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Economics of Spraying Times and Rate of Application of Carbaryl on the Yield of Okra *Abelmoschus esculentus*

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Abstract

Okro yield responds to carbaryl concentration level and number of sprayings. Carbaryl concentration of 0.17 and 0.35% with 3 sprayings are best for effective insect pest control to achieve high return/yield in early late seasons crops. Higher yields are obtained in the early season than late season and in sprayed than unsprayed plots. Okro production is more profitable in the late season than early season because of higher product (okro) price. Commercial okro production enterprise is within reach of an average farmer because of its relatively low cash outlay requirement and short lifespan.

Introduction

Production of okra *Abelmoschus esculentus* (L.) Moench in Nigeria has changed in recent year from the intercropping production (Adenuga, 1971) to monocropping. The increased production resulted from increased demand because of the relative easy by which okro soup can be prepared. The producers (okro farmers) have therefore transformed from the erstwhile subsistence to commercial level because good returns can be got from the production of the crop.

The major pests of okro in Nigeria have been listed as *Dysderus superstitiosus* (Fallen), *Empoasca fascialis* (Jacobi), (Glov.), *Spodoptera littoralis* F., *Spilosoma maculosa* Cr., *Sylepta derogata* F., *Podagrica* spp., *Leptocorisa elegans* Blote, *Acanthomyia horrida* Germ, *Lygaeus festivus* Thumb, and *Oxycarenus* spp. (Adenuga, 1971; Taylor, 1974; Akinlosotu, 1977). The population of these pests have built up in recent years as a result of monocropping and increased production of okro. Insecticides such as DDT, lindane and carbaryl are the major weapons used by the farmers to control these pests thus preventing damage (Adenuga, 1971). While DDT has decreased considerably in usage, lindane and carbaryl are still in use. The recent high price and non-availability have brought to a sharp decline the use of lindane in controlling field pests of okro. Carbaryl marketed as Vetox is currently the leading insecticide for the control of okro pests. Adenuga (1971) used 3 levels of carbaryl-60, 90 and 120 a.i/10l water and found that on three defferent occassions each of the concentration gave highest yield. The author concluded that sprarying okro with insecticide could be a profitable proposition especially for the dry season cropping. As many as ten applications were made before the end of fruit harvest. In Oyo State of Nigeria, it is not uncommon to see farmers making between 7 and 10 applications because of weekly application schedule often followed.

In view of the escalating prices of insecticides, the expanded hectarage of production, and the increasing commercial nature of the okro production enterprise, itis considered that the present 7-10 number of sprayings should be reviewed. The present study considered the economics of spraying times and concentration of carbaryl on the yield of okra. Yield is a good indication of the damage (by the insect pests) prevented by the insecticide.

Materials and Methods

Okra variety Sekona Local was established at the Obafemi Awolowo University Teaching and Research Farm in the early (rainy) and late (dry) seasons of 1986. A randomized complete block design was used in which four carbaryl concentration levels of 0, 0.17, 0.35 and 0.70% were sprayed. Each concentration was applied for 1, 2, 3, 4 and 5 times before harvesting commenced at 60 days after planting (DAP) for the early season plantings. Control plots were not sprayed. Each plot 3m by 5m, consisted of 4 rows and 10 stands per row. Okra stands were spaced at 1m between and 0.5m within rows. The plots were separated from one another by 1.5m space. All the missing stands were supplied at 2 weeks after planting and only one plant per stand was allowed. Weeding was by hand as necessary. Spraying for all treatments commenced at 28 DAP with subsequent applications at one week interval. By this arrangement the plots which received one application were done at 28 DAP only, those which received two were done at 28 and 35 DAP only, those receiving three was at 28, 35 and 42 DAP, etc. Harvesting of marketable fruits followed the local practice of 4 days interval from all the 40 stands per plot. A total of 12 harvestings per planting were done and on each occasion the fresh weight of okro fruits were taken. The weights were subjected to analysis of variance and the means of the treatments compared using Duncan's new multiple range test (Steel and Torrie, 1960).

The average yield at each carbaryl concentration level for each number of spraying was determined for each of the two seasons. The two seasons' means were subjected to the statistical test of difference between two means using t-test statistic. The behaviours of yield with change in number of spraying (when carbaryl concentration levels were held constant) and with change in carbaryl concentration, (when the number of sprayings were held constant) for each and the two seasons were identified. The carbaryl concentration that gave the highest average yield at each spraying number was identified for each of the two seasons to find the relationship between carbaryl concentration level and number of sprayings.

