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CONTROL OF FOLIAR INSECT PESTS ON EGGPLANT WITH SYSTEMIC GRANULAR INSECTICIDES

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ABSTRACT

Deep, point placement of systematic granular insecticides at the base of eggplants 44 days after transplanting controlled foliar insect pests — aphid *Aphis gossypii* Glover, leafhopper *Amrasca biguttula biguttula* (Shiraki), whitefly *Bemisia tabaci* (Gennadius), mealybug *Ferrisia virgata* (Cockerell), flea beetle *Luperomorpha serricornis* (Duvivier), and spotted ladybeetle *Epilachna vigintisexpuncta philippinensis* Dieke — through harvest, 129 days after treatment. Except for mephosfolan, three materials (phorate, disulfoton, and carbofuran) at 1 kg A.I./ha dosage, split into two applications, gave as good control as double the rate applied as a split. Carbofuran at 2 kg A.I./ha applied once was as effective as the split application , so the single application saved labor. Carbofuran produced the highest yield, possibly as a nematocide. Residues in the fruit of carbofuran were under residue tolerances set in the USA and Canada. Based on produce efficacy and savings, farmers have switched to deep, point placement of carbofuran granules rather than their accustomed weekly foliar sprays.

Keywords: Eggplant, systemic insecticide, *Aphis gossypii, Amrasca biguttula biguttula, Bemisia tabaci, Ferrisia virgata, Luperomorpha serricornis, Epilachna vigintisexpuncta philippinensis*, insecticide residues.

INTRODUCTION

In Tanauan, Batangas Province, Philippines, eggplant is grown as a cash crop for the nearby Manila Market. The crop is timed to be harvested during the monsoon season as often typhoons cause damage to other vegetable growing areas in northern Luzon escalating prices.

Batangas farmers grow mainly maize, upland rice, and mixed vegetables on land holdings averaging about 1 ha. Most farmers devote about 0.1 ha to eggplant. Seedbeds are established near the homestead in April and are watered from nearby wells before the monsoon rains come. Land is prepared in the dry season (December-April), and eggplant is transplanted as single plants in plow furrows about 1 m wide in May with the first heavy rains. The distance between plants in a row is 75 cm giving a population of 13,000 plants per hectare. Fertilizer is applied plant by plant and weeding is done by off-barring between rows with a plow followed by handweeding. Management is good because of the potential high value of the crop.

The Dumaguete Long Purple variety was introduced from the University of the Philippines in Los Baños in the mid-1960s when eggplant became a common commercial crop. Farmers harvest eggplant on a weekly basis from August through October.

Eggplant foliage is attacked by a wide array of foliar insect pests: 1) aphid, *Aphis gossypii* Glover, 2) Leafhopper, *Amrasca biguttula biguttula* (Shiraki), 3) whitefly, *Bemisia tabaci* (Gennadius), 4) mealybug, *Ferrisia virgata* (Cockerell), 5) flea beetle, *Luperomorpha serricornis* (Duvivier) adults, and 6) spotted ladybeetle, *Epilachna vigintisexpuncta philippinensis* Dieke larvae and adults.

Farmers spray insecticides every other week, choosing cheap broad spectrum chemicals such as methyl-parathion or azinphos-ethyl. Lever-operated knapsack sprayers are used and farmers typically underdose (Litsinger et al., 1980). Infested plants become stunted and set few fruit. The large umbrella-like leaves offer protection from much of the spray because the insects feed from the undersides. Farmers complained to us that their insecticide usage was ineffective which prompted us to study the use of systematic granulars applied to the root zone. Studies in India had shown that granular insecticides were highly effective in controlling a narrower spectrum of eggplant foliage-feeding insect pests.

The methods of application varied. Ayyama et al. (1976) broacasted granules on the soil surface 15 and 44 days after transplanting (DAT) but found foliar sprays were superior for mealybug, *Centrococcus insolitus* (Green) control. Mote (1978) banded the granules in a ring around each plant and covered the chemical with soil to achieve 94-99% control of the leafhopper, *Amrasca devastans* Dist. for 15 days. Uthamasamy *et al.* (1973) and Kumanesan and Baskanan (1976) incorporated granules at the base of each plant 15 DAT to achieve 80 to 100% control of leafhopper, *A. devastans* and aphid, *A. gossypii.*

Using a similar method but applying the granules twice — 15 and 30 DAT — Banerjee and Raychaudhuri (1987) achieved up to 78 and 95% control of spotted ladybeetle, *Henosepilachna vigintioctopunctata* Fab. larvae and adults, respectively.

None of the reports provided information on rainfall or soil type, therefore it is difficult to compare studies (Nesmith and Averre 1978).

