Frequency and timing of insecticide application to control cocoa mirids

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ABSTRACT

This 5-year study was conducted at five sites on farmers' farms of mixed populations of mature hybrid and Amelonado cocoa varieties to ascertain the best time to apply the least number of chemical applications to effectively control cocoa mirids, *Distantiella theobroma* (Dist) and *Salhbergella singularis* Hagl. A plot size of 0.8 ha at each site was given treatments of lindane as Gammalin 20 at 280 g.a.i./ha in 56 l of water as follows: (1) one application in October, (2) two applications in September and October at 28 days' interval, (3) two applications in October and November at 28 days' interval, (4) the CRIG recommended four applications in August, September, October and December, and (5) untreated control. The treatments were arranged in a completely randomised block design. Mirid population counts were taken before treatment and 48 h after treatment. Fresh mirid-damaged trees, pod and tree population counts, canopy rating, and minor pests and predatory arthropod population were also recorded. At the end of the 1st year, there was no significant difference in mirid re-infestation rates between the single application (October treatment) and the untreated control treatment, although the percent degraded cocoa trees in the former treatment was higher (13.2 per cent) as compared to 10.0 per cent in the latter. Throughout the 5-year study period, mirid seasonal re-infestation was lower in the treated than the untreated control plots, the average re-infestation rates (mirids per plot per season) being as follows in increasing order: 2.6 (CRIG 4-treatments/year), 5.7 (September/October), 8.2 (October/November), and 71.2 (untreated control). Tree canopy improved by factors of 5.0, 6.0 and 4.6, respectively for the treatments September/October, October/November, and the CRIG 4-treatments/year, but there were no significant differences among these factors whilst the untreated control plots deteriorated by a factor of 3. As regards yield, the September/October treatment had the highest mean number of pods of 2.033 per plot, and the control plots had the lowest of 1,125 pods per plot. It is recommended that two applications of lindane (Gammalin

RÉSUMÉ

OWUSU-MANU, E. : *Fréquence et minutage de l'application d' insecticide pour le contrôle des mirids de cacao.* Cette expérience de 5 ans s'est déroulée à cinq sites sur les champs des cultivateurs des populations mixtes de hybride mûr et les variétés de cacao Amelonado pour s' assurer du meilleur temps d'appliquer le moindre nombre d'applications chimiques pour lutter efficacement contre les mirids de cacao, *Distantiela theobroma* (Dist) et *Salhbergella singularis* Hagl. Une superficie de lot de 0.8 ha à chaque site était soumise aux traitements de lindane comme Gammalin 20 à 280 g.a.i./ha en 56 l d'eau comme suit : (1) une application en Octobre, (2) deux applications en Septembre et Octobre à intervalle de 28 jours, (3) deux applications en Octobre et Novembre à intervalle de 28 jours, (4) les recommendations de CRIG de quatre applications en Août, Septembre, Octobre et Décembre, et (5) un contrôle non-traité. Les traitements étaient arrangés dans un dessin de bloc complètement choisi au hasard. Les comptes de population de mirid étaient faits avant le traitement et 48 h après le traitement. Les arbres récemment endommagés par mirid, les comptes de population de cosse et d'arbre, l'indice de voûte et la population des insectes ravageurs et d'arthropode prédateur mineurs étaient également enregistrés. A la fin de la première année, il n'y avait pas de différence considérable dans les proportions de réinfestation par le mirid entre la seule application (traitement d' Octobre) et le traitement de contrôle non-traité, malgré que le pourcentage des arbres de cacao dégradé dans le traitement précédent soit plus élevé (13.2 pour cent) par comparaison à 10.0 pour cent dans le dernier. Durant toute la période d' étude de 5 ans, la réinfestation saisonnière par le mirid était moindre dans le traité que dans les lots de contrôle non-traités, les proportions (mirids par lot par saison) de réinfestation moyenne étant les suivants dans l'ordre décroissant : 2.6 (4 - traitement de CRIG / an), 5.7 (Septembre/Octobre), 8.2 (Octobre/Novembre), et 71.2 (contrôle non-traité). La voûte d' arbre améliorait par les facteurs de 5.0, 6.0 et 4.6, respectivement, pour les traitements Septembre/Octobre,

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20) per mirid season is sufficient.

