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Studies on root and tuber crops grown in association with coconut

2. Efficacy of Calcium Carbide and leaves of *Croton aromaticus* and *Averrhoa bilinbi* in breaking dormancy of Dioscorea yams

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ABSTRACT

The relative efficacy of CaC_2 Kappetiya *(Croton aromaticus)* and bilin (*Averrhoa bilinbi*) leaves in breaking the dormancy of Dioscorea yams *(Dioscorea alata L.)* was compared in two experiments. CaC_2 treatment for 5 hours induced setts of var. Kahata angala to commence sprouting in 16.8 days, while a mixture of Kappetiya and bilin leaves applied for 4 days and only Kappetiya leaves for 5 days induced sprouting in 21.3 and 32.9 days, respectively. Moreover, the number of setts induced to sprout was 56% with all 3 materials when averaged over the 3 types of setts used. But Kapettiya and bilin leaves induced 85% sprouting in head setts as against 76.7% with CaC_2. CaC_2 on the otherhand induced a larger number of tail setts to sprout.

With variety Kiri khondol application of kappetiya and bilin leaves for 3 days and only kappetiya for 5 days induced sprouting in 16.6 and 17.6 days respectively ; and the percentage sprouting was 48.5 and 58.7, respectively. Untreated setts of Kahata angala and Kiri khondol commenced sprouting only after a rest period exceeding 120 days.

In both varieties, and in all treatments, head and middle setts sprouted earlier and gave a higher % of sprouting than the tail setts.

INTRODUCTION

In the tropics, yams in general and Dioscorea species in particular have considerable potential as a regular source of carbohydrate in the diet. In many Asian countries including Sri Lanka where the diet is predominantly cereals, Dioscorea yams are a cheap substitute.

It is a common practice to grow Dioscorea species as intercrops in coconut lands, especially because they tolerate the heavy shade and thrive well even on marginal lands. The yams of Dioscorea have a definite dormant period and do not sprout for 4 to 4½ months after harvesting. This imposes a physiological limitation to year round planting and the production

of off season crops. Seasonal gluts could be prevented and market prices stabilised if a simple technique to break dormancy is available. Hutton (1942) reported that calcium carbide, ethylene chlorhydrin and ethrel (5%, 2 - chloroethyl phosphonic acid) induced sprouting of Dioscorea.

Purseglove (1968) stated that materials producing ethylene might have a beneficial effect in breaking the dormancy of Dioscorea yams. As kappetiya *(Croton Aromaticus L.)*. and bilin *(Averrhoa bilinbi L.)* leaves are traditionally used to ripen banana fruits presumably by producing ethylene, it appeared worthwhile to investigate the possibility of using these leaves for breaking the dormancy of Dioscorea yams. Further, the use of chemical means at village level seems a remote possibility. The present study was therefore initiated to compare the efficiency of readily available local materials, kappetiya and bilin leaves with calcium carbide in breaking dormancy in Dioscorea. A premilinary report of the work was presented earlier (Ibrahim *et al* ., 1983).

MATERIALS AND METHODS

Two experiments to compare different methods of breaking dormancy of Dioscorea yams were conducted at Bandirippuwa Estate, Lunuwila. In both experiments the planting material used was cut pieces of yams, each piece (sett) weighing 100 g. Since the buds are distributed over the whole yam in *D.alata*, the setts were categorised into 3 types namely, heads, middles and tails. Pieces of yams closest to the attachment of the vine were the heads. Fifteen setts were used for each treatment. Before treatment, the cut surfaces of setts were smeared with wood ash. The treated setts were placed in closed cardboard cartons and stored for 24 hours at room temperature (80 ^{o}F). The setts were then planted in nursery beds and mulched with a thin layer of straw and watered daily . A randomised block design with three replicates was employed.

In the first experiment, planting material used was setts of *D.alata var*. Kahata angala and the materials tested were calcium carbide (CaC_2); kappetiya leaves ; and a mixture of kappetiya and bilin leaves in equal proportions. In the CaC_2 treatment the setts were soaked in a 1.5% aqueous acetylene solution (Campbell *et al.*, 1962) for 4,5 and 6 hours. In the other treatments each sett was wrapped with 4 to 5 leaves of either kappetiya or a mixture of kappetiya and bilin leaves and enclosed in a polythene bag for 3, 4 or 5 days. Untreated setts enclosed in polythene bags and kept for 3, 4 or 5 days served as the control.

In the second experiment the planting material was setts of var. Kiri khondol and the materials compared were kappetiya leaves and a mixture of kappetiya and bilin leaves in equal proportions, as described in the first experiment.

In both experiments, the number of days to initiate sprouting and the percentage sprouting over a period of three weeks after the initiation of sprouting were recorded.

