........... A ..... 4 1 1 1 1 1 1 - + + + 1 \*\*\*\*\*\*\*\*\*\*\*\*\*\* anaderes a service and the trained But or a group a superiord Bridgente - Strate & at a tradition in the strate - A and at 1- and 1- and 1-- and and in the same まっちゃうまちとちちました うちょう アード・アード・デード・デード・ . . . . . . . . ときき、最大な 上部に、上三部 ビール . . . . . . . . . ショネ・素をきまい薄える う 4 1 2 2 4 4 9 4 8 . . . . . . . . \*\*\*\*\*\*\*\*\*\*\*\*\*\*\* ... . . . . . . 10-4-5 4 - ---

「 、 、 チ 、 キ 、 チ メ あ 、 フ と つ 1.4 ins 1 4 + + + . . . . 4 - 4 1.1.1.1 ..... 1 1 1 1 2 2 - - -8 . . . . . . . . 2 2 4 4 ..... 2. 9. 9 . 8 . . . .

a set of a set of a set of a set ----. . . . . . . . . \* \* \* \* \* \* \* \* \* 85.4 2 . . . . . . . \* \* 6 \* \* \* . . . . . . . . . . . . . . . . . 4.1.2. 4.1. 4.1 .

Lastal and spread and the standard and the states of the state 1 . . . ..... 1 1 . . . . . . . . . . 4 . . . . . . 8. 5. 8. 2 . . . . . . Sand at the 2 . . . . . . . . ........ Sector and a sector and a sector a ション ちょう いまいち あんろう ちゅうなおちろ 水をすぬきちまう

かんゆのをくまたと事まとも意味ないとう の and seed recently address . . . . . . . まっていて考えのとううとくと考えたかと考え、 1 8 E 1 8 The second second



......

2 1 1 1 . . . . . . . . . . . indexes or manife to this is the days of sales of the same to and in the second of the second s . . . . . . . . . . 0 3 4 - . 8 ..... 3 - 1 + 2 1. 4 7 8 4 5 x 5 x 4 -----............ 14 T - 12 - 1 - 1

4 1 - 9 2. 4.4 3 + - + \$ + - + 1 PARAMANA A AVIA 4 m 2 .

. . . Days of Incubation allight for in the segmented and for

and a state of the state File a 

. . . . · 21144-1.1.1.1. 4 4 . . - 1 + F - + # 1 P. 1. P. T. T.

1.4 2 1 1 1 2 2 3 3 4 \* + + + + + -1 A. A. S. + A. . . . . 5 . . S . . . ......... S . . . . . . . . . . the state of the state of the state of . . . . . and the second s 13 . . B----......

. . . . have been and an an inter and the part of the state of th 3 1 1 A . . . .

\*- \*\*\* \* 1 1 4 \* + + E. L. C. L.

もうしてき きちをうち うちのうち こうち ふうち かちのち ちちのちちちち

. . . .

1 4 A - - - -

100 A 10 A 1.1

And the Base mildle and which the me

. .

1. 11

Sound attain to the first the sound of a sound at a sou

-----

and a state of the

28.2 

. .

- 7

.

.

. . .

17 19 15.

. 6 .

. . . . . . .

G. TOLOLO . . 

112 -. . . . \$ \* \* \* \* \* \* \*

\$ · · · · . . . . . . \* \* \* ......... 一 き とんないとういため、おいかち シャクション とき とかとうと とう . . . . 5 . 8 . . 8 \$ · \$1. . . . . .

-· · · · · · · · . . . ALC: D 1. 3. 

a strange i 5 4.4 1 4 E - - t 1 4 t . . . . . ÷. . . Solar Director

1.1.1 1.1 

were a construction of the second of the sec .

. \* 1 - 1 1 1

2. 2. 2. 1. 1.

. . . erest and ender the search of the second 1 1 1 1 1 1 . . . . . .

1 - - - × 

I an one down to an appearing the second of the second 1 -

. . . . inte sori 540 Contraction Street as the Part . . 1 .

4.1 「「王」またとの「書」の「書」を書える」「「「王」」の書」「「書」をの」書」「「王言」」の書で、「書」」で書 

-----a - 1 - 1 - 2 - - - - -

1. 1. 6. 1 . ¥ . . . . . . . 2 4-1- 8- 1-2 4 .