In Batangas the crop is vulnerable to insect damage for six months (May to October). We tested the concept of point, deep placement as was developed for rice (Aquino and Pathak, 1976) to achieve long lasting control. Uthamasamy et al. (1976) achieved control for three months from a single application at 1-1.5 kg A.I./ha dosages of systemic granules. We allowed the crop to grow for 1.5 months before the first application and followed with a second application two months later. Four systemic granular insecticides were available for testing and we compared total dosages of 1 and 2 kg A.I./ha.

Farmers in the following year began using granules and we became concerned with potential insecticide residues in the fruit. Carbofuran was the only granular insecticide available to them, therefore we monitored its residue levels in the fruit throughout the harvest season in 1977. In 1979 we interviewed farmers to learn of their rate of adoption and application methods.

MATERIALS AND METHODS

Field efficacy

Four systemic inseciticides — disulfoton (Disyston 5G), phorate (Thimet 10G), mephosfolan (Cytrolane 3G), and carbofuran (Furadan 3G) — in granular formulation were compared in a crop transplanted April 28, 1975. Each chemical was tested at two split dosages totalling 1 and 2 kg A.I./ha. The first application was June 11 and the second September 24, 44 and 105 days after transplanting, respectively. A third carbofuran treatment was a single dosage of 2 kg A.I./ha applied once on June 11.

The granules were placed in the root zone by jabbing the soil with a pointed pole making two holes about 15 cm from the base on opposite sides of each plant. The soil was moist from rain and holes were easily made 6-8 cm deep. Granules were placed by hand in the holes and covered by a push of the foot. Plots, 50 m^2, were laid out in a farmers' field in a randomized complete design with three replications.

Soils are a medium-textured, clay-loam alfisol (pH 6) of recent volcanic origin. Rainfall was recorded daily from a station less than 1 km away for 1975 and 1977 growing seasons.

Insect pests were sampled in a stratified manner by selecting six plants, three each from a random selection of two rows per plot. Insects were recorded from randomly selecting five of the youngest fully developed leaves per plant.

Yield was subsampled as the trial was superimposed on a farmer's field. The number of marketable fruit per plant was recorded on August 27, September 17, and October 9 and 22. The farmer determined which fruits were of marketable quality. Levels of significance are at the 5% confidence interval using Tukey's test for statistical separation of means (Steel and Torrie, 1980).

Farmer adoption

We interviewed farmers in the village of Cale in October, 1981 selecting every third house. The minimum criteria was that an informant had to have grown eggplant for at least five years and planted an area greater than 0.05 ha. The farmers were interviewed individually and asked what insecticides they had used that season including frequency dosage, and method of application.

Residues in the fruit

In a separate trial, transplanted May 3, 1977, we tested the carbofuran residue load in harvested eggplant fruits. The first four treatments were single applications of carbofuran at dosages of 0, 1, 2, and 4 kg A.I./ha on June 6, 34 DAT. Treatments 5 to 8 were split dosages totalling 0, 2, 4, and 8 kg A.I./ha with the second application on August 7. The granules were incorporated into the soil as previously described. The trial with 25 m^2 plots was replicated four times in a randomized complete block design. Five fruits were harvested on eight occasions from the center of each plot from August 23 to October 18, placed in plastic bags in a portable cooler packed with dry ice, and taken to the Pesticide Residue Laboratory at IRRI for analysis. The five fruits per plot were pooled and macerated. A 10 g sample was taken from the fruit mass and analyzed for carbofuran by gas-liquid chromatography following the procedure of Seiber et al. (1978).

RESULTS AND DISCUSSION

Field efficacy

The aphid *A. gossypii* was significantly controlled (95-99%) on June 25, 14 days after application, by all chemicals and dosages tested (Table 1). Treated plots ranged (per 30 leaves) from 0.6 to 4.6 aphids compared to 102 in the untreated. By the July 30 sampling date, 49 days after application, disulfoton, phorate, and carbofuran gave 99-100% control (0-2.7 aphids/30 leaves) at low or high dosages. Mephosfolan achieved 100% control at the high dosage but significantly less (65.3 aphids/30 leaves) at the low dosage. The untreated, however, averaged 1034 aphids per 30 leaves.

On August 27, 77 days after application, aphid numbers had declined in the untreated check to 24.1 per 30 leaves, perhaps due to heavy rains earlier in the month (Fig. 1) and the stunted, chlorotic condition of the plants. Aphid populations never recovered during the rest of the season. Excellent (87-98%) control of aphids (per 30 leaves) was achieved by the high dosage of disulfoton (3.2), mephosfolan (0.6), and carbofuran either as a split (2.5) or single (0.4) application. Low dosage treatments among all insecticides were not significantly lower (6, 1-12.0) than the untreated check.

As of September 17, insecticide activity rejuvenated, apparently as a result of the rainy period in early September, producing a new flush of chemicals translocated from the soil up the root systems to leaves (Fig. 1). Phorate at 2 kg A.I./ha and disulfoton at 1 kg A.I./ha suppressed (84-94% control) aphid numbers (per 30 leaves) (2.5 and 6.3, respectively) whereas mephosfolan at 1 kg A.I./ha had significantly more aphids (43.8) than the untreated (39.1), 94 days after application.

