

Economics of Application of three Insecticides on the Yield of Watermelon in Southern Nigeria

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ABSTRACT

Watermelon *Citrulus lanatus* Schrad was grown on the field under rainfed in the early and late seasons at Ile-Ife, Nigeria. Sixteen insect pests were observed attacking watermelon among which these six *Aulacophora africana* Wse, *Zonocerus variegatus* (L.) *Epilacha chrysolina* Th. *Dacus cucurbitaceae* Kars., *Anoplocnemis curvipes* F. and *Leptoglossus australis* F. were rate as abundant because of a total count of over 80 individuals on a 17 x 9m plot per week. Permethrin (Ambush) at 0.06 and 0.04% in the early and late cropping seasons respectively controlled insect pests and effectively gave highest weight of marketable fruits of watermelon. Propoxur at 0.16% in the late season and carbaryl at 0.4% in the early season also prevented some damage. Production, Trading, Profit and Loss analysis showed that watermelon production could be profitable if insect pests are controlled. Marginal returns were highest in the late cropping season.

Introduction

The tree crop culture of farmers in southern Nigeria is probably responsible for the half developed food crop culture in this part of the country. The situation is such that a typical farmer who derives major income from tree crops (cocoa, oilpalm, coffee, citrus, etc) finds little or no time to grow nonstaple foods like watermelon *Citrulus lanatus* Schrad. Watermelon originated in Africa but it is surprising that many farmers in southern Nigeria do not grow watermelon even when such farmers have been growing seedmelon *Citrulus sp.* for a long time. On the other hand, in the more northerly part of Nigeria, watermelon is grown on commercial basis especially in the Benue and Plateau State. The difference in the climatic conditions of southern and northern Nigeria can not be implicated for this practices because watermelon grows well and with same quality when produced in humid areas as in arid and semi arid regions (Janick, 1963). Two factors may be identified for this lag in watermelon production in southern Nigeria. Poor market for watermelon is the first factor but this had improved considerably in the last 10 years at urban centres. This upward trend will continue if watermelon becomes more available in the market. Insect pests is the second factor which constitutes an important hinderance in watermelon production in Nigeria. Insect pests attack the roots, stems, leaves, buds, flowers, tendrils, fruits and seeds of watermelon. Janick et al (1981) estimated that attack on flower and fruits alone may lead to a yield loss of 65%. No serious considerations therefore will be given to the production of watermelon without recommendations on control of insect pests associated with this crop in the field.

Inorganic insecticides like Bordeaux mixture and Ethylene dibromide were the earliest to be used as repellent against various insect pests on this crop (Knott, 1955). Following those were 3 chlorinated hydrocarbon insecticides: DDT, lindane and aldrin. DDT was used mainly against thrips, *Nezara viridula* L., and *Aulacophora africana* (Bohlen, 1973) while lindane and aldrin

were used as seed treatment against soil insect, (Janick, 1963, Ransomaklina 1972). Because of their less persistent nature, members of the organophosphorus (OP) insecticides have been popular in the control of watermelon pests in the last four decades till the present time. These OP's were used mainly to control thrips, spider mites, melon beetles, leaf hoppers, aphids and hemipterous bugs. Among the carbamates, carbaryl was used to control *A. africana*, thrips, aphids, grasshoppers, *Heliothis armigera* and *Dacus* sp. (Bohlen, 1973). The newer insecticides especially the synthetic pyrethroids, with their unique properties of quick knock down, lower mammalian toxicities and biodegradability are likely to replace the organophosphates in the control of watermelon pests. In this study, insect pests of watermelon and their control with carbamate (propoxur and carbaryl) and synthetic pyrethroid (permethrin) insecticides and the profitability of watermelon production in southern Nigeria are reported.