RESULTS

EXPERIMENT 1

Number of days to sprouting

The materials tested, the duration of treatment and the type of planting material had a highly significant influence on the time taken to induce sprouting in Kahata angala. The results are presented in Table 1.

Table 1 *No. of days taken to sprouting of* D. alata *var. Kiri khondol (mean of 15 setts)*

	Types of planting material			
Treatment	*Heads*	*Middles*	*Tails*	*Mean*
Control	125.0	125.0	125.0	125.0
Calcium carbide				
4 hours	18.4	18.8	20.0	19.1
5 hours	16.1	17.1	17.3	16.8
6 hours	15.8	16.4	17.1	16.4
Mean	16.8	17.4	18.1	
Kappetiya leaves				
3 days	38.5	38.7	39.6	38.9
4 days	31.6	33.6	37.6	34.3
5 days	30.3	31.9	36.5	32.9
Mean	33.5	34.7	37.9	
Kappetiya and Bilin leaves				
3 days	24.0	25.3	26.9	25.4
4 days	19.9	20.0	23.9	21.3
5 days	18.6	18.3	21.2	19.4
Mean	20.8	21.2	24.0	
LSD (P=0.001)		1.07		
CV(%)		2.60		

Calcium carbide treatment was the most effective in breaking dormancy and sprouting commenced 17.5 days after treatment. This was followed by the mixture of kappetiya and bilin leaves and only kappetiya leaves with sprouting commencing 22.0 and 35.4 after treatment, respectively. All these materials tested significantly advanced the time of sprouting over that of the untreated control which took over 4 months to sprout.

Setts treated with CaC_2 for 5 hours commenced sprouting in 16.8 days which was significantly earlier than in setts treated for 4 hours which took 19.1 days to sprout. There was no difference in sprouting between the 5 hour and 6 hour treatments. Setts treated with a mixture of kappetiya and bilin leaves for 4 days commenced sprouting in 21.3 days which was significantly earlier than with the 3 day treatment which sprouted in 25.4 days. There was no difference between the 4 day and 5 day treatments. Treatment with kappetiya leaves for a period of 5 days induced sprouting to commence in 32.9 days, which was significantly better than with the treatment for 4 days which induced sprouting in 34.3 days, which in turn was significantly better than the 3 day treatment (38.9 days).

All materials tested induced the sprouting of heads significantly earlier than the tails. The differences between the heads and middles were not significant.

Percentage sprouting

The type of planting material had a significant effect on the percentage sprouting in Kahata angala. Although there was no difference in % sprouting between the materials tested and the duration of treatment there was a significant interaction between materials and the type of planting material.

The mixture of kappetiya and bilin leaves induced 85% of the head setts to sprout, and was significantly superior to CaC_2 which caused 76.7% sprouting. However, in the case of tail setts CaC_2 proved to be superior to the mixture of kappetiya and bilin leaves with 57.1% and 48.2% sprouting, respectively. There was no difference in the efficacy of these two material in the sprouting of middle setts (Table 2a).

Sprouting in heads was 80.7% (Table 2b) which was significantly larger than in middles (69.7%) which in turn was significantly larger than in tails (53.5%).

EXPERIMENT 2

Number of days to sprouting

The materials tested, duration of treatments and the type of planting material had a significant influence on the time taken to commence sprouting in Kiri Khondol. There was also an interaction between materials and the duration of treatments.

Both the mixture of kappetiya and bilin leaves and kappetiya leaves only were effective in breaking dormancy and sprouting commenced in 16.4 and 19.8 days respectively as compared to 121 days for the control. The mixture of kappetiya and bilin leaves was significantly superior to kappetiya leaves only (Table 3a).

With the mixture of kappetiya and bilin leaves the time taken to commence sprouting was not influenced by the duration of treatment whereas with kappetiya leaves, increasing the treatment time from 3 to 5 days resulted in a progressive and significant reduction in the time taken to commence sprouting (Table 3a).

Both materials tested induced the sprouting of heads significantly earlier than the tails. There was no difference between the heads and middle setts (Table 3b).

Percentage sprouting

Setts treated with kappetiya leaves had a significantly higher percentage of sprouting than in those treated with kappetiya and bilin leaves, the value being 58.7 and 48.5, respectively. Also increasing the duration of treatment from 3 to 4 days significantly increased the sprouting from 45.2% to 55.1% (Table 4).

Sprouting was poorest in the tail setts with only 23.8%. Sprouting was significantly higher in the middle and head setts with 63.0% and 74.3%, respectively (Table 4).