Since the physical maximum is not necessarily the economic optimum and using the profit maximising objective the Production, Trading, Profit and loss accounts (Wood, 1967) for each of the two seasons were prepared and Marginal analysis was used to determine the most economical (profitable) carbaryl concentration level, and number of spraying using current input and output prices. The total amount of cash needed to cultivate one hectare of okro farm size at the on going input market price and the duration of the enterprise were determined.

Results

Yield of okra in the plots sprayed with insecticide was generally and individually on the average higher than the yield in control plots for early and late seasons (Tables 1 & 2).

The average yield of early season okro was higher than that of late season. The difference between the means of the yields of the two seasons is statistically significant at 1% level (Table 2).

The variation in the number of sprayings analysis (Figure 1) showed that for all the 0.17% and 0.35% carbaryl treated plots, yield was highest for each and the two seasons combined with 3 sprayings. In the 0.70% carbaryl treated plots, one spraying in the early season and two spraying in the late and the two

Table 1: Average Yield (g) of Okro at Different Carbaryl Concentration levels and Different Number of Sprayings

		Early Season	
Concentration (%)		****X ± S_x**	**Highest Mean**
One Spraying			
Control	0	2157.0 ± 390^{c}	
	0.17	3240.0 ± 415^{b}	
	0.35	3370.3 ± 39^{b}	
	0.70	3883. ± 364^{a}	3883.7
Two Sprayings			
Control	0	1699.0 ± 877^{b}	
	0.17	3306.0 ± 255^{a}	
	0.35	2987.7 ± 67^{a}	
	0.70	3775.0 ± 292^{a}	3775.0
Three Sprayings			
Control	0	3589.7 ± 410.4^{b}	
	0.17	4786.7 ± 599.9^{a}	4786.7
	0.35	3493.3 ± 20.0^{b}	
	0.70	2770.0 ± 217.5^{b}	
Four Sprayings			
Control	0	2115.0 ± 387.3^{b}	
	0.17	3382.0 ± 652.1^{a}	3382.0
	0.35	2970.0 ± 491.9^{a}	
	0.70	2963.0 ± 604.0^{a}	
Five Sprayings			
Control	0	2166.0 ± 188.6^{a}	
	0.17	2980.3 ± 607.4^{a}	
	0.35	2232.0 ± 42.6^{a}	
	0.07	3250.7 ± 1154.9^{a}	3250.2

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

Table 2: AVERAGE YIELD (g) OF OKRO AT DIFFERENT CARBARYL CONCENTRATION LEVELS AND DIFFERENT NUMBER OF SPRAYINGS

		Late Season	
Concentration (%)		**$\bar{X}_1 \pm S_X$	**Highest Mean**
One Spraying			
Control	0	1649.7 ± 986.6[a]	
	0.17	1402.0 ± 586.4[a]	
	0.35	2309.3 ± 688.2[a]	2309.3
	0.70	2094.0 ± 766.6[a]	
Two Sprayings			
Control	0	2222.0 ± 997.1[a]	
	0.17	2030.0 ± 562.2[a]	
	0.35	2065. ± 1419.4[a]	
	0.70	3484.7 ± 480.1[a]	3484.7
Three Sprayings			
Control	0	1178.8 ± 992.6[b]	
	0.17	30443.7 ± 847.8[a]	
	0.35	3830.7 ± 1513.1[a]	3830.7
	0.70	2182.7 ± 1019.8[a]	
Four Sprayings			
Control	0	979.3 ± 426.0[a]	
	0.17	1781.3 ± 386.5[a]	
	0.35	2663.3 ' 839.5[a]	2663.3
	0.70	1655.0 ± 508.8[a]	
Five Spraying			
Control	0	1648.0 ± 1007.5[a]	
	0.17	2806.0 ± 1007.5[a]	2806.0
	0.35	2451.0 ± 2276.9[a]	
	0.70	2068.0 ± 1513.7[a]	