. . . -. . . - 4 - A.-. 8 . . \*\*\* . . . . . . . . . 4 . . 1 - 1 - 5 18 . . . . . . . . . . 6 . . . . . . . . . . . . . + \* . . 415. 2 . . 第 メー・チー ふんきととしをうと とき と ち 、 ぎ \* 1 1 A 1 1 A CONTRACTOR OF A CONTRACTOR A

1 4 1 1. 1 2. 7 . 1.2 2 . . . . . . . -

manifest aparte a particular a particular and a second a \* 1.1 2.4 .

. . . E. the second second . .

. . 1 1 2 2 4 

the second second and a second second

4 

11 . . . . . . The tax at the sector of

increase as the plants matured despite the somewhat restrictive influences of the pot. Rhizome grew most rapidly during March to June for <u>C. dactylon</u> and <u>S. halepense</u> and from June to September for <u>D. scalarum</u> and <u>I. cylindrica</u>. There were cases when the amount of rhizome diminished. These losses occurred in the winter months; all species showed decrements in length of rhizome between September and December, while rhizome in one planting of <u>D. scalarum</u> decreased also between December and March. These losses in total length must be due to decomposition, but there were also losses in fresh weight unaccompanied by a decline in length, notably by <u>I. cylindrica</u>, which may have been due to depletion or redistribution of reserves.

- 36 -

Partition of growth between aerial shoots and rhizome varied and was found to be most efficient in <u>I. cylindrica</u>. The mean % of rhizome by weight was lowest with <u>D. scalarum</u>. The figures were: <u>D. scalarum</u>, 6.7%; <u>C. dactylon</u>, 15.6%; <u>S. halepense</u>, 18.7% and <u>I. cylindrica</u>, 28.6%. However, the productivity as measured by the numbers of regenerating fragments (and hence new plants) obtained, which may be termed the reproductive potential, was greatest for <u>C. dactylon</u> which achieved an overall mean of more than 30 new plants from each stock parent. The increase in offspring was almost linearly related to age with this species for the first nine months, although as Fig. 7 shows this did not hold with all of the species.

The most favourable period for planting (i.e. that resulting in the greatest number of new plants) depended on the species; thus for C. dactylon March was best; for D. scalarum and S. halepense, December and for I. cylindrica, September followed closely by March. As Fig. 8 shows, however, the maximum number of new plants was not always obtained from the plants having the greatest quantity of rhizome or yielding the greatest number of fragments, although for D. scalarum and S. halepense this relation did hold. For C. dactylon, while the number of prepared fragments did depend on rhizome length, the peak for regeneration did not coincide, as December planted material regrew but poorly. With I. cylindrica the number of regenerated fragments depended closely upon the number of available fragments. The number of available fragments was not however related to the total rhizome length. It was more related to the extent to which branching occurred in the system, and this appeared to be in some cases an inverse function of length. Fig. 8 gives some guide as to choice of planting date for maximum productivity of the stock plant. Winter planting (December or March) presumably allows for establishment prior to the most favourable growth period (March - June) and hence gives highest yields.

As mentioned previously there is a general lack of information on the growth and regeneration of the rhizome system of these species, except for <u>S. halepense</u>. There is thus much need for such studies on this aspect of the biology of these weeds. Pot experiments of the kind reported here can never be a substitute for field studies but they can serve as an indication of trends to be expected in the field, and are useful in the comparisons of species and clones, and can be used to investigate critical effects of environmental factors. Field studies on <u>C. dactylon</u>, <u>Cyperus rotundus</u> L. and <u>S. halepense</u> are indeed at present in progress in Israel at the moment (Horowitz, unpublished communication 1968) but similar work needs to be done in other areas of the tropics and sub-tropics if the results are to be widely applicable.

#### 8. ACKNOWLEDGEMENTS

I wish to express my thanks to Mr. C. Parker and to Dr. K. Holly for their helpful advice and continued interest in this work, and to Mr. R. Collery for his able assistance in completing the seasonal assessments of production and regeneration.

