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CARBOFURAN RESIDUES IN BANANA

IN recent years there has been a considerable increase in the death or slow decline of banana due to a root nematode called *Radopholus similis* and carbofuran (3% G) at the rate of 42 g per plant has been found to be successful in controlling the nematode (Anon[2]). Although this chemical control has been increasingly adopted by many farmers in Tamil Nadu, little is understood in respect of the translocation and persistence of carbofuran in the edible parts of banana.

An experiment was conducted in banana (var. Robusta) with carbofuran treatment as pralinage. Banana suckers were dipped in clay slurry and over that, carbofuran 3% granules (42 g/plant) were sprinkled and planted. At the time of harvest (8½ months after the insecticide application), the pseudo-stem and banana fruits (both ripe and unripe) were analysed for the carbofuran (Gupta and Dewan[4]) and its metabolites by TLC techniques (Gupta and Dewan[5]). The banana fruits were analysed after removing the peel.

Table I shows the residues of carbofuran in pseudo-stem and banana fruits as estimated by colorimetric and TLC methods. The colorimetric determination gives the total quantity of carbamates and the phenolic metabolites present and does not distinguish between carbamates and other metabolites. Hence the TLC estimation was also carried out to find the nature of carbofuran residues present in the edible parts. The psendo-stem contained 0·084 ppm of total residues and consisted of carbofuran and 3-hydroxy carbofuran. Banana fruits (unripe) recorded 0·082 ppm of total residues while the ripe fruits had registered a higher value of 0·102 ppm. The higher residues in ripe fruits as compared with the unripe fruits might be due to the slightly lower extraction in the case of the latter as evidenced from the recovery percentages of fortified samples.

In both the ripe and unripe banana fruits the parent compound was not detected and the entire residues were accounted for by 3-hydroxy, 3-keto carbofuran and by their respective phenols. However, other than 3-hydroxy carbofuran and the unaltered parent compound, no other metabolites were detected in the pseudo-stem. The total residues of carbofuran in banana fruits as estimated by the colorimetric method were 0·082 and 0·102 ppm for ripe and unripe fruits respectively while the TLC data showed that the toxic metabolits, *viz.*, 3 hydroxy and 3-keto carbofuran residues accounted for only 0·065 and 0·085 ppm in ripe and unripe banana respectively and the rest of the residues would have been possibly accounted for by the non-toxic metabolites like 3-hydroxy and 3-keto carbofuran phenols. As indicated earlier the colorimetric estimation gave higher values of residues since it included the phenolic metabolite besides the carbamate compounds. The contents of toxic carba-

TABLE 1

Residues of carbofuran and its metabbolites in the edible parts of banana

Edible parts	Residues in ppm,				
		TLC Technique			
	Colorimetric	Carbofuran	3–OH carbofuran	3–Keto carbofuran	Other metabolites
1. Pseudo-stem	0·084	0·035	0·050	ND	ND
2. Banana fruit (Unripe-peel removed)	0·082	ND	0·040	0·025	*†
3. Banana fruit (ripe-peel removed)	0·102	ND	0·050	0·035	*†

* 3-OH carbofuran phenol. † -- 3 Keto carbofuran phenol. ND -- not detected.

mate metabolites were low and they fell below the accepted tolerance level of 0·1 ppm fixed by the Environmental Protection Agency, USA (Anon.[1]) and such results of low residues in the harvested produce (below the tolerance level of EPA, USA) was encountered by Bhattacharjee *et al.*[3], in soybeans, Kapoor and Kalra[6] in sorghum and Rajukkannu *et al.*[7,8], in sweet potato and rice.

All these results showed that carbofuran when applied to banana, at the time of planting, got translocated to pseudo-stem and fruits. The residues, although in small amounts, persisted in pseudo-stem and fruits till the time of harvest. The content of carbofuran and other toxic metabolites in the edible parts was so low that they were below the tolerance level of EPA, USA and thus carbofuran can safely be used as a plant protection chemical in banana against the root nematode *without* any residue hazard.

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PHOTOSYNTHETIC CARBON DIOXIDE FIXATION BY RICE EARS

IN cereals, though the major photosynthetic contribution is by leaf blades, the leaf sheath and the inflorescence also contribute considerably towards the total photosynthesis of the plant[1,2]. It is reported from shading or detachment treatments that the total contribution of ear or panicle photosynthesis to grain weight in rice is in the range of 8 to 22%[3-6]. Differences reported on the relative contribution of ears to total dry weight may be due to techniques employed, varietal characteristics or management practices[7]. In the present investigation, the varietal differences in the relative photosynthetic activity of the ear were assessed by $^{14}CO_2$ technique[8].

Photosynthetic CO_2 fixation was determined in the excised ears of uniform age at anthesis in 4 field grown rice varieties (dry season, 1977). Photosynthetic rate in the leaves (second from top) was also assessed simultaneously. The cpm values obtained were converted to mg CO_2 as per Naylor and Teare[9] and the activity was expressed as mg CO_2 fixed per g fresh material per hour, so as to facilitate meaningful comparison between leaves and ears. In a parallel set, total chlorophyll content was also estimated following acetone extraction[10]. Each variety was replicated five times and there were five ears or leaves under each treatment.

The photosynthetic activity of ears and leaves differed significantly among the rice varieties (Table I). Ears fixed less CO_2, varying from 1·2 (*Ptb.* 10) to 4·5 mg (*JS* 52–102), accounting only 5 to 20% of the leaf activity per g f.wt.

TABLE I

Leaf and ear photosynthesis in rice

(mg CO_2 g^{-1} fresh wt. $hr.^{-1}$)

Variety	Leaf	Ear	Mean	% of leaf
Ptb. 10	26·0	1·2	13·6	4·6
JS. 52–102	22·1	4·5	13·3	20·4
Ratna	32·0	2·5	17·3	7·8
T. 3 mut.	22·1	1·4	11·7	6·3
Mean	25·5	2·4	14·0	9·8

C.D. (5%) Variety = 2·3, Part = 1·6, Interaction = 2·3.

The chlorophyll content was considerably lower in the ears than in the leaves and did not vary significantly between the varieties (Table II). However, the efficiency in $^{14}CO_2$ fixation per unit chlorophyll differed remarkably among the varieties. Thus, although *Ptb.* 10 and *JS.* 52–102 had almost the same