The plots receiving the second split on September 24 experienced significant (52-89%) control (1.3-5.5 vs 11.4 aphids/30 leaves in the untreated check) of aphids on the October 9 sampling date, 116 days after application. Even the plot with the single, high-dosage carbofuran application had 58% control (4.8 aphids/30 leaves). By the last sampling date, 129 days after application, on October 22, phorate, mephosfolan, and carbofuran, at the high dosage level, gave significant (92-93%) control (0.8-0.9 vs 11.9 aphids/30 leaves).

All insecticides greatly reduced leafhopper, *A biguttula biguttula* numbers (91-99% control) by June 25. Carbofuran treatments gave the highest degree of control reducing populations to 0.3-2.3 leafhoppers per 30 leaves compared to 219 in the untreated. The high dosage of mephosfolan also gave excellent control (1.3 leafhoppers/30 leaves). All treatments suppressed leafhopper densities (96-100% control) by July 30 when the untreated averaged 439 leafhoppers per 30 leaves. Only mephosfolan at the low dosage resulted in significantly less efficacy per 30 leaves (19.0 leafhoppers) compared to other chemicals and dosages. The heavy rains in early August apparently caused an overall population decline as by the August 27 sampling date the untreated was only 23.6 leafhoppers per 30 leaves. The two high dosage carbofuran treatments provided the most sustained (61-78%) control (5.2-9.1 leafhoppers/30 leaves).

The last sampling date September 17, before the second application September 24, showed a very low leafhopper population even in the untreated (9.5 leafhoppers/30 leaves). Only the single application of high dosage carbofuran provided significant (86%) control (1.3 leafhoppers/30 leaves). On the October 9 sampling date, after the second application, the carbofuran treatments also provided the most rapid (87-97%) control (0.4-1.9 leafhoppers/30 leaves) compared to the untreated 14.7 leafhoppers. The single high dosage of carbofuran provided 73% control up to the October 22 sampling date (4.2 vs 15.3 leafhoppers/30 leaves). The high dosages of disulfoton, phorate, and carbofuran, as split applications, also provided significant (71-77%) lefhopper control on this last sampling date (3.4-4.5 leafhoppers/30 leaves).

The high split dosages of carbofuran and disulfoton were effective (87% control) against whitefly, *B. tabaci* on June 25 and lowered the population from 8.5 to 1.0-1.1 whiteflies per 30 leaves. By July 30 the high dosage of phorate and all three carbofuran treatments gave sigifnicant (87%) control (4.8 vs 0.6 whiteflies/30 leaves). Whitefly numbers were too low by the August 27 sampling date perhaps also due to heavy rains. The low dosage carbofuran provided the best (100%) control by the September 17 sampling date (0 vs 2.2 whiteflies/30 leaves). Populations were too low during the rest of the season for meaningful comparisons to be made between treatments.

In contrast with the other leaffeeding pests, flea beetle, *L. serricornis* numbers were low at the beginning of the season and increased with crop age. By July 30, flea beetle adults averaged 7.8 per 30 leaves in the untreated check. The low dosage carbofuran treatment reduced the population most (79% control) to 1.6 flea beetles per 30 leaves. The other treatments were no different than the untreated check. On September 17, the high dosage provided best control (0 vs 2.0 flea beetles/30 leaves) followed by the low dosage of disulfoton (1.2 flea beetles/30 leaves). Populations were relatively higher on October 22 with 6.6 flea beetles per 30 leaves in the untreated check. Only carbofuran, either at low or high dosage split applications, gave significant (68-71%) control (1.9-2.1 flea beetles/30 leaves).

The spotted ladybeetle, *E. vigintisexpuncta philippinensis* proved highly susceptible to insecticides as all chemicals gave 100% control on June 25 (0 vs 2.0 ladybeetles/30 leaves). Populations were very low for other sampling dates except on October 9 when 2.6 ladybeetles were found per 30 leaves. Phorate and mephosfolan again gave complete control at the low application rate. Other treatments were no different than the untreated check.

All insecticides, even at the low dosage level, showed efficacy against aphid, leafhopper, whitefly, and ladybeetle pests of eggplant. Only disulfoton and carbofuran showed efficacy against flea beetle. All chemicals were effective for 129 days against the aphid, but the low rate of mephosfolan was intermediate in efficacy. Carbofuran was the quickest acting against leafhopper and most consistent against whitefly and flea beetle. Phorate, mephosfolan and carbofuran were particularly good against the spotted ladybeetle.

The difference in efficacy between the 2 and 1 kg A.I./ha dosages varied by insecticide. Disulfotan at 1 kg A.I. was equally effective except on the June 25 sampling date against whitefly. Likewise, there was similar efficacy with the two rates of phorate except on aphids September 17. The higher rate of mephosfolan gave superior control except on four occasions — leafhopper June 25 and aphids on July 30, August 27, and September 17. Carbofuran at 2 kg A.I./ha was superior to a lower dosage only on two occssions — leafhopper on August 27 and flea beetle on September 17. However, there were no differences in insect counts on any dates between the single and split applications of high dosage carbofuran.