ころうち かっかい あまうちんちか しない かったいない アリンティーキャンクないない ないない ちょうかい アリーレン モー・シアレン デント あたいか たいかくろう 2 - 4 - -2 - + + + 38.00 S & 4 357 9 1 1 1 \* \* \* \* \* \* 2 . . . . . シンテキンデン教にないのを . . \*\*\*\*\*\*\*\* 1 2 A 4 . . \*\*\*\*\*\*\* 1. 16 1 A-1 2 8 4 6 2 2 4 4 . . . . . 1 - 2 + 3-0-0-0 . \* ... 4. 11 4 5 4 4 1 10.0 564+52+24 1 . 1 . . - 3. r. e. 1. 4. 21. 1 A . 1 . . . . . . . . . 1. 4. a. . . . . . 1 14 1 \*\*\*\*\*\* 1 1 1 .... .... 8 ...... · · · 1 4 - -1 . . -----1. 1 . . . . 111 A . . . . . . . . +1 +87.2 . . . . . . . . . 1.2.1.2 A & . . . . . . Max - shest to burn a spike a de saint in the according to a and an ana part is a A. A. 1. Sant in the short with Party A STATUTE A THE A CONTRACT OF ANY A DESCRIPTION AND A STATUTE A and he specific to the first And Frank Strate and the Fight Made 17 . So taken 10-and an open service to see to an appear with the relation of the . . -- . . . 6 - · · · · · · · · · ......... 豊く 1 1 1 1 1 \*\*\*\*\*\*\*\*\*\*\*\*\*\*\* 4 4 - 4 · · 1:5125:::. 4. 1 × + 1 - - E ちょうと見るしまとなってるまとい . . . . 228 224 A It is a set a set a set 1 . L . E 121911 あいしん しんだい トロック 6 612 1 ---- X - + . . . 4 4 4 2 . . . . . . . 2712 2.1.2.1 ................ 1 1 4 1 - K/E 3 - 2 - - 1 12 .... 4 5 2 4 4 4 5 4 4 . . . . . . finite Bet in & Granter & c - - - it as a rest made to market a あいや ないないからの 二日本 とうちいましき とうちょう in The Section and have been all the second is the angenticity - and ever all and it is and the for the to make a state of a state of the state of a state of the state of a manufact quilters 5 6 1. 1 · .... . . ... .... . . . State States a 8 4 7 . ..... ションをもう イインディー しい 1. . . うえきもくももう 第二十五 第五八三 1.21 . . . こうそうちょう ちょう あえり シュタイト やい 1. - 5 . . 8 4 4 - 2 2 4 「大学をという」 そうちちをやるのを見たいろいなりることをしいが、 うろうろうををないをうろうく モットコー チャックト 5.1 14 14 14 14 「あるとをきるると、書き 「もまとこう」 \$ ....... 1 1 1 - 1 E -. . . 1.00 ------ 子をと言えてこと事 - もうう - 8 \*\*\*\*\*\*\*\*\*\*\*\* . . . . . . 1 1 2 1 1 10 anoprisite por set a deservation provide a destruction of the second Same B. Parka Brids 15. I TANK IN MANY IN THE R. P. - farmer a temperature and Caller and the state of the state the set that the set the set of t and the state and the set of an and the set of and Martin Barrison Jake Barris . - 1 E 2 5x-1 14 × 1 × 4.1 3 . . . . . 「まる」をありたとなりともの書いるか。 A + + + + . . 1 + + + -\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\* . . . . 1.14 111-912+1 1144 Stat States - 3.1 . . ...... 1 - 4 + 2 - 2 + 2 + 2 + 2 -ムナ日来・テリト学 1. 7 2 3 - -4. 4 1 2 3 3 A -1. H . T . -第二、アンテムという書、 シンス・シアーキャイ \*\*\*\*\*\*\*\*\* A & + + + 6 . . N 1. 1 12124 . 1 . . . . A . . . . . 1.2 14 1 \*\*\*\*\*\*\* A . 2 . 7 . . . 1 2 4 \$ . . . + t . . . 4 1 4 4 8 9 9 4 4 **8** + 1 **4 4** 7 + 1 e-sense is 2 merispectures. Contrary and I all the man with the state of a garger of a sin to rear of and drawy stor inite find a for game or de das -later age to the state and R + + + -. 1 50 S . . . . . . . . . 1. 1. 1. \*\*\*\*\*\*\*\* 4 27.43 . . ..... ままち、まちにちの気をする、日子をまたち、ろうとうち、 · · ..... . . . . and the state of t 188+2-8-1118+114+11++ ......... 1 ........ 4 + 5 + 1 2 + 1 4 1 1 4 1. . . . . . . . 1 2 - 1 1 1 1 2 2 2 - 2 1 A + 1.1 康子蒲保遗善日外日书惠子日子之易十日月) 8 5 6 6 7 + + + # | + + + ......... .... -----1 1 1 4 118 2 1 1 4 THERE I REPAIR CRATERS 第121日日の第2日 クモ ..... th plant age in the number . . 1 . 1 A 10 14 2 4 1 1 . . in the second se - 1 d of regener \* 1199994 inorease wi . . 1. 1. 1. which a safe a deal - - - and - - - when any and a start of the back 13.5 1 A 7 4 4.4 4 - 4 - 4 -.... \* = 2.3.2 ................ 書をましる意といきるをとるとの . . . . S + 1 + 1 + 1 + 1 + 1 きょくちょうし なりをきとりる うちょうかく ............... 4 4 4.2 5.2 1.4 第二年を日本をうちまを重えるのを考える後のあるとうの形ちのと考えていたち、、、もちもんが、第三、、も .......... 着え ちゅうぎょくちょ . da da Ca 2 4 3 1 8 1.1 2 - ふんいわれいないとうりょう A . . . . . . . . . . 8 . .