Materials and Methods

Variety Dave I was selected for these tests because of its earliness and tolerance to fungal diseases. The late season crop was planted in August 1985 on a 121 x 33m plot at a spacing of 2m x 2m at the Teaching and Research Farm of Obafemi Awolowo University, Ile-Ife. Two insecticides, permethrin (Ambush 25^R) and propoxur (Under 20^R) were used. Five levels of propoxur 0.005, 0.01, 0.015, 0.02 and 0.025% active ingredient (a.i.) in water and five levels of permethrin 0.02, 0.04, 0.06, 0.08 and 0.1% a. i. were used. The insecticides were applied weekly for 5 weeks beginning at 21 days after planting. Control plots were sprayed with water only, and each plot was replicated 3 times. Each treatment occupied a 11m x 11m plot consisting of 4 rows and 4 plants per row. A 2m wide border surrounded each plot to absorb insecticide drift if any. A complete randomized block design was used. Insect pest populations were monitored by visual counts of the different types of pests on the two middle rows for each treatment twice weekly with minimal disturbance of the insects or the foliage. Samples of the pests were preserved and identified at the Insectarium of the Obafemi Awolowo University of Ife.

At harvest the fruits were sorted into good (mature, damage free and weighing not less than 2kg) and bad (undersized, damaged by insects or pathogens or cracked) fruits. The data in this experiment were subjected to analysis of variance and the means compared by Duncan multiple range test. An early season crop was planted in April 1986 on 102 x 90m plot. The crop was treated with 5 levels of carbaryl and permethrin. Carbaryl was chosen to place propoxur earlier used because of the unavailability of the latter. Levels of permethrin used in the late season planting of 1985 were repeated. Carbaryl was used at 8.8, 17.5, 35.0, 45.0 and 70.0g of commercial formulation Vetox 85 per 10 l water. These represented 0.075, 0.15, 0.30, 0.39, and 0.60% a.i. respectively. Each treatment was a 3 row plot consisting of 21 stands on a 17 x 9m plot size. A 2.5m wide border surrounded each plot because of the spreading nature of watermelon. Control plots were sprayed with ordinary water. Experimental design used was randomized completed block with each treatment replicated 6 times. The following cultural practices were carried out and cost estimated: land preparation, planting, supplying at 14 days after

planting (DAP), fertilizer application at 20 DAP, 3 insecticidal spray at 43, 50 and 57 DAP, 2 hand weedings at 19 and 42 DAP and harvesting at 74 DAP. Data were subjected to analysis of variance and the means compared by lsd at 5% level. In computing the economics of watermelon production the treatment which gave the highest yield of good fruits for each insecticide was used. The 1988 cost of labour, equipment, tractor hire and seed were used.

Results

Sixteen insect pest species were found to be associated with watermelon at Ile-Ife. Of these, *Aulacophora africana* Wse (Coleoptera) *Zonocerus variegatus* F. (Orthoptera), *Epilachna chysomelina* Var. (Coleoptera), *Dacus cucurbitaceae* Kars (Diptera) *Anoplocnemis curvipes* (Hemiptera) and *Lep toglossus australis*, F. (Hemiptera) were rated abundant as they had a total count of over 80 individuals per week. Rated frequent were *Chrysolagria nairobi* Borch (Coleoptera), *Cletus fuscescens* Wlk (Hemiptera), *Luperoides lineata* Kars (Coleoptera), *Asbecesta travasa* Hans (Coleoptera) and *Copa delata* Wse (Coleoptera). These had a count of 30-79 per week. Rated rare were *Aspavia armigera* F. *Nezava viridula* L. *Lygaeus rivularis* Germ *Dysdercus superstitiosus* F. (the four were Hemipterans) and *Chelisoches flavipennis* L. (Coleoptera) because each had a count of 1-30 per week. The Coleopterous pest inflicted destructive feeding on foliage, the young seedlings being mostly affected. Feeding also occurred on young fruits. The polyphagous feeder *Zonocerus variegatus* shared similar feeding habit with the Coleoptera. The Hemipterous pests punctured the young fruits and made the fruits susceptible to pathogens attack. Where the fruits survived such attack, permanent scars are left on the fruits which reduce their marketability.