Highest yield in marketable fruit (no./havested plant) was recorded with the high dosage of carbofuran either applied once (5.1 fruits) or split (4.7 fruits). The yield of the split low dosage application was significantly lower (4.4 fruits) than that of the single dosage. The untreated averaged only 2.1 fruits per plant. Yield from the other chemicals was significantly higher than that of the untreated check but less than those of the carbofuran treatments. The high dosages of disulfoton, phorate, and mephosfolan were equally effective (3.2-3.6 fruits/plant). The low dosages of phorate and disulfoton were equal in yield to those of the high dosage. But the low dosage of mephosfolan yielded significantly fewer fruits (2.8/plant) than that of the high dosage (3.6 fruits/plant).

Eggplant is attacked by root knot nematodes *Meloidogyne* spp. (Sasser and Carto, 1985) and high populations have been recorded in Batangas (Castillo et al., 1976). Phorate also has nematocidal properties against *Meloidogyne* spp. The high yields from carbofuran may have also been a result of nematode control. Based on the manufacturer's recommendations, nematocidal activity occurs at higher rates than needed for insect control (Bayer, 1974). The point placement perhaps concentrated the chemical which were at nematocidal levels. Carbofuran exhibits a phytotonic effect on rice and the same phenomenon may also be occurring on eggplant (Venugopal and Litsinger, 1984).

The poor control obtained by Ayyama et al. (1976) from soil-surface broadcasting granules was undoubtedly due to the high degree of degradation when the insecticide was exposed to sunlight and hot temperatures on the soil surface. Uthamasamy et al. (1973) achieved significant control for 90-100 days from one application of phorate, fensulfothion, disulfoton, or aldicarb at 1-1.5 kg A.I./ha applied to younger plants aged 15 DAT. We achieved good control of a broader pest complex for 129 days from application on older plants aged 44 DAT.

The long residual activity is no doubt a result of the deep placement that reduced degradation of the active ingredient (Seiber 1978). The frequent showers ensured moist soil for continued uptake of the chemical by the root system. In both studies, late season protection was not as necessary as foliar pest populations naturally declined, probably from a combination of mortality from heavy rainfall and a lower nutrient status of injured and senescing plants. Examples in rice (Siddaramapa et al. 1978) and maize (Felsot et al 1981) have shown that, over time, repeated carbofran use in a soil selects for strains of bacteria which naturally breakdown the chemical. This problem will be minimized as farmers rotate the location of eggplant each year. Point placement will also reduce the soil area where the microbial selection would be occurring compared to broadcast treatments in rice or banding in maize. Future trials could look at earlier application times and lower dosages of single applications of carbofuran, possibly in combination with fertilizer. It would also be useful to determine the relative importance of nematodes on yield with and without insect damage.

Farmer adoption

The carbofuran treated plants were tall, dark green, and vigorous, and as carbofuran was the only available systemic granular insecticide, farmers began adopting it. The cost of the farmers' use of m-parathion sprayed ten times per season was equivalent to that of carbofuran at 2 kg A.I./ha. The labor for point placement of granules (2 person-days per 0.1 ha = 2 people in 1 day) was less than that for ten spray applications (5 person-days = 1 person 0.5 days each spraying) principally because water is difficult to secure and transport.

A survey revealed that 19 of 20 farmers switched from sprays to carbofuran granules. The one farmer who did not said he was afraid of insecticide residues in the fruit. Most (75%) farmers applied carbofuran at doses below 1 kg A.I./ha, but 20% applied at 2 kg AI./ha (Table 2). All farmers deep placed granules using our method.

Residues in the fruit

There was no difference in the carbofuran residue patterns for single or split applications (Fig. 2). Both insecticide applications (June 6 and August 7) occurred before the first harvest and subsequent residue analysis. A possible explanation is that the second application came after the eggplant formed all of its leaves.

Carbofuran is mainly taken up by actively growing leaves (Seiber et al. 1978). The large residue pulse in early September was coincident with the heavy rains (76 mm) during the first week in September (Fig. 3). Rains subsided by the second week of September but the heavy rains during the third (72 mm) and fourth (78 mm) weeks brought out a second peak in the 1 kg A.I./ ha dosage treatment.