1.11至人屬大白白水溝

きちるからをとうおうまちらえ ! む

もあえるもの見からえきるとない、 遊ったさえてもなかり薄したでも含く、ためありたけにありますの長く

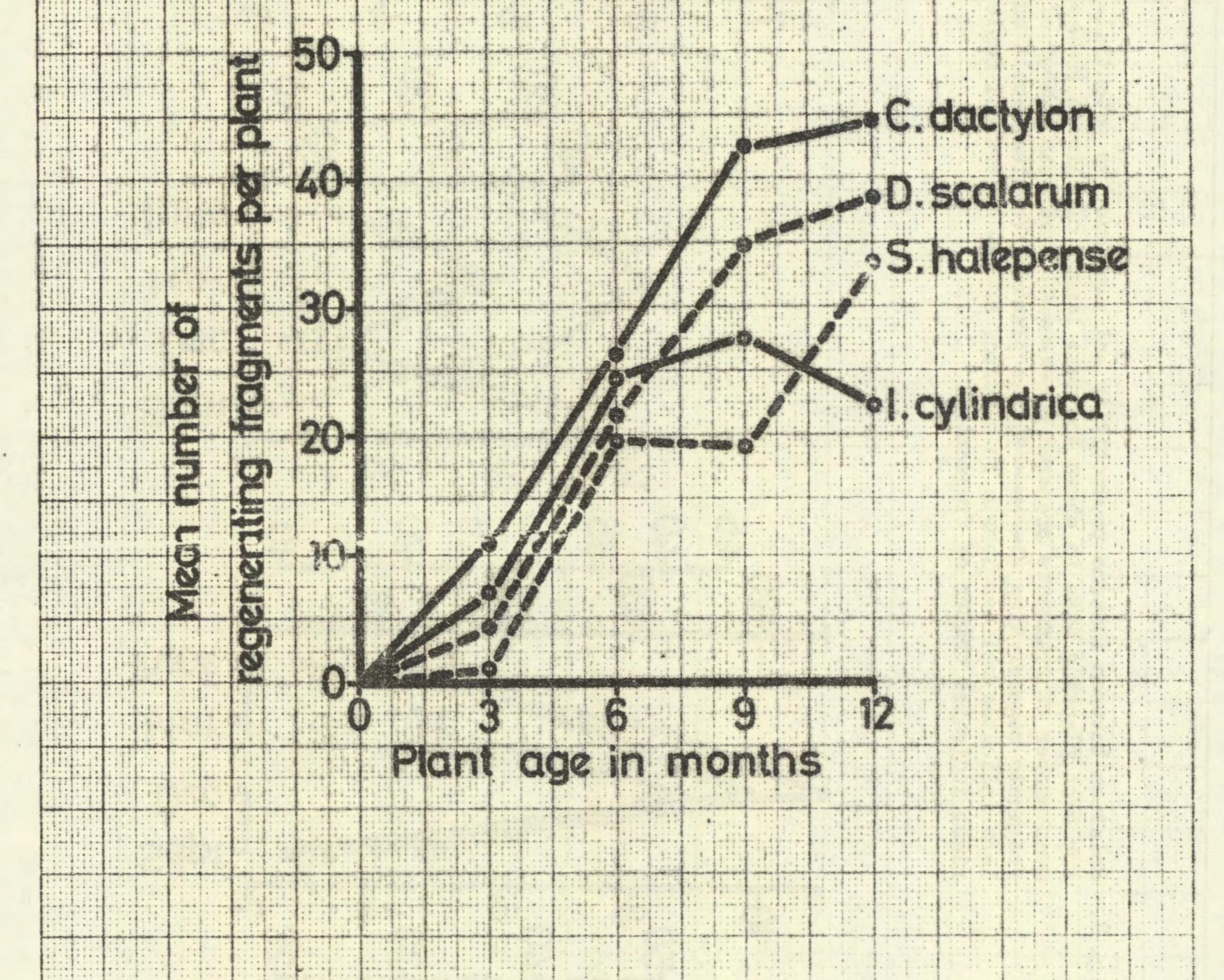