Due to poor rainfall during the late growing season, yield was low but differences among treatments were significant (Table 1). Propoxur applied at 0.64% killed all the watermelon treated with it. The 0.16% propoxur and 0.04% permethrin gave the highest weight of good fruits of 60.7 and 69.4 kg respectively per plot. For propoxur, other concentrations better than the control (untreated) were 0.04 and 0.08%. For permethrin, 0.06 and 0.08% were better than the control but yield of good fruits was decreasing at the 0.04% which appeared optimum was exceeded. For the permethrin treated plots in the early season planting, 0.06% permethrin gave the highest yield of good (marketable) fruits (Table 2). The same concentration also gave one of the least weight of insect damaged fruits. Lower concentrations of 0.02 and 0.04% also gave a yield of 84.5 and 81.7 kg per plot respectively, but their total weights of bad fruits (undersized, insect damaged and crack) were higher than those of 0.06%. Carbaryl-treated plots did not show any significant difference among treatments for the yield of good (marketable) fruits. Generally, the weight of bad fruits decreased as the concentrations of either carbaryl or permethrin increased but the weight of good fruit was highest (therefore optimally produced) at 0.4 and 0.06% carbaryl and permethrin respectively.

Discussion

The present study has shown that watermelon grows well in southern

Table 1: Mean fruit yield/Plot of watermelon crop treated with different concentrations of propoxur and Permethin on the field*

	Percent Concentration	Wt of good Fruits	Wit of bad Fruits
Propoxur	0 (Control)	9.7 a	3.7 a
	0.04	22.6 b	9.3 a
	0.08	34.5 b	10.0 a
	0.16	60.7 c	17.0 b
	0.32	4.2 a	1.7 a
	0.64	0.0 a	0.0 a
Permethrin	0 (Control)	5.1 a	1.7 a
	0.02	9.0 a	3.0 a
	0.04	69.4 d	20.0 c
	0.06	39.6 c	11.0 b
	0.08	12.1 b	6.0 a
	0.10	7.4 a	2.0 a

*Means followed by same letter not significantly different at 5% level by Duncan's multiple range test.

Table 2: Mean fruit yield/Plot of watermelon crop treated with different concentration of carbaryl and permethin on the field.*

	Percent Concentration	Wt of good fruits	Wt of under-sized	Bad Insect damaged*	Bad Fruits Cracked
Carbaryl	0(Control)	62.3 a	3.1 a	2.4 a	1.3 a
	0.08	72.2 a	4.3 a	0.9 a	4.5 b
	0.2	70.3 a	4.2 a	3.0 b	1.3 a
	0.3	78.8 a	4.0 a	3.5 bc	0.7 a
	0.4	82.2 a	3.7 a	3.3 b	0.7 a
	0.6	62.0 a	3.2 a	1.5 a	0.8 a
Permethron	0(Control)	62.3 a	3.1 a	2.4 a	1.3 a
	0.02	84.5 ab	4.3 a	2.1 a	1.8 a
	0.04	81.7 a	4.0 a	3.2 b	1.3 a
	0.06	87.0 b	4.7 a	1.6 a	1.8 a
	0.08	73.2 a	3.3 a	0.8 a	1.2 a
	0.1	59.5 a	3.3 a	1.7 a	0.5 a

*Means followed by same letter not significantly differ by 1sd (0.05)