For the single application (June 6), the highest dosage (4 kg A.I./ha) carbofuran resulted in a single peak in the first half of September when 76 ppb were recovered in the fruit. The peak of the split application (74 ppb) of 8 kg A.I./ha was mid-September, no higher than the single application. Residue levels in both the single 4 kg A.I./ha dosage and split 8 kg A.I./ha dosages linearly declined until the October 18 sampling date. It is noteworthy that the rainfall also declined from late September through October. The residue curves for the 2 kg A.I./ha single application and 4 kg A.I. split application followed the pattern of those of double the dosage. Peaks occurred at September 6 with 54 and 48 ppb, respectively, and declined, thereafter. There were two peaks at the 1 kg A.I./ha rate, as a single application and 2 kg A.I./ha split application. The first peak on September 6 ranged from 58-60 ppb, respectively, and the second at

September 20 ranged from 50-60 ppb, respectively. The peaks of the lower rates were synchronized with the rainfall pattern. There was a low background level of 7-8 ppb in the two untreated checks.

There is no tolerance level for carbofuran in eggplant fruit but looking at other crops the tolerance levels for carbofuran in the USA and Canada vary from 100-1000 ppb (Table 3). Tolerances of registered insecticides in eggplant range from 250 for mevinphos to 1000 for m-parathion. The residues in the fruit under Philippine conditions do not vary much from 1-8 kg A.I./ha but are below the 100 ppb tolerance limits set for carbofuran in edible commodities.

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Fig. 1. Daily rainfall (mm/day) from Tanauan, Batangas June-October, 1975.

Fig. 2. Carbofuran residues in parts per billion detected from eggplant fruit. Tanauan, Batangas, 1977.

Table 1. Efficacy of systemic granular insecticides applied to the soil against foliar insect pests of eggplant[a]. Cale, Batangas, Philippines.

Insecticide	Total dosage (kg A.I./ha)	Applications[b]	Sampling date (no./30 leaves)						
			June 25			July 30			
			Aphid	Leafhopper	Ladybeetle	Aphid	Leafhopper	Whitefly	Flea bettle
Disulfoton	1.0	Split	3.1 b	17.0 e	5.9 bc	1.3 a	1.1 a	2.4 ab	8.4 b
Disulfoton	2.0	Split	2.6 b	19.9 e	1.0 a	0.3 a	2.0 a	1.5 ab	5.8 b
Phorate	1.0	Split	2.7 b	7.1 c-e	2.1 abc	2.7 a	1.1 a	1.4 ab	6.3 b
Phorate	2.0	Split	4.6 b	6.3 b-e	1.9 ab	2.3 a	1.3 a	0.6 a	5.5 b
Mephosfolan	1.0	Split	1.3 b	12.2 ed	1.7 ab	65.3 b	19.0 b	3.4 ab	4.3 b
Mephosfolan	2.0	Split	0.6 b	1.3 abc	2.2 abc	0.0 a	4.2 ab	2.6 ab	3.6 ab
Carbofuran	1.0	Split	3.3 b	2.3 a-d	3.2 abc	0.9 a	2.1 a	0.6 a	1.6 a
Carbofuran	2.0	Split	1.2 b o	0.3 a	1.1 a	0.0 a	0.6 a	0.6 a	3.5 ab
Carbofuran	2.0	Once	0.9 b	0.6 ab	1.2 ab	0.0 a	0.3 a	0.6 a	5.0 b
Untreated check	-	-	101.5 a	21.9 f	8.5 c	0.34 c	4.39 c	4.8 b	7.8 b

Table 1. continued... /2

Insecticide	Total dosage (kg A.I./ha)	Applications[b]	Sampling date (no./30 leaves)					
			August 27		September 17			
			Aphid	Leafhopper	Aphid	Leafhopper	Whitefly	Flea bettle
Disulfoton	1.0	Split	6.1 bcd	24.3 c	6.3 ab	8.1 a	1.9 b	1.2 a
Disulfoton	2.0	Split	3.2 abc	16.9 bc	10.9 abc	4.7 ab	3.0 b	1.6 b
Phorate	1.0	Split	7.2 cd	19.6 bc	21.1 bc	7.0 b	0.4 ab	0.8 ab
Phorate	2.0	Split	6.6 bcd	18.3 bc	2.5 a	6.4 b	1.0 ab	1.9 b
Mephosfolan	1.0	Split	9.9 cd	14.1 bc	43.8 d	10.5 b	0.8 ab	1.3 ab
Mephosfolan	2.0	Split	0.6 ab	23.1 c	16.1 bc	12.2 b	0.4 ab	1.0 ab
Carbofuran	1.0	Split	12.0 cd	24.3 c	17.6 bc	4.9 ab	0.0 a	1.5 b
Carbofuran	2.0	Split	2.5 abc	9.1 ab	10.9 abc	3.2 ab	0.8 ab	0.0 a
Carbofuran	2.0	Once	0.4 a	5.2 a	11.8 abc	1.3 a	1.0 ab	0.3 ab
Untreated check	-	-	24.1 d	23.6 c	39.1 c	9.5 b	2.2 b	2.0 b