- 2日第二 生 -

- \* - T + + \* \* ·

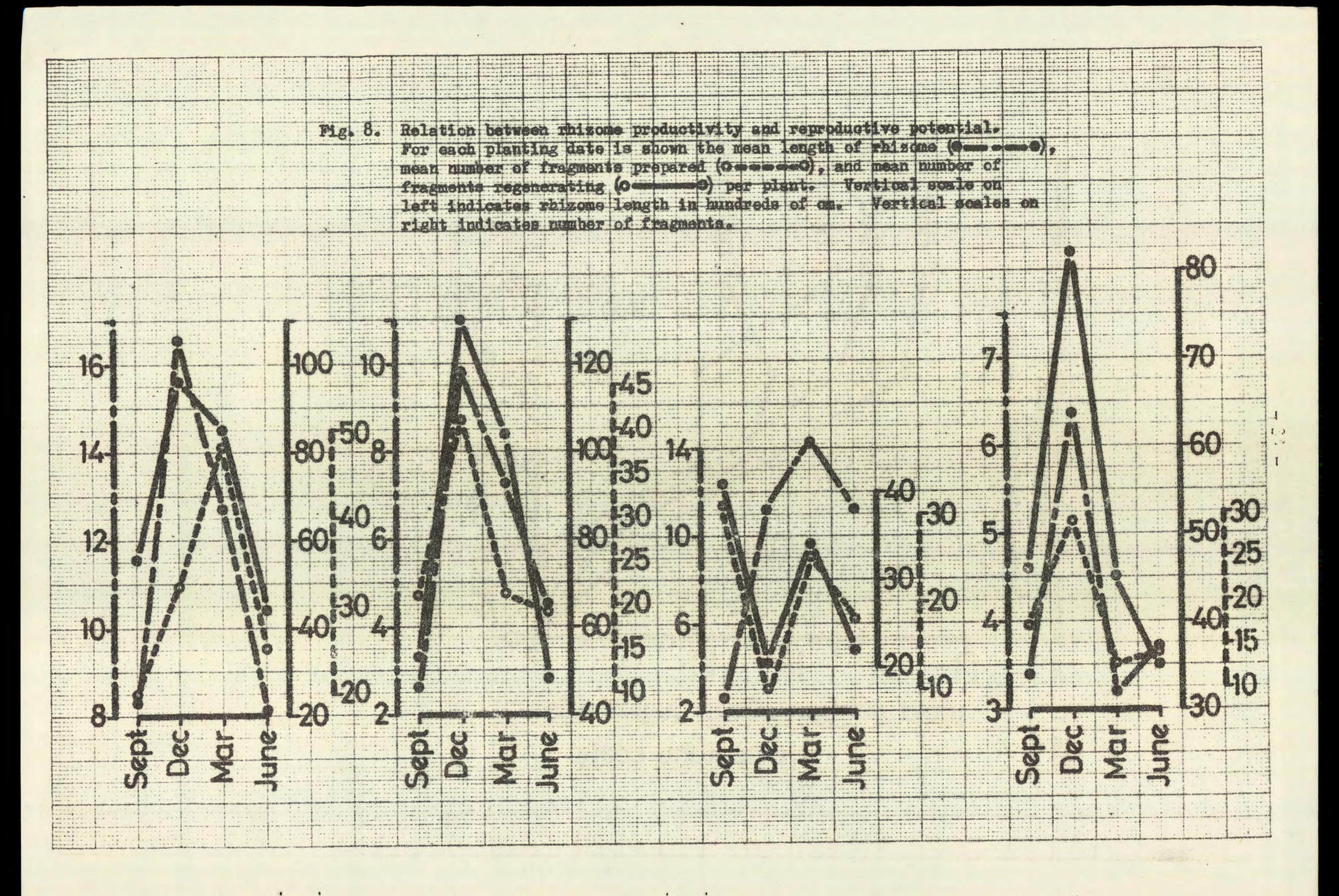
The second second

2.8

. . .