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Octobre/Novembre, et les 4-traitements de CRIG / an mais, il n'y avait pas des différences considérables parmi ces facteurs alors que les lots de contrôle non-traités détérioraient par un facteur de 3. En ce qui concerne le rendement, le traitement de Septembre/Octobre donnait le plus élevé de nombre moyen de cosses de 2.033 par lot, et les lots de contrôle avaient les plus baisses de 1, 125 cosses par lot. Il est recommandé que deux applications de lindane (Gammalin 20) par saison de mirid sont suffisantes.

Introduction

Chemical control of cocoa mirids, *Distantiella theobroma* (Dist) and *Salhbergella singularis* Hagl was initiated when the insects were first recognised as serious pests of cocoa in Ghana (Dudgeon, 1910). It was not until 1957 when lindane, as Gammalin 20, was recommended for mirid control to be applied once in June and July at 28 days' interval with a dosage of 280 g.a.i./ha in 56 l of water (Stapley & Hammond, 1957). The application of Gammalin 20 was to be repeated with half the dosage in November and December.

Mirid control could be better when lindane at 280 g.i.a./ha was applied in August, September, and October at 28 days' interval and in December (Peterson *et al.*, 1966). This recommendation was based on the population build-up of the mirids which started in July and peaked in either October or November. Youdeowei (1971) observed in field trials in Nigeria that when treatment was applied during the lean mirid season, that is, March to May, the population could not build-up during the succeeding months to a damaging level. However, Owusu-Manu & Manteaw (1976) observed in Ghana that mirid control during the lean period only shifted the population peak from October to December, and it did not affect the level of damage caused by the mirids.

In all these trials and subsequent recommendations, the frequency of application had been four times per mirid season at a fixed time of the year. Farmers cannot afford to treat their farms four times per mirid season as recommended because of high cost of inputs due to the withdrawal of subsidy and the high labour cost (Anon, 1995; Asante, 1997). This was confirmed in a country-wide survey conducted in 1994 (Anon, 1995), and another survey conducted by the Cocoa Research Institute of Ghana in 1991 in the Offinso District which indicated that only 0.4 per cent of the farmers applied the full recommendation (Donkor, Henderson & Jones, 1991).

This experiment was, therefore, designed to determine the least number of chemical applications per mirid season and the best time to apply this rate. The reduced rate should neither affect the yield economically nor the damage to an unacceptable level.

Materials and methods

Three and two sites of mirid-infested farmers' cocoa farms were selected at Saafi and Akuase near Nkawkaw in the Eastern Region of Ghana, respectively. Plot size of 0.8 ha with mature (over 15 years old) mixed hybrid and Amelonado cocoa varieties was demarcated at each site for each treatment. Tree population ranged between 850 and 2,216 per plot with an average of 1,600 trees. All the farms had never been sprayed with chemicals to control either mirids or blackpod disease. Weeding was done once in either October or November during the peak harvesting period. No pruning and mistletoe removal had ever been carried out. The following treatments were applied:

a) One application in October during mirid population peak.
b) Two applications, September and October at 28 days' interval, before and during the mirid population peak.

c) Two applications, October and November at 28 days' interval, during and after the population peak.
d) Four applications as recommended, August, September, October and December at monthly intervals.
e) Untreated control.

There were five replicates per treatment in a completely randomised block design. Lindane as Gammalin 20 was applied at a dosage of 280 g.a.i./ha in 56 l of water by using a motorised knapsack mistblower, Solo 423, with constrictor No. 2.

The following factors were used to compare the treatments: monthly mirid population, monthly fresh mirid-damaged trees, yearly pod count and canopy improvement as well as populations of cocoa minor pests and mirid predatory arthropods.

Monthly visual count of all mirids in each plot was done to a hand height before each application and 48 h later. Trees showing fresh symptoms of mirid damage were also noted, before each application. Pods (more than 5.0 cm diameter) were counted on all trees in each plot once a year. Pod counts for the first 2 years were done during the major cocoa season (October) while in the remaining years, counting was done in the minor crop season (July). Canopy rating or grading the conditions of the canopy was done at half-yearly intervals, beginning from August. Canopy rating was done on 50 randomly selected trees along each diagonal of the plot, resulting in 100 trees per plot. Canopy assessment was based on the percentage of degraded cocoa trees caused by mirid damage. Numbers of cocoa minor insect pests and mirid predatory arthropods, on each tree in each plot, were recorded on monthly basis. Monthly mirid counts, however, continued until March the following year.

The experiment covered a period of 5 years, from August 1992 to March 1997.

Results

The results of the 5-year study are summarized on yearly basis (Tables 1 to 5). The initial 48-h mortalities for the different treatments were similar since one insecticide, lindane, was used throughout. The mean mortalities ranged between 97.3 and 99.9 per cent for *D. theobroma,* and between 98.7 and 99.9 per cent for *S. singularis* (Table 1).