Table 1. continued... /3

Insecticide	Total dosage (kg A.I./ha)	Applications[b]	Sampling date (no./30 leaves)						Marketable fruit[c] (no./plant)
			June 25			July 30			
			Aphid	Leafhopper	Ladybeetle	Aphid	Leafhopper	Flea bettle	
Disulfoton	1.0	Split	3.2 a	6.0 ab	0.8 ab	2.1 ab	4.6 ab	5.9 b	3.1 cd
Disulfoton	2.0	Split	5.3 a	4.4 ab	2.4 b	5.8 ab	4.5 a	5.3 b	3.4 c
Phorate	1.0	Split	2.9 a	4.3 ab	0.0 a	4.4 ab	4.8 ab	4.5 ab	3.3 c
Phorate	2.0	Split	1.6 a	6.0 ab	2.3 b	0.8 a	3.9 a	3.9 ab	3.6 c
Mephosfolan	1.0	Split	5.5 a	5.9 ab	0.0 a	4.4 ab	7.2 ab	7.9 b	2.8 d
Mephosfolan	2.0	Split	2.7 a	6.0 ab	0.3 ab	0.9 a	7.6 ab	5.6 b	3.2 c
Carbofuran	1.0	Split	2.4 a	1.9 a	0.6 ab	1.6 ab	6.5 ab	2.1 a	4.4 b
Carbofuran	2.0	Split	1.3 a	1.2 a	0.3 ab	0.9 a	3.5 a	1.9 a	4.7 ab
Carbofuran	2.0	Once	4.8 a	0.4 a	0.6 ab	3.9 ab	4.2 a	4.4 ab	5.1 a
Untreated check	-	-	11.4 b	14.7 b	2.6 b	11.9 b	15.3 b	6.6 ab	2.1 e

[a] Average of 3 replicates. Means in a column, followed by similar letters are not significantly different ($P > 0.05$) by Tukey's test (Steel and Torrie). Aphid and leafhopper nymphs and adults, whitefly adults, lady beetle larvae and adults, flea beetle adults.

[b] Splits applied June 11 and September 24.

[c] Average of four harvest dates.

Table 2. Frequency of farmer's dosages of carbofuran on eggplant. Cale, Batangas, Philippines

Dosage (kg A.I./ha)	Farmers (%)
2	20
1	5
0.75	15
0.4	50
0.1	5
<0.1	5

[a]n = 19

Table 3. Tolerance levels for carbofuran residues in various food commodities and other insecticides in eggplant in the USA and Canada.

FDA tolerances for carbofuran		FDA tolerances in eggplant fruit	
Commodity	ppb	Insecticide	Tolerance level (ppb)
Banana fruit	100		
Maize grain	100	Mevinphos	250
Peanut seeds	100	Demeton	300
Rice grain	200	Methyl parathion	1000
Strawberry	400		
Carrot	300		
Green pepper fruit	1000	Azinphos-ethyl	300

Source (Bayer, 1974).

