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Studies on the Use of Encapsulated Pesticides for Control of Banana Bunchy Top Disease

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The effect of encapsulated formulation of six insecticides *viz.*, aldicarb sulfone, bendiocarb carbofuran, isofenphos, orthene, and methomyl, was evaluated by applying in the leaf axils of banana against banana aphid The encapsulated formulation were prepared by filling the two-piece gelatin capsules with soluble or wettable powders of insecticides. All insecticides except bendiocarb were found to be effective in controlling the aphids. The herbicide capsule, prepared by filling with 2,4-D wettable powder, was found to be effective in destroying the diseased plants, when implanted into the pseudostem of the plant. A simple applicator, "Capsule dropper", to place the capsules in the leaf axils of grown up plants and a hand unit for preparing encapsulated formulation were designed.

The bunchy top disease, caused by Musa Virus 1, believed to have been introduced into India from Sri Lanka in 1940, has caused great havoc to the hill banana in Lower Pulneys (Tamil Nadu) by 1972. As the affected plants do not bear the bunch, the loss is considerable, when the incidence is high. It has caused extinction of "Virupakshi", the hill banana variety most sought after for its taste and keeping quality, in about half of the total area of 45,000 acres in the hill. Perennial cultivation and favourable weather conditions are conducive for the aphids (*Pentalonia nigronervosa* coq.), the only known vector transmitting the disease and help the disease to spread fastly.

Attempts made to control the virus by applying aureomycin (Wardlaw, 1972), heat therapy and injecting gibberellic acid (Ramaswamy 1967 and Govindaswamy *et al.*, 1977) did not prove to be successful. However, adopting phytosanitation to reduce the source of inoculm and applying insecticides to control the vector movement are useful to some extent (Regupathy and Kulasekaran. 1980). Removing the diseased plants at weekly interval and spraying methyl demeton at monthly interval arrested further spread of the disease. Spraying is difficult due to the tall growing nature (>54 m) of the virupakshi banana. As high as 80% of planters are having small holdings, they can not afford to use power sprayer. Further, in certain plantations situated in difficult terrains, carrying the water proves to be costly affair, when the water source is far away. During summer, scarcity of water aggravates the problem.

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The removal of diseased plants consumes lot of labour. During coffee picking season the labour problem is so actue that removal of affected plants is almost stopped. Regupathy and Subramaniam (1980) reported that 2, 4-D, when iujected into pseudostem, was found to be effective in destroying the diseased plants.

The present investigation was carried out to find out the effective and easy-to-adopt-method of applying insecticides to kill the aphids and herbicide to destroy the diseased plants, especially when the labour is scarce.

MATERIAL AND METHODS

Preparation of capsules : Capsules were prepared by filling two-piece empty gelatin capsules purchased from the pharmacist, with wettable or soluble powders of the insecticides or herbicide as the case may be. After filling, they were capped.

Field trial :

Three field trials were conducted with various encapsulated insecticides (Table I) in planter's holdings, one in Pooplankodaikanal and two in Kodalangadu. The trials were laid out in a simple randomised block design with three replications. There to four months old suckers of 120-150 cm height were selected to facilitate counting of aphids. Each plot consisted of 3 rows of 5 plants each. Capsules having insecticides (50 mg a. i.) were applied in the top most leaf axil (Fig. 1) @ one per plant. Aphid population was assessed by counting total aphids on three plants in the middle row of each plot leaving border rows and plants, before and after application. This was continued at weekly interval. The percent reduction in aphid population was corrected using Sun and Shephard (1947) formula.

To fix the optimum dose. an observational trial was conducted by applying capsules having insecticides at 50, 100 and 200 mg a. i. For each dose 25 plants in each of medium and full grown trees were included. As standard for comparison in all the trials pseudostem injection of monocrotophos and methyl demeton (Regupathy, 1978) were included.

Herbicide

The capsules were prepared by filling with 2, 4-D (Forenoxone 80 WP) at 200 mg/capsule. An unreplicated trial was conducted at St. Mary's Estate, Perumbarai. Each plot consisted of about 100 diseased plants. The capsules were implanted into the pseudostem of the plants @ 1/plant by making an incision (PLATE 1) at a height of 60-90 cm from the base. For comparison, an equal dose of 2, 4-D was injected into the diseased plants in another plot. The wettable powder was made into 20% suspension in water and injected using a hypodermic syringe. Observation on the number of trees falling after treatment was made for 15 days.