Table 2 *Percentage sprouting of* D.alata *var. Kahata angala three weeks after initiation of sprouting (mean of 15 setts)*

2(a) Effects of method of treatment and planting material

Type of planting material	*Method of treatment*		
	CaC_2	*Kappetiya leaves*	*Kappetiya and Bilin leaves*
Heads	61.17 (76.7)	63.55 (80.2)	67.17 (85.0)
Middles	57.00 (70.4)	56.78 (70.0)	56.00 (68.7)
Tails	49.07 (57.1)	47.99 (55.2)	43.95 (48.2)
Mean	55.75	56.10	55.71

Figures in parentheses indicate detransformed values

LSD (P=0.05)	5.02
CV(%)	9.49

Table 2 (b) *Effect of planting material*

Type of planting material	*% sprouting*
Heads	**63.97 (80.7)**
Middles	**56.59 (69.7)**
Tails	**47.00 (53.5)**

Figures in parentheses indicate detransformed values

LSD (P=0.001) 2.90

CV (%) 9.49

Table 3. *No. of days taken to sprouting of* D.alata *var. Kiri khondol*

3 (a) *Effects of method and time of treatment*

Time of Treatment	*Method of treatment*		
	Kappetiya leaves	*Kappetiya and bilin leaves*	*Control*
3 days	**21.6**	**16.6**	
4 days	**20.4**	**16.3**	
5 days	**17.6**	**16.4**	
Mean	**19.8**	**16.4**	**121**

LSD (P=0.001) 0.86

CV(%) 0.48

Studies on roof and tuber crops

3(b) *Effect of planting material*

Type of planting material	*Number of days*
Heads	**17.8**
Middles	**17.6**
Tails	**19.0**
LSD (P=0.001)	**0.61**
CV (%)	**0.49**

Table 4 *Percentage sprouting of* **D.alata** *var. Kiri khondol three weeks after initaiation of sprouting (mean of 15 setts)*

		% sprouting	*LSD (P=0.001)*
	Kappetiya leaves	**50.04 (58.7)**	**5.17**
Method of treatment	**Kappetiya & bilin**	**44.12 (48.5)**	
	3 days	**42.24 (45.2)**	
Time of treatment	**4 days**	**47.90 (55.1)**	**6.33**
	5 days	**51.10 (60.6)**	
	Heads	**59.52 (74.3)**	
Types of planting material	**Middles**	**52.55 (63.0)**	**6.33**
	Tails	**29.18 (23.8)**	

Figures in parentheses indicate detransformed values
CV (%) 11.06

DISCUSSION

Soaking for 5 hours in a 1.5% acetylene solution was the most effective method of breaking dormancy in Kahata angala yams. Treatment with a mixture of kappetiya and bilin leaves for 4 days was a close second and induced sprouting in 23 days, which was 6 days longer than with calcium carbide. With kappitiya leaves sprouting commenced on the 33rd day. In variety Kiri khondol, kappetiya and bilin leaves (3 days) and kappetiya leaves (5 days) induced sprouting on the 17th and 18th day, respectively.

Although the sprouting of var. Kahata angala commenced early when treated with CaC_2, the percentage of setts sprouting was 56% with all 3 materials tested. In Kiri khondol, however, kappetiya leaves induced 58.7% of the setts to sprout whereas with kappetiya and bilin only 48.5% sprouted.

In both varieties all treatments applied greatly reduced the rest period and induced sprouting 80 to 110 days earlier than the untreated control.

According to Hamberg (1947) the various treatments, which promote the sprouting of yams and tubers appear to cause the disappearance of growth inhibiting substances occurring just beneath the skin. Very little information is available on the physiological and biochemical aspects of dormancy in Dioscorea. Campbell *et al.*, (1962) suggested that it is associated with a low level of glutathione in the yam, and that the glutathione level is high when dormancy is breaking. Even though kappetiya and bilin leaves have been traditionally used by farmers in Sri Lanka for ripening of banana fruits, no attempt has been made to study the chemicals or gases that are released by these leaves which may be responsible for the acceleration of the ripening process.

In both varieties, the treatments tested induced sprouting of the head and middle setts earlier than in setts taken from the tail region of the yam. Also the percentage sprouting of heads and middles was higher than that of the tails. Thus it is desirable to use either head or middle pieces as planting material. In a previous investigation, Campbell *et al.*, (1962) also demonstrated the superiority of heads and middle pieces of yams and they attributed this to the presence of a gradient in physiological maturity of the whole yam from head to the tail region. On the contrary Onwueme (1973) reported no difference in the rate of sprouting between the middle and tail setts. From the results presented and discussed above, it is evident that kappetiya and bilin leaves are only marginally inferior to CaC_2 as an effective agent for breaking the dormancy of Dioscorea yams. These leaves which are freely available in Sri Lanka would provide local farmers with a simple and convenient method of reducing the rest period and facilitate year round cultivation of these yams.

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