. . - - -. . . . . . . the second and a second a second and a second and a second and a second a second and a second a second and a second a second a second and a second a 4 1 1 4 -\* \* 1 . . . . x - 2 -. . . . . . T 1 . . . . . there as fills a star . . . . . \* - 18+ 11\$ 11\$ L. a' 3 . . . 1 \* 6 \* \* 1 R 0.51 a lateral and in the second . . . . . . . . . . . . ÷ .... . . and a state of the . 2024 - 21 - 21 1 1 . . - 3 + \*\* \*\* \*\* -1 9 1 2 . . 1 4 4 1 - 1 - 1 - 4 1 . . . . . . . . 4 . 6 . 4 + -2 -. 1 1.1.1 5 1 . . - - 2 5.1 1 . . 1 × × 1 2 12 -キーモンチンをした夏をしきと見かれたがない、「おり「おりかん」「おうない」「「おうな」」「「おうな」」「「おうな」」「「おうなのまし」」「「おうなのました」」」」「 1 Y Y I - - - E - - E Y 1 Y 2 1 S and provident in the second row that is the more A stand of the second and a second descendence of the second descenden and the first to dance after a set the group whether 1 . . . . . - -. . . for the second of the second 1.2.1.4 See See See . . . . . . 「二」を見るとも考し、「「「「」」を見ていていませた」の表したとう。 . . . . . 2.1 ままきちょうとき きょうちょう とうし としつ シストレート アイン・アイン・アイ 1 1. . 1 1 1. 1. 1 \*\*\*\*\*\*\*\*\*\*\*\*\* an bet A. A. and the second and th - they are a north good to Achieve destate in a second and a second a secon



#### 9. REFERENCES

- 39 -

ABDUL-WAHAB, A.S. (1967). Plant inhibition by Johnsongrass and its possible significance in plant succession. Ph.D. Thesis Univ. Oklahoma, pp. 43

ANDERSON, L.E., APPLEBY, A.P., and WESELOH, J.W. (1960). Characteristics of Johnsongrass rhizomes. Weeds, 8, 402-06

ANON. (1965). Rep. Div. Pl. Ind. C.S.I.R.O. Aust., 1964/65, 145

BOYD, F.M. (1967). A life history study of the growth potential and carbohydrate food reserves of Johnsongrass (Sorghum halepense (L.) Pers.) rhizomes. Ph.D. Thesis Univ. California, Davis, pp. 88

EDWARDS, D.C. and BOGDAN, A.V. (1951). Important grassland plants of Kenya. Nairobi. Pitman. pp. 124

HENSON, I.E. (1969). Studies on the regeneration of perennial weeds in the glasshouse. I. Temperate species. Tech. Rep. N.R.O. (12), pp. 23

HOLM, L: (1969). Weed problems in developing countries. Weed Sci., 17, 113-18.

HULL, R.J. (1966). Physiology of rhizome bud germination in Johnsongrass. Proc. N. cent. Weed Control Conf., 19-20

INGLE, M. and ROGERS, B.J., (1957). Growth of Johnsongrass rhizome buds. Res. Rep. N. cent. Need Control Conf., 162

INGLE, M. and ROGERS, B.J. (1961). The growth of a midwestern strain of Sorghum halepense under controlled conditions. Amer. J. Bot., 48, 392-9F

IVENS, G.W. (1967) East African weeds and their control. Nairobi. Oxford University Press, pp. 244

MCWHORTER, C.G. (1961). Morphology and development of Johnsongrass plants from seeds and rhizomes. Weeds, 9, 558-62

OTIEND, N.C. (1967). The anatomy of common pasture grasses in Kenya: II. Digitaria scalarum Chiov. (African couch grass). E. Afr. agric. For. J., 33, 23-30