RESULTS AND DISCUSSION

Insecticide capsules :

Pseudostem injection of methyldemeton and monocrotophos was found to be highly effective in checking aphid populations (Table I) as has been reported by Regupathy (1978). They effected almost 100% kill of the aphids. The re-establishment of aphid colonies was not observed even four weeks after injection. Carbofuran, isofenphos and acephate, when applied in capsules were equally effective in reducing the aphid population. Though other toxicants *viz.*, aldicarb sulfone and methomyl, were on par with the above toxicants their initial knock down effect was less. Bendiocarb was found to be least effective.

At present the cost of empty capsules meant for pharmaceutical purpose is 2 paise/capsule. But production from cheaper and waste material on larger scale will bring down the cost of the encapsulated insecticides, as strict quality control meant for human consumption need not be observed. The dose of the insecticide required is 50, 100 and 200 mg a. i. for small, medium and full grown banana plants, respectively for effective control of the aphids.

Mode of action

The inclined nature of the last unfurled leaf next to the heart leaf helps in the collection of dew or rain water. Due to its verticality and waxy surface of the leaf; the drops after coalescing roll down along the channel like midrib and collect as a small pool around the base of the petiole (leaf axil) (Fig. 1).

The capsule, when applied in this leaf axil, imbibe the water and burst out releasing the toxicants inside, 2 to 3 days after application. The dispersed wettable or soluble powders of toxicants get suspended or dissolved in it, simulating the spray fluid applied in the leaf axils. The inflow of new flush of water makes the toxicant fluid overflow along the other leaf axils and pseudostem. Due to contact as well as systemic action of the insecticide the aphids present around the heart leaf, around the bases of petioles of the leaves and around the base of the pseudostem at soil level get killed.

Herbicide capsules

The observational trial conducted with 2, 4-D capsules revealed that application of 2, 4-D, irrespective of method of application, was 100% effective in destroying the unwanted diseased plants. The treated plants broke at ground level and fell to the ground within a week. Implanting of encapsulated capsule hastened this by 2 to 3 days compared to injection into the stem. Comparitively it is easier to implant the capsule than injecting the herbicide. The amount of formulated 2, 4-D (80% WP) to be filled in the capsule is 200-400 mg depending on the size of the plant. Generally hill banana is cultivated as mixed crop with coffee in Pulneys. Hence while using 2, 4-D, some care should be taken to avoid the damage to coffee bush from

falling banana plants. The plants after 2. 4-D treatment will start leaning to one side before breaking at ground level. At this time. 2, 4-D treated plants could be easily pushed away so as to fall in the Interspace between coffee bushes. This caution should be taken only when the banana plants are big enough to cause damage.

Labour savers :

To tide over the practical difficulties in placing the capsules in the axils of grown up trees and to prepare insecticide capsules as at present no pesticide company in India is formulating encapsulated formulation, a "capsule dropper" and a "capsule filling unit" were designed.

Capsule dropper :

It consists of a metal tube of 2.5 cm in diameter and 11 cm long, revetted to an "Y" shaped frame in such a way that the container could be tilted by pulling a nylon rope tied to the open end of the tube (Plate 2). By pulling the rope the capsule placed in the tube could be made to fall into a funnel like guider which guides the capsule to the targeted place. The guider is made from tin plate, about 20 cm long. The upper end is wider (5 cm) than the bottom end (1 cm). The frame could be fixed to a pole of desirable height. The cost of fabri. cation including the material is only Rs. 3/- per piece.

Capsule filling hand unit :

It consists of wooden capsule holder, metal through grate spreader and push-pin plate (Fig. 2). The capsule holder is a wooden plank with shallow holes dug out corresponding to the number and inter-distance between runners to hold the capsule. The metallic trough is rectangular in shape and fitted with metallic runners below. The number and size of the runners could be varied, In the prototype, there are 4 rows of 5 runners each and are of 4 mm in diameter. The length of the runners depend on the quantum of the material to be filled in the capsule. The runners are open at both ends but could be closed temporarily at bottom by means of a drawable metallic grate (Fig. 2A). A piece of metallic plate will serve as a spreader in the push-pin-plate aluminium pins, corresponding to the number of runners fixed to a merallic plate with a handle,

Keeping the runners closed (Fig. 2A) insecticide powder is spread on the trough in such a way that the runners are packed with insecticide. This could be accomplished with the help of the spreader (PLATE 3 right). Then pulling the grater, the runners are opened (Fig. 2B). Using the push-pin-plate (PLATE 3 left) the material in the runners is emptied Into the corresponding capsules in the holder below. After removing the trough the capsules are capped and ready for application.