**Means followed by the same letters are not significantly different at 5% by Duncan's new multiple range test.

seasons gave the highest yield. Analysis of the variation in the carbaryl concentration level at constant spraying number (Figure 2) showed that plots which received only one insecticide spraying at 28 DAP, had the highest average yield when 0.70% and 0.35% carbaryl was used in the early and late seasons respectively. In plots that received only two insecticide sprayings at 28 and 35 DAP, the highest yield for the early, late and the two seasons combined was obtained with 0.70% carbaryl. When 3 insecticide sprayings were made at 28, 35 and 42 DAP, the highest yield in the early, late and two seasons combined was obtained with 0.70% carbaryl. When 3 insecticide sprayings were made at 28, 35 and 42 DAP, yield was highest in the early, late and two seasons combined in plots treated with 0.17%, 0.35% and 0.17% respectively. With four sprayings at 28, 35, 42 and 49 DAP the highest yield was obtained in the 0.17% carbaryl treated plots for late season. Five sprayings at 28, 35, 42, 49 and 56 DAP gave the highest yield for the late and combined seasons at 0.17%. In general, highest yield was obtained in the plots that received three insecticide sprayings.

The results of Tables 1 & 2 and Figures 1 & 2 also showed that when the treated plots are considered together yield increased up to maximum of three sprayings beyond which yield decreased progressively.

Considering physical quantities only, 3 sprayings of 0.17% carbaryl and 3 sprayings of 0.35% concentration gave the highest yield for early and late seasons respectively (Tables 1 & 2). They are also the most economical (profitable) levels (Table 4). Table 4 shows that okro production is profitable even when no insecticide is used but the profitability increases markedly with the use of insecticide despite the high price of carbaryl (insecticide).

In the early season, (Table 4) the incremental cost of spraying 0.17% carbaryl three times is ₦(755-160) 595 (difference between harvesting and insecticide application costs for 0 and 0.17% of carbaryl). The incremental revenue of spraying 0.17% carbaryl three times is ₦(3031.6 - 1485.4/ha) ₦1546.20/ha (difference between sales revenue for 0 and 0.17% of carbaryl). The net-gain from use of no insecticide and this level of carbaryl is ₦(1546.20 - 595.00) ₦951.20. Similar analysis showed that the Net Gain from spraying 0.70% of carbaryl insecticide once on okra farm is ₦(₦974.30-440.00) ₦534.30. For early season crop carbaryl applied at the rate of 0.17% three times before harvest gave the highest net return.

Using the same marginal analysis for late season crop, the highest net-return was obtained when carbaryl was used at the rate of 0.35% three times before harvest. The late season production of okro is more profitable than the early

Table 3: Difference Between the Means of Early and Late Season Okro Yield(s) (g).

SEASON	EARLY	LATE
X	3035.9	2166.3
n	20	20
S_X	730.2	725.3

t_c = 3.81

0.01 < p < 0.001

S_X = Standard error (S.E.)

t_c = T-test statistics

season despite the lower average yield of the late season. The total cash requirement of the agricultural production of one hectare of okro farm to achieve maximum yield and prevent any cash shortage embarassment is about ₦2,000.00. The investment duration is about 4½ months.

Discussion

Carbaryl reduced the effect of insect damage which is why the average yield of sprayed plots is higher than the control (unsprayed). The incidence of insect infestation is higher during the dry season (late season) than the rainy season (early season) and non-availability of adequate amount of soil moisture during the dry season accounted for generally lower yield obtained in late season.