OYER, E.B., GRIES, G.A. and ROGERS, B.J. (1959). The seasonal development of Johnson Grass plants. Weeds, 7, 13-19

POP-ANTOSKI, S. (1954). Contribution à la connaisance de la puissance des rhizomes des mauvaises herbes à former des organs aeriens per l'enfauissement à profondeurs differentes. Annu. Fac. Agric. Sylvic. Univ. Skopje, 1951/2. 5, 233-62

RAMAKRISHNAN, P.S. and SINGH, V.K. (1966). Differential responses of the edaphic ecotypes in Cynodon dactylon (L.) Pors. to soil calcium. New Phytol., 65, 100-08

ROCHECOUSTE, E. (1962) Studies on the biotypes of Cynodon dactylon (L.) Pers. I. Botanical investigations. Weed Res., 2, 1-23 -

SANTIAGO, A. (1965). Studies in autecology of Imperata cylindrica (L.) Beauv. Proc. 9th int. Grassl. Cong. São Paulo. 499-502

### SOERJANI, M. and SOEMARWOTO, O. (1969). Some factors affecting the germination of alang-alang (Imperata cylindrica) rhizome buds. PANS, 15, 376-80

- 40 -

STAMPER, E.R. (1957). The problem of Johnson grass. Proc. 10th S. Weed Conf., 149-52

THOMAS, P.E.L. (1967). A rhizome germinating technique for glasshouse propagation. PANS, (C), 13, 221-22

THOMAS, P.E.L. (1969). Effects of desiccation and temperature on

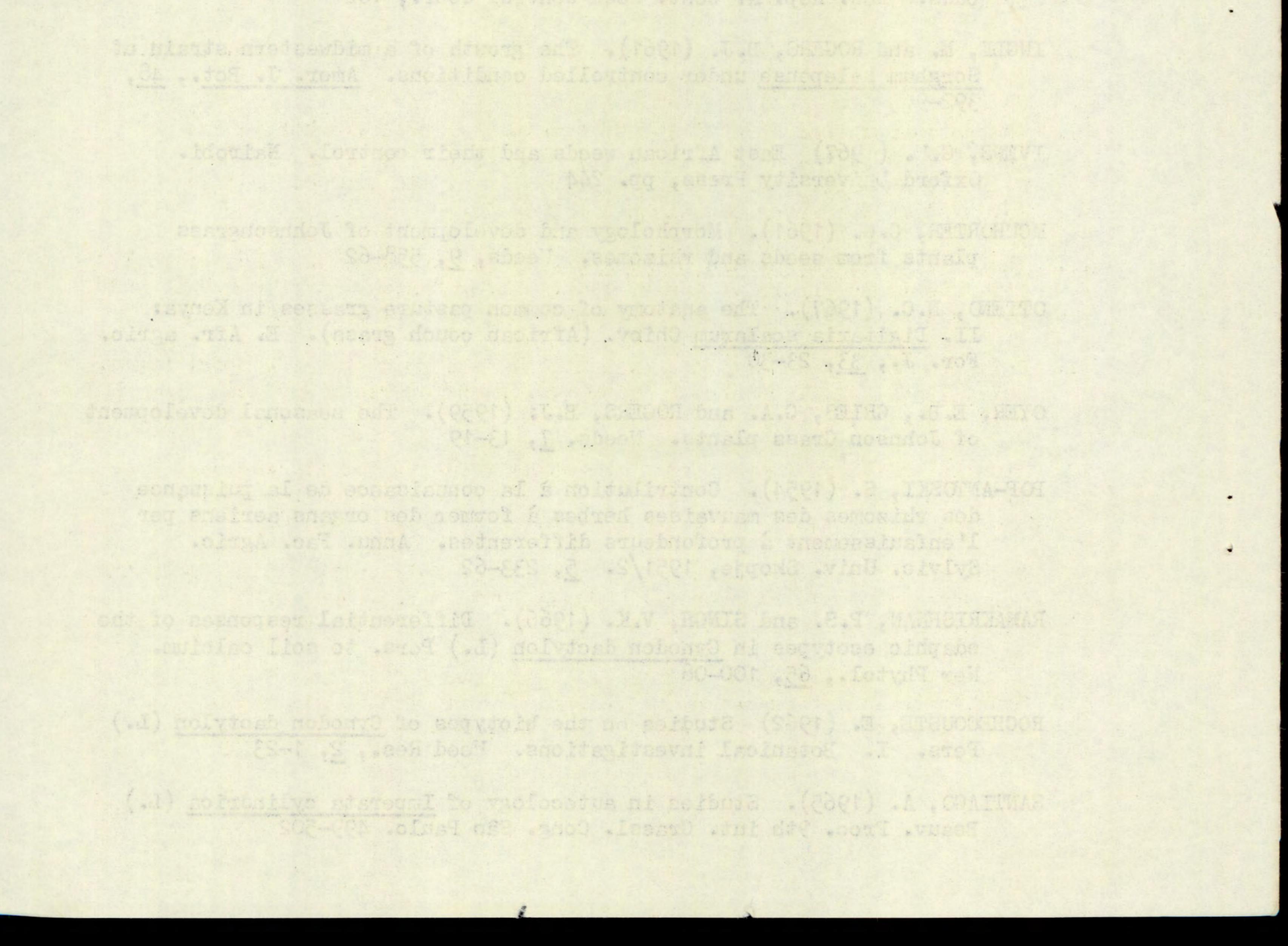
survival of Cyperus esculentus tubers and Cynodon dactylon rhizomes. Weed Res., 2, 1-8