It could be concluded that by applying encapsulated insecticides, the vector population could be reduced and there by their movements. The aphids live in colonies consisting of nymphs (young ones), female adults

which may be either wingless (apterous) or winged (alate). Normally the aphid colonies consist of only nymphs and wingless adults. Under the influence of certain environmental and intrinsic factors, the colonies produce winged forms which are responsible for the spread of the disease in far off plantations. One of the important factors in the determination of wing production is the "group effect" the simple presence of other aphids. When the crowding is too much beyond which the substratum could not hold, this phenomenon is given effect for the dispersal of aphids to other plants. Repeated application of insecticides at 4 to 5 weeks interval will keep the vector population well below the point required for triggering the dispersal.

The efficiency of capsule method of application depends on the water accumulated in the leaf axils. Lower pulneys receives rains, on an average in 1 to 14 days/month (Table II). Frequent rains are received from August to November. It is during this period the disease incidence is very high (Regupathy *et al.*, 1978). Kolkaila and Soliman (1954) reported that the aphid activity was greatest during the winter months and alate forms appeared during the rainy period. Ramanatha Menon and Christudas (1967) also reported that in Kerala the aphid population showed upward trend with the pre-monsoon showers and maintained this level till the end of the period of heavy rain. It is well known that the efficacy of insecticides will be maximum when insect population is high. Though during January to February, the rainy days are less (1 to 2 days) accumulation of water is seen in the leaf axils due to setting of dew. In summer months capsules applied immediately or the next day after the rains will be highly effective.

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TABLE I : EFFECT OF LEAFAXIL APPLICATION OF ENCAPSULATED INSECTICIDES ON BANANA APHID (MEANS OF 3 OBSERVATIONS)

	Pooplankodakanal		Kodalangadu									
	Initial aphid Population (Nos.)	2 weeks after treatment (CM)	Initial aphid Population (No.)	Trial I (CM) weeks after treatment				Initial aphid population (No.)	Trial II (CM) weeks after treatment.			
				1	2	3	4		1	2	3	4
Aldicarb sulfone Temik sulfone 75 WP)	298	85	785	53	63	85	82	603	28	26	74	55
Acephate (Orthene 75 SP)	204	74	189	89	90	98	99	513	76	79	85	84
Bendiocarb(Garvox 80 WP)	92	56	75	33	32	67	67	197	32	60	62	61
Isofenphos (Oftanol 40 SD)	267	96	590	92	98	98	99	146	72	91	93	90
Methomyl (Lannate 90 SP)	367	78	652	43	61	83	28	322	81	88	85	80
Garbofuran (Furadan 50 SP)	—	—	—	—	—	—	—	1650	100	100	100	100
Methyldemeton (Metasystox 25 EC)	435	92	175	100	94	98	100	170	100	100	100	100
Monocrotophos (Nuvactron 40 Sc)	202	96	100	100	100	100	100	312	100	100	100	100
Untreated	495	—	453	—	—	—	—	1317	—	—	—	—

CM — Corrected moitality in %

TABLE II MEAN RAIN FALL AT HORTICULTURAL RESEARCH STATION, THADIYANKUDISAI (1966 to 1978)

	Rainfall (mm)	Rainy Days
Jan	9.4	1.0
Feb	15.0	1.7
Mar	50.5	2.5
Apr	116.0	6.1
May	110.1	7.6
June	65.2	5·2
Jule	90.1	7.6
Aug	112.3	8.2
Sep	201.5	10.6
Oct	292.5	13.8
Nov	188.9	10.7
Dec	121.1	6.9