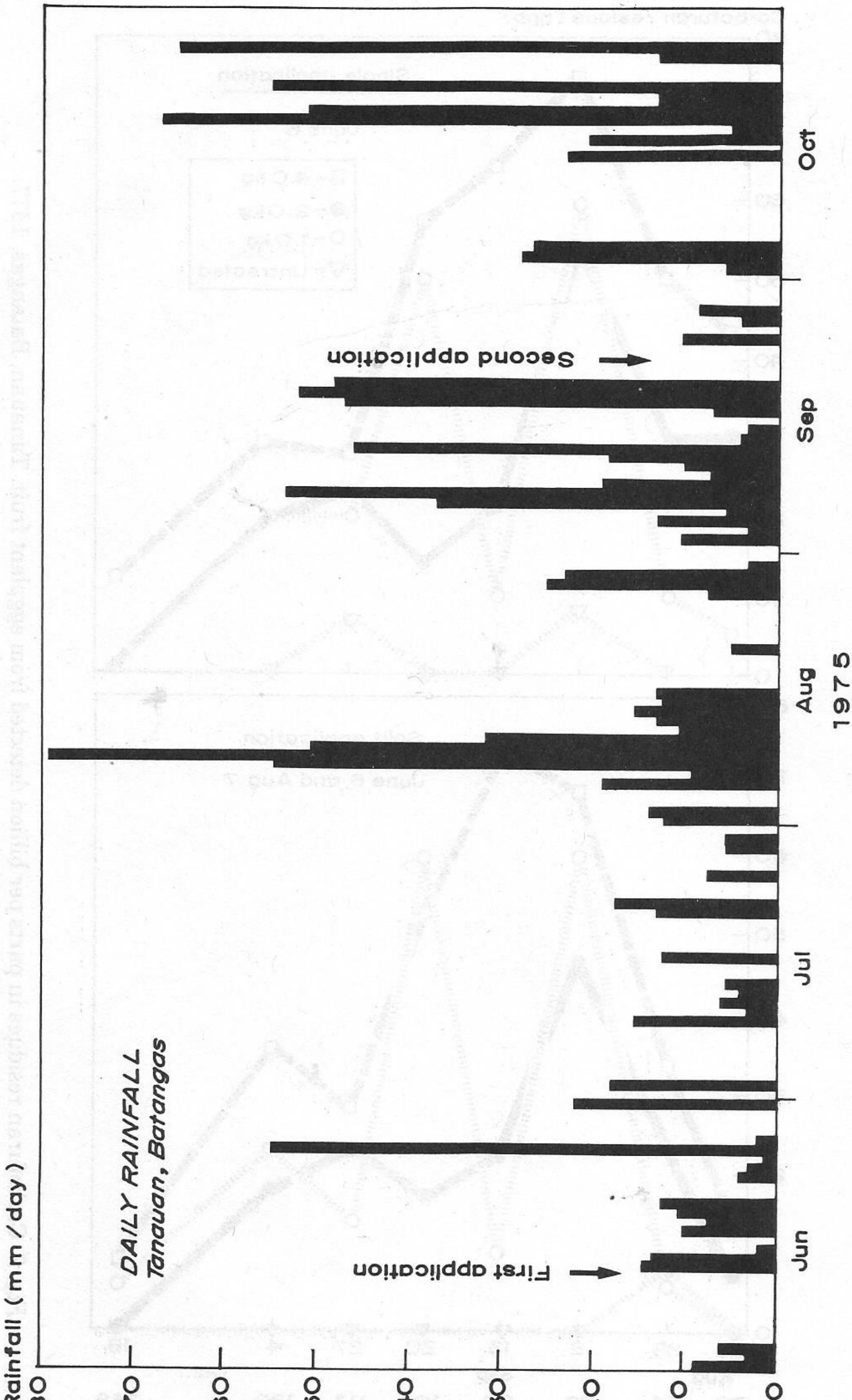

Fig. 1. Daily rainfall (mm/day) from Tanauan, Batangas June-October, 1975.