Fresh mirid damage was very low in all the treated plots over the 5-year period, except on the October/November treatment in 1995/96 which had significantly higher freshly damaged trees than the untreated control (Table 2). Visual observation at the end of the 1st year showed no marked differences in canopy regeneration and fresh mirid-damaged trees for the 2-application treatments (September/October and October/November) and the recommended 4-application

TABLE 1

Mean 48-h Mortalities of Distantiella theobroma *and* Sahlbergella singularis *Over a 5-year Period, 1992/93 - 1996/97*

Treatment	*Mean 48-h mortality*											
	1992/93		*1993/94*		*1994/95*		*1995/96*		*1996/97*		*5-year mean*	
	D. t	*S. s*	*D. t*	*S. s*	*D. t*	*S. s*	*D. t*	*S. s*	*D. t*	*S. s*	*D. t*	*S. s*
October	99.0	99.2	-	-	-	-	-	-	-	-	99.0	99.2
September/October	99.3	99.4	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	99.9	99.9
October/November	100.0	97.7	100.0	100.0	92.5	98.5	94.2	100.0	100.0	100.0	97.3	99.2
August-December	97.7	95.7	100.0	100.0	97.0	98.0	100.0	100.0	100.0	100.0	98.9	98.7
Untreated control	17.8	-21.3	1.1	8.7	13.0	-82.1	-50.0	-67.9	-46.7	-57.1	-13.0	-43.9

D. t. = *Distantiella theobroma*
S. s. = *Sahlbergella singularis*

TABLE 2

Percentage of Trees Showing Fresh Mirid Damage, 1992 - 1997

Treatment	*Mean percent fresh mirid damage*					
	1992/93	*1993/94*	*1994/95*	*1995/96*	*1996/97*	*5-year mean*
October	10.4	-	-	-	-	-
September/October	11.8	0.2	0.1	0.3	0.3	2.5
October/November	6.4	0.3	0.2	23.3	1.0	5.2
August-December	3.0	0.8	0.4	0.3	0.3	0.1
Untreated control	61.8	3.7	13.4	7.4	9.1	19.1

TABLE 3

Mean Numbers of Mirids Per Plot Per Season Over a 5-year Period (1992 - 1997)

Treatment	*Mean mirid seasonal cumulative*					
	1992/93	*1993/94*	*1994/95*	*1995/96*	*1996/97*	*5-year mean*
October	23.4	-	-	-	-	-
September/October	21.6	2.4	0.6	1.7	2.2	5.7
October/November	8.0	3.4	2.2	15.3	11.2	8.2
August-December	4.0	4.0	3.8	0.4	1.0	2.6
Untreated control	180.4	22.4	11.4	144.8	127.2	71.2

TABLE 4

Percentage of the Canopy Degraded by Mirid Damage During the 5-year Period (1992-1997)

Treatment	*Percent degraded trees per plot*						
	1992/93	*1993/94*	*1994/95*	*1995/96*	*1996/97*	*5-year mean*	*% improvement 1992/97*
October	13.2	-	-	-	-	-	-
September/October	3.6	0.2	1.0	2.8	2.6	2.0	5.0
October/November	4.0	2.0	0.6	9.2	4.6	4.1	6.0
August-December	7.0	4.2	3.0	6.0	4.6	5.0	4.6
Untreated control	10.4	11.6	4.2	2.2	5.8	6.8	-3.2

TABLE 5

Mean Number of Pods Over the 5-year Period, 1992-1997

Treatment	*Mean number of pods per plot*							
	1992(Oct)	*1993(Oct)*	*1994(Jul)*	*1995(Jul)*	*1996(Jul)*	*1997(Jul)*	*Mean pods/year 1993-1997*	*Percent pods increase*
October	290.6	387.2	-	-	-	-	-	-
September/October	2036.2	1318.6	2143.2	2757.8	1827.8	2118.2	2033.0	-1.5
October/November	613.0	896.8	1635.6	2358.6	2039.4	1650.2	1734.1	182.9
August-December	1068.8	719.4	867.4	1839.8	1367.2	1800.0	1318.8	23.4
Untreated control	637.0	961.0	1182.5	1227.6	1479.8	776.4	1125.4	76.7

treatments. There were no fresh mirid-damaged trees on any of these three treatment plots after March 1993. There was, however, no difference between the single application (October) and the control treatments. The damage on the October plots was so severe that this treatment (October) was withdrawn from further trials.