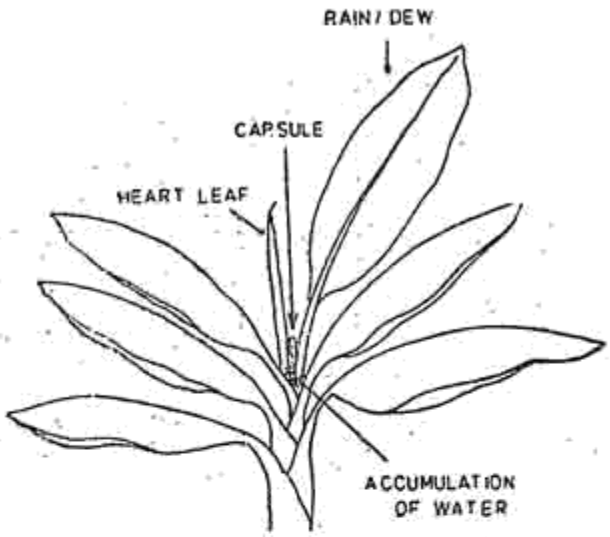

Fig. 1

Fig. 1 Schematic diagram showing accumulation of water in the leaf axil and placement of capsules

Fig 2 Schematic diagram of capsule filling hand unit.

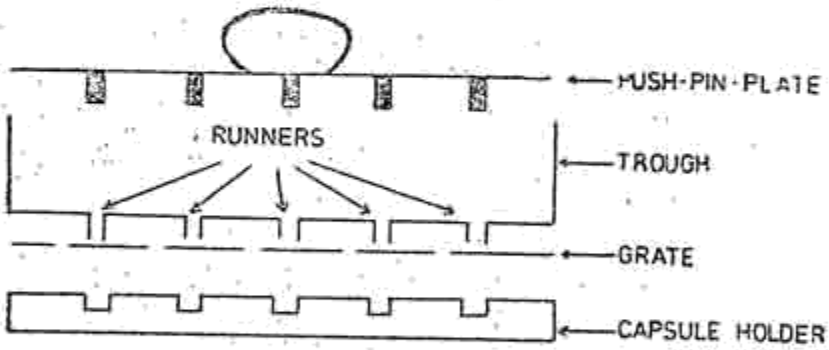

Fig. 2 A

'osition of grate closing the runners

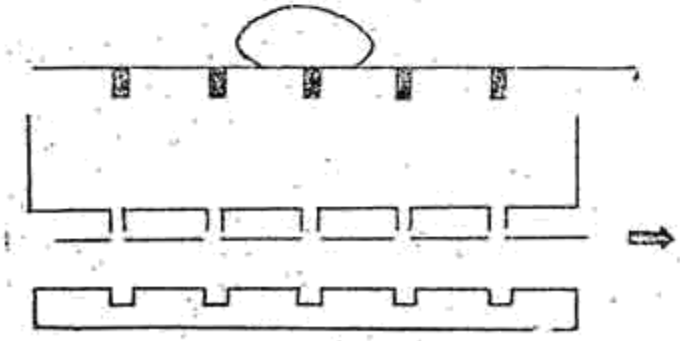

Fig. 2 B

Position of grate opening the runners.

PLATE 1 Implanting of weedicide capsule

PLATE 2 Capsule dropper

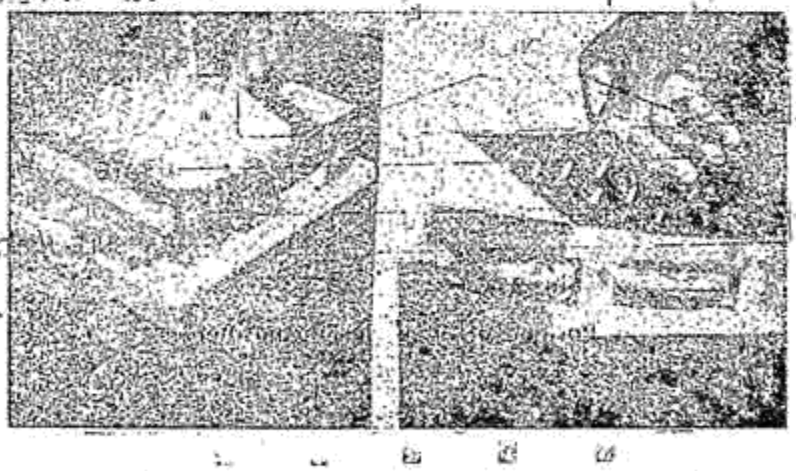

PLATE 3 Spreading of insecticide (Right) and Emptying of Insecticides in capsule using Push-Pin Plate (left)