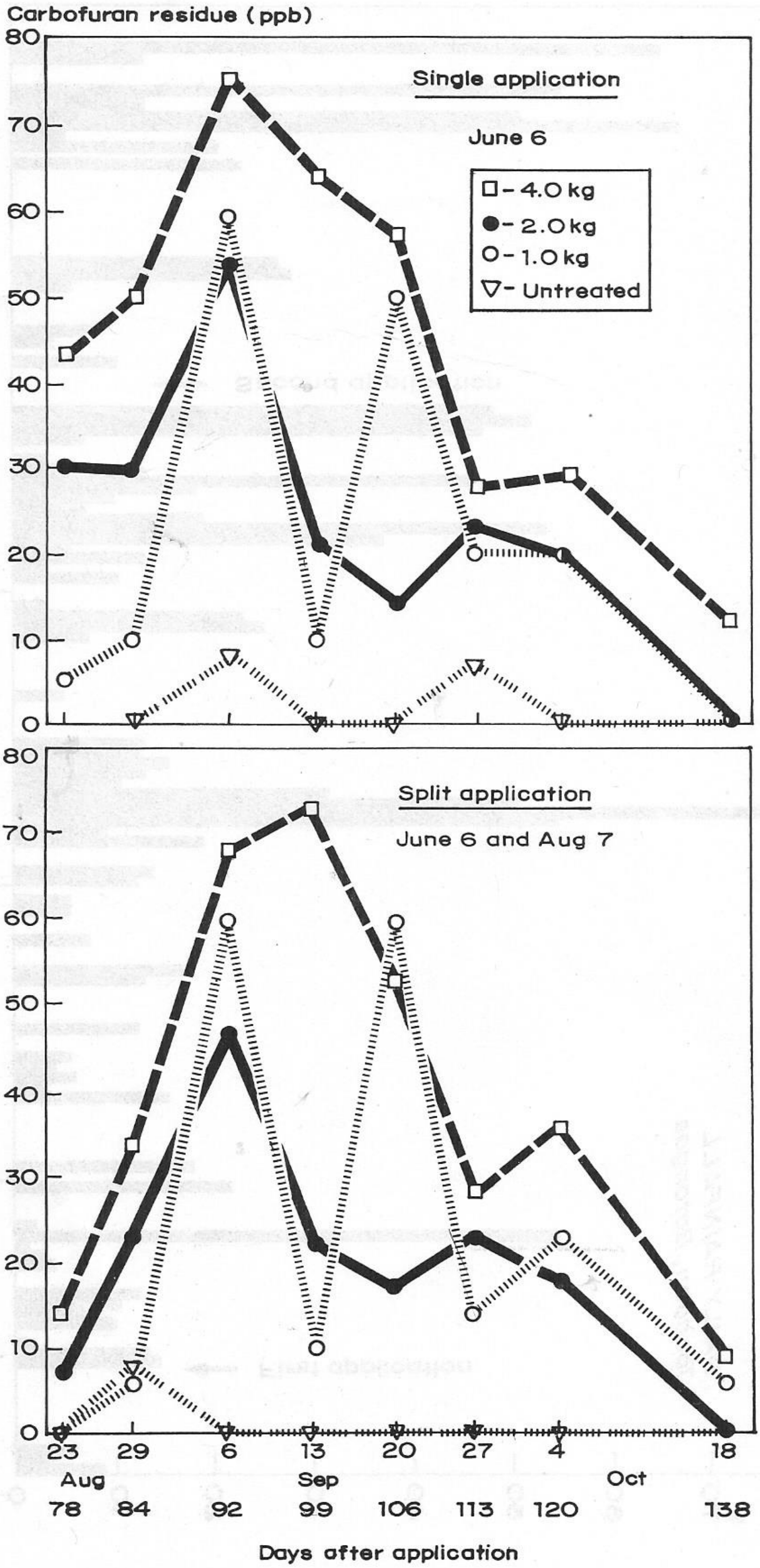

Fig. 2. Carbofuran residues in parts per billion detected from eggplant fruit. Tanauan, Batangas, 1977.

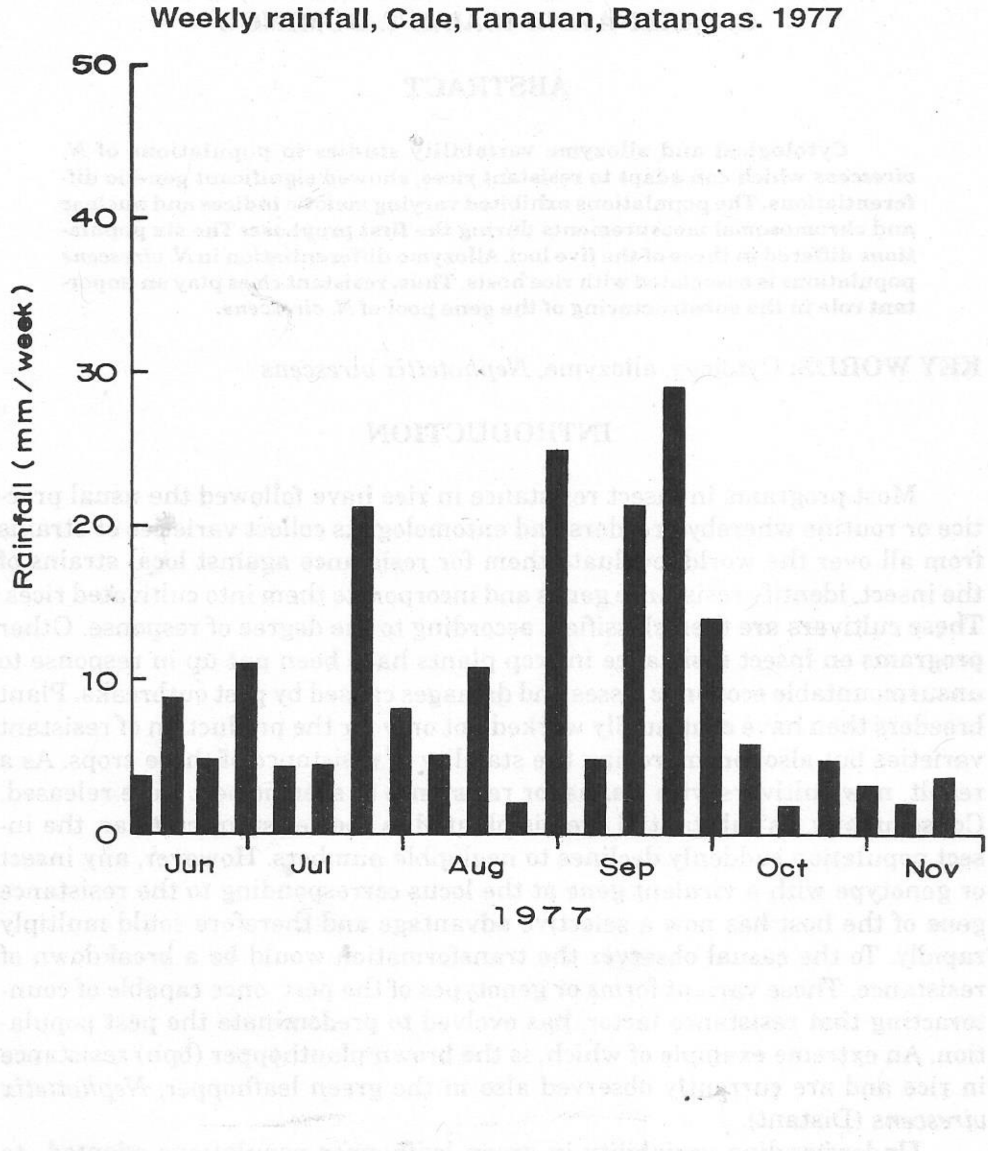

Fig. 3. Weekly rainfall (mm/week) from Tanauan, Batangas June-November, 1977.