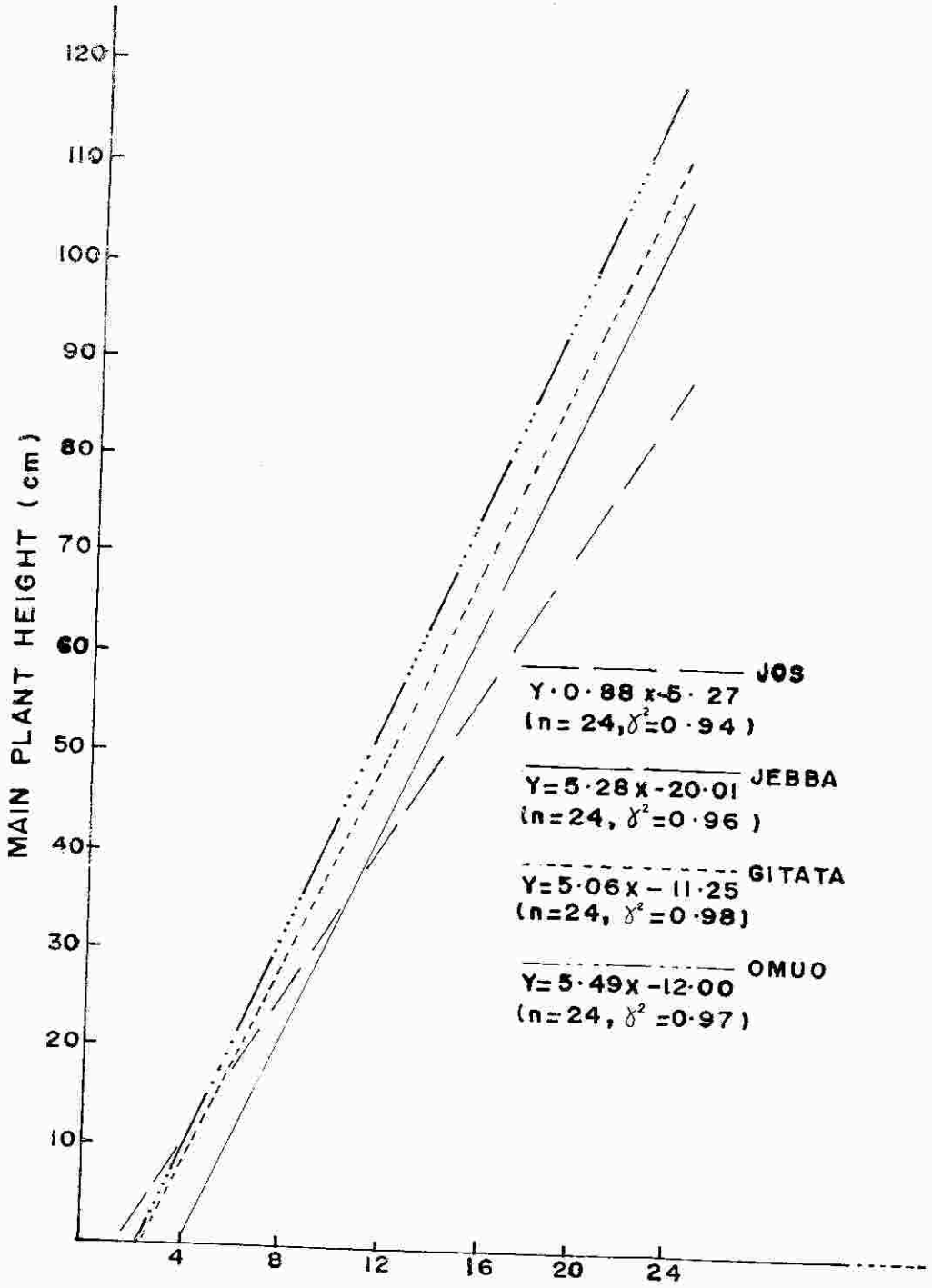

Figure 3. LINEAR REGRESSION OF I.PULCHRA GROWTH RATES IN THE SCREENHOUSE UNIVERSITY OF IFE CAMPUS

Table 4: PRODUCTION, TRADING, PROFIT AND LOSS ACCOUNTS FOR OKRO PRODUCTION AT DIFFERENT BEST CARBARYL CONCENTRATIONS LEVELS AND NUMBER OF SPRAYINGS (EARLY & LATE SEASONS)

	EARLY SEASON			LATE SEASON		
Farm Size (Ha)	1	1	1	1	1	1
Carbaryl Concentration (g/10 litres)	0	17.5	70.0	0	35.0	70
Number of Sprayings	0	3	1	0	3	2
Yield (kg) — 5% wastage	1,485.4	3,031.5	2,459.7	972.5	2,426.1	2,207.0
Price (₦/kg.)	1.0	1.0	1.0	1.50	1.50	1.50
Sales	1,485.40	3,031.60	2,459.70	1,458.75	3,639.15	3,310.50
Land Preparation — Ploughing (2ce)	150.00	150.00	150.00	150.00	150.00	150.00
— Harrowing	75.00	75.00	75.00	75.00	75.00	75.00
Planting — Seeds	25.00	25.00	25.00	25.00	25.00	25.00
— Labour	50.00	50.00	50.00	50.00	50.00	50.00
Weeding (3ce)	300.00	300.00	300.00	300.00	300.00	300.00
Fertilizer Application (2ce) — Material	50.00	50.00	50.00	50.00	50.00	50.00
— Labour	50.00	50.00	50.00	50.00	50.00	50.00
Depreciation — Land clearing	20.00	20.00	20.00	20.00	20.00	20.00
— farm 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
Miscellaneous	100.00	100.00	100.00	100.00	100.00	100.00
Harvesting	160.00	320.00	260.00	102.37	255.38	232.32
Insecticide Application — Chemical	—	195.00	260.00	—	390.00	260.00
— Labour (₦50/spraying)	—	150.00	50.00	—	150.00	50.00
— Equipment (rent = ₦30/spraying)	—	90.00	30.00	—	90.00	30.00
Total Cost (₦)	1,220.00	1,815.00	1,660.00	1,162.37	1,945.38	1,632.32
Net Profit (₦)	265.40	1,216.60	799.70	296.38	1,693.77	1,678.18
Marginal return	—	951.70	534.30	—	1,397.39	1,381.80