**Fruits with scars or partly rotten as a result of punctures or feeding by insects.

Nigeria if the limiting factor of insect pests can be eliminated. All over the world, cultivation of cucurbits is hampered by destructive feeding on foliage and fruits by a number of species of Lyperini (Coleoptera: Chrysomelidae: Galerucine). In Nigeria, the Old World Aulacophorina, *Aulacophora africana* and *Epilachina chrysomelina* are the most abundant as found in this study and probably the most destructive. Other Coleopterous pest formed the bulk of those classified as frequent in this study. While Hemiptera is next to Coleoptera in importance, most of the hemipterous pests found on watermelon in this study are grouped as rare. The grasshopper *Zonoceus varigatus* are found only in the late season cropping. Their mode of attack in lines of suicide squads (Olaifa and Akingbohunge 1986) makes them a severe pest of agricultural crops. However unless watermelon is grown with irrigation in December to March, grasshopper may not constitute a problem after all. Those found in this study occurred at the fruit maturing stage, the state at which the effects of foliage feeding may not constitute important yield loss factor. Some of the insects attacking watermelon at Ile-Ife were listed among the 31 insect pests of watermelon in south western Nigeria (Akinlosotu 1977). The production trading and profit and loss account for watermelon at different best insecticide concentration (Table 3) showed that watermelon production can be a profitable venture only if Insecticides were used to control insects pests. In the early season, the producer can still make a profit without any insecticidal application but in the late season, he will be producing at a loss (N804.20 on one hectare crop). If insecticides are used profit margins become high. The marginal return from use of insecticide permethrin for example, in the early and late cropping seasons were N346.80 and N1643.60 respectively. In calculating the late season sales, the early season price was used but this is not always so especially in big cities like Ibadan or Lagos. The N0.50 was used at Ile-Ife as against N1.00 in Ibadan or Lagos in order to promote watermelon sales at Ile-Ife. The marginal return is therefore going to increase considerably if watermelon is grown or sold in Ibadan, Lagos or Benin City.

In conclusion, permethrin at 0.04 to 0.06% (the later concentration for the early growing season when rainfall is high) performed best in controlling watermelon pests. Carbaryl at 0.4% and propoxur at 0.16% also appeared optimum for the control of watermelon pests. Even though watermelon can be produced profitably in the early growing season without insecticide application, pest control with insecticides increased marginal returns. Watermelon production is at a loss in the late growing season as result of a more severe insect problem during this period. It is more profitable to grow watermelon in the late growing season if insecticidal control of pests are done.

Table 3 Production Trading, Profit and Loss Accounts Watermelon at Different Best Insecticide Concentration and Number of Spraying.

	EARLY SEASON			LATE SEASON		
	Control	Carbaryl	Permethin	Control	Propoxur	Permethin
Farm Size (Ha)	1	1	1	1	1	1
Insecticide Concentration %	0	0.4	0.06	0	0.16	0.04
Number of Spraying	0	3	3	0	5	5
Yield (Kg)-5% wastage	3863.3	5103.9	5402.0	761.6	4765.7	5448.8
Price (N/Kg)	0.50	0.50	0.50	0.50	0.50	0.50
Sales	1934.20	2552.00	2701.00	380.80	2382.90	2724.40
Land Preparation-						
Ploughing (2ce)	200.00	200.00	200.00	200.00	200.00	200.00
Harrowing	100.00	100.00	100.00	100.00	100.00	100.00
Planting & Supplying-Seeds	100.00	100.00	100.00	100.00	100.00	100.00
- Labour	100.00	100.00	100.00	100.00	100.00	100.00
Weeding (2ce)	200.00	200.00	200.00	200.00	200.00	200.00
Fertilizer Application						
(2ce) materials	50.00	50.00	50.00	50.00	50.00	50.00
— Labour	25.00	25.00	25.00	25.00	25.00	25.00
Depreciation Land Clearing	20.00	20.00	20.00	20.00	20.00	20.00
— arm Implement	40.00	40.00	40.00	40.00	40.00	40.00
-Land(rent)	50.00	50.00	50.00	50.00	50.00	50.00
-Interest on Loan	150.00	150.00	150.00	150.00	150.00	150.00
Insecticide Application						
- Chemical	—	150.00	150.00	—	150.00	150.00
- Labour (N50/spraying)	—	150.00	150.00	—	250.00	250.00
- Equipment rent						
(N30/spraying)	—	90.00	90.00	—	150.00	150.00
Harvesting and Carting	150.00	180.00	180.00	50.00	180.00	200.00
Miscellaneous	100.00	100.00	100.00	100.00	100.00	100.00
Total Cost	1285.00	1705.00	1705.00	1185.00	1865.00	1885.00
Net Profit or Loss	649.20	847.00	996.00	-804.2	517.90	839.40
Marginal Return	—	197.80	346.80	—	1322.1	1643.6

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