Mirid seasonal cumulation was significantly lower in the treated plots than the untreated control plots throughout the 5-year study period (Table 3). The October/September treatment had an initial high rate of re-infestation of 21.6, but improved significantly during the subsequent years. The 4-treatment a year had the lowest rate of re-infestation (2.6), followed by the September/ October treatment (5.7) and then the October/ November treatment with 8.2 (Table 3).

The percentage of degraded trees in the October plots was more than that in the control plots at the end of the 1st year, that is, 13.2 and 10.4 per cent, respectively (Table 4). In the subsequent years, the September/October treatment had gradual improvement in the canopy, but decreased during the 4th year (1995/96). The overall canopy improvement for this treatment over the 5-year period was five fold. The 4-treatment a year had a similar improvement pattern, a factor of 4.6, which was not significantly lower than the previous treatment. The October/November treatment had an erratic pattern of degradation, but had the best improvement factor of 6. The untreated control plots deteriorated by a factor of 3.2 (Table 4).

Table 5 summarizes pod count over the 5-year period. There seems to be a pattern of pod production in all the treatments over the study period. The October/November and the control treatments had gradual increases up to the end of the 3rd and 4th years, respectively. The September/October treatment had pod increases from the end of the 1st year up to the end of the 3rd year. In all, the October/November treatment had the highest percent yield increase of 183, while September/October had a decrease of 1.5 over the 5-year period. The September/October treatment had the highest yield, with a mean number of pods of 2,033 pods/plot. The control treatment had the lowest mean number of pods of 1,125.4 pods/plot.

Visual observation at the end of the trial,that is March 1997, showed that there were no differences in the damage caused by mirids between the three treatments, although the untreated control plots had some degree of mirid damage. The canopies of the treated plots had closed, with contiguous and interlacing canopies.

Discussion

As lindane was the only insecticide used in this study, it was expected that mirid mortalities within the treatments would be similar. Freshly damaged trees, however, showed remarkable differences in the treatments. Where lindane application was delayed, even for 1 month instead of August, there was high incidence or percentage of freshly damaged trees. High mirid recovery rates were observed in the September/October and October/ November treatments, which indicated that there had been a high mirid population build-up before the application of the insecticide, or that the chemical was applied late when the mirid population had reached a very high level. This is more pronounced in the October/November treatment. The timing for initial application of insecticide to control mirids is thus very crucial.

Mirids are highly aggregated in their distribution, and few trees may harbour mirids within a large area (Owusu-Manu, 1972). Individual trees have high mirid populations at any given time, irrespective of the time of the year (King, 1972). It is thus essential to start treatment of mirid-infested farms immediately fresh mirid damage appears on the farm. The time of application of insecticide should be when fresh damage appears.

In this study, it was observed that when the insecticide was applied only once in October, during the season, there was a high incidence of mirid damage and a high rate of re-infestation. This shows that it is impossible to kill all the mirids

with one application. Those that are not killed would reproduce and lead to population increase. Secondly, some of the mirid eggs which hatched after the application of the insecticide might not be killed. There is, therefore, the need to apply control measures in mirid-infested farms at least two times consecutively at reasonable intervals, depending on the persistence of the insecticides.

The trial was conducted on farms with different cocoa age groups and different degrees of maintenance. Thus, the yield pattern and the actual yield figures for the various farms would differ considerably. This may account for the differences in pod counts within the treatments recorded in this study. Pod count, however, gave some indications of the effect of the treatment on the overall yield pattern over the study period. Although pod count or yield seems to be a good determining factor, it may be unreliable, especially when farms with different age groups of trees are used for the study. In this study, mirid numbers (re-infestation rate) and fresh mirid-damaged trees seem to be the more reliable characteristics to assess the effectiveness of the different treatments.

The current recommendation involves spraying four times in a mirid season (Stapley & Hammond, 1957; Peterson *et al.*, 1966), which most farmers cannot afford due to high cost of inputs and labour (Donkor *et al.*, 1991; Anon, 1995; Asante, 1997). In this study, two applications per mirid season in September and October at 28 days' interval were as effective as the four recommended applications. Since the cost of application has been reduced by 50 per cent, more farmers are likely to adopt mirid control measures.

Conclusion

It is clear from this study that two insecticide applications in September and October per mirid season will result in an effective control of cocoa mirids throughout the year, and the formation of closed interlacing canopy. The starting period will depend on the extent of the initial mirid damage.

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