History, 1.2. (1959).. Sandies on the reference ion of perendial reads in the the glassandari, T. Topperate species. Tech. Sep. N.R.O. (18), bo. 23

This D.C. S.C. and BOGBAN, 14951 . Troortoortant grachand here .D.C. DIANE

HILL, F.J. (1966). Ityratology of shithers bud control for John Johnson -

emonities and Rocents, D.J., (1957). Greate de Johnsengrange autome



#### AGRICULTURAL RESEARCH COUNCIL

WEED RESEARCH ORGANIZATION

#### Technical Reports

- 1. Susceptibility of ornamental plants to simazine and other chemicals. Trees and shrubs. November, 1964. G.W. Ivens. Price - 5s. Od.
- 3,5-Di-iodo-4-hydroxybenzonitrile. A progress report on experimental work by the A.R.C. Weed Research Organization. May-October, 1963.
  K. Holly and J. Holroyd. No charge.
- 3. Chemical control of bracken. 1964. G.L. Hodgson. Out of print.
- 4. Susceptibility of ornamental plants to simazine and other chemicals. Annual, biennials and herbaceous perennials. April, 1965. G.W. Ivens. Price - 2s. 6d.
- 5. A survey of the problem of aquatic weed control in England and Wales. October, 1967. T.O. Robson. Price - 5s. Od.
- 6. The botany, ecology, agronomy and control of Poa trivialis L. roughstalked meadow-grass. November, 1966. G.P. Allen. Price - 5s. Od.
- 7. Flame cultivation experiments 1965. October, 1966. G.W. Ivens. Price - 3s. Od.

8. The development of selective herbicides for kale in the United Kingdom.
2. The methylthiotriazines. Price - 5s. Od.

- 9. The post-emergence selectivity of some newly developed herbicides (NC 6627, NC 4780, NC 4762, BH 584, BH 1455). December, 1967. K. Holly and Mrs. A.K. Wilson. Price - U.K. and overseas surface mail - 4s. 3d.; overseas airmail - 10s. Od.
- 10. The Liverwort, <u>Marchantia polymorpha</u>, L. as a weed problem in Horticulture; its extent and control. July, 1968. I.E. Henson. Price - U.K. and overseas surface mail - 2s. 9d.; overseas airmail - 3s. 9d.
- 11. Raising plants for herbicide evaluation; a comparison of compost types. July, 1968. I.E. Henson. Price - U.K. and overseas surface mail - 2s. 3d.; overseas airmail - 3s. Od.
- 12. Studies on the regeneration of perennial weeds in the glasshouse;

.

- I. Temperate species. May, 1969. I.E. Henson. Price U.K. and overseas surface mail 2s. 6d.; overseas airmail 5s. 9d.
- 13. Changes in the germination capacity of three Polygonum species following low temperature moist storage. June, 1969. I.E. Henson. Price - U.K. and overseas surface mail - 2s. Od.; overseas airmail -4s. Od.
- 14. Studies on the regeneration of perennial weeds in the glasshouse; II. Tropical Species. May, 1970. I.E. Henson.