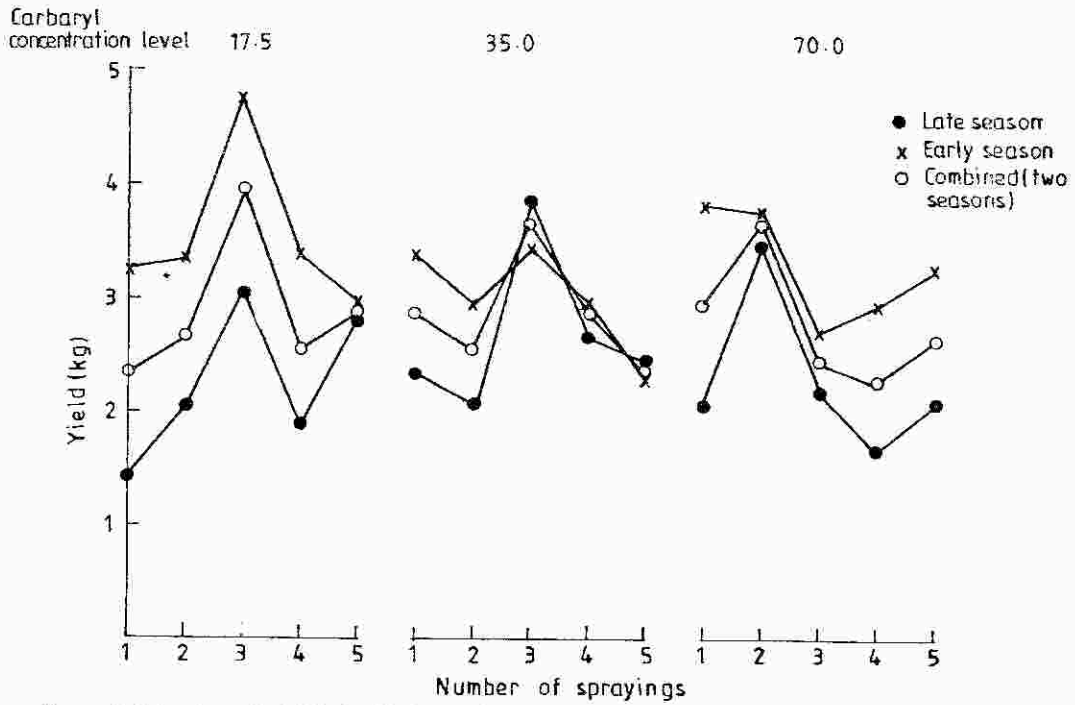

Figure 1: Behaviour of yield (g) with change in the number of sprayings at each constant carbaryl concentration level

The inverse relationship between carbaryl concentration level and number of sprayings suggests that large number of sprayings may be phytotoxic. More work is required on the suitability of carbaryl on okro as indications were there in this study that carbaryl cannot prevent damage by flea beetles *Podagrica* spp. Also research on the residue of carbaryl is suggested because profitable yield at 0.70% carbaryl for only one spray is an indication of persistence of the active ingredient.

The profitable nature of the okro production enterprise even at zero level of insecticide is as a result of increase in demand for theproduct (okro) which causes price hike and makes relatively large scale commercial production profitable. The increase in profits with the use of insecticide (carbaryl) is because

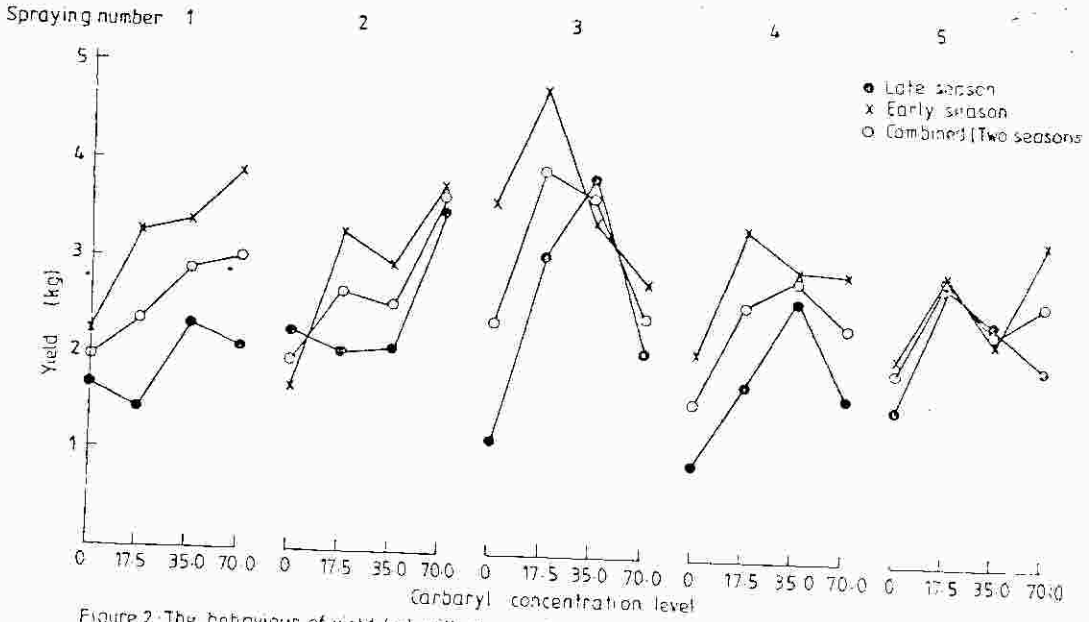

Figure 2: The behaviour of yield (g) with change in carbaryl concentrations at constant number of spraying

the addition to revenue resulting from high yield is more than the increase in cost which makes the use of the insecticide economically rational. The more profitable situation of late season production of okro despite lower yield is because of high price which atimes is more than double the early season okro price. The investment cash outlay of ₦2,000.00 is relatively small. Family labour which does not involve any cash out-flow could be used to substitute for part of the labour required to ease cash flow problem of the farmer. The enterprise lifespan is short (about 4½ months) during which the farmer should have earned income and made profits which makes it a lucrative investment for farmers in developing countries that are constantly faced with cash liquidity problems. It does not require heavy investment in fixed assets which makes folding up easier in case of losses.

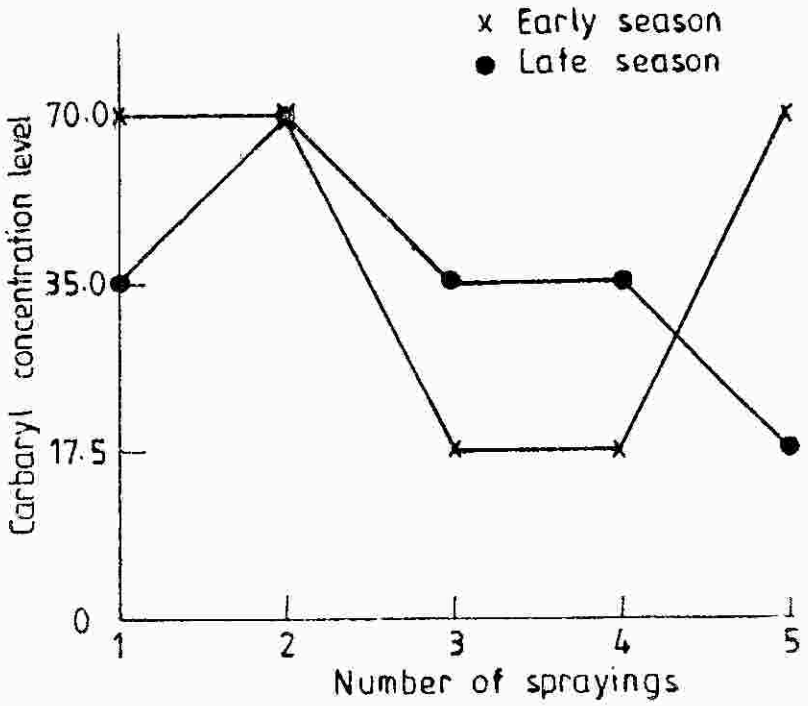

Figure 3: Behaviour of carbaryl concentration levels as number of sprayings to obtain highest average okro yield increases (Early & late seasons)

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