A STUDY OF THE EFFECTS OF APPLICATION OF CARBARYL ON PEST INCIDENCE AND YIELD OF IRRIGATED OKRA (Abelmoschus esculentus (L.)Moench)

BY

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D E C L A R A T I O N

The candidate hereby declares that the whole of the work now submitted as a Thesis for the Master of Science degree (Crop Protection) of Ahmadu Bello University is the result of his investigation (except where reference is made to published literature and where assistance is acknowledged) and has not been part of any presentation for any other qualification .

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A STUDY OF THE EFFECTS OF APPLICATION OF CARBARYL ON PEST INCIDENCE AND YIELD OF IRRIGATED OKRA (Abelmoschus esculentus(L.) Moench .)

ABSTRACT

In most parts of Nigeria okra is highly valued for making soups. Production is generally limitted by pests and diseases. Irrigation is the only means of producing okra pods during the dry season.

This thesis evaluates the effects of application of carbaryl on pest incidence and yield of irrigated okra.

The experiment was conducted in a randomised block design with nine treatments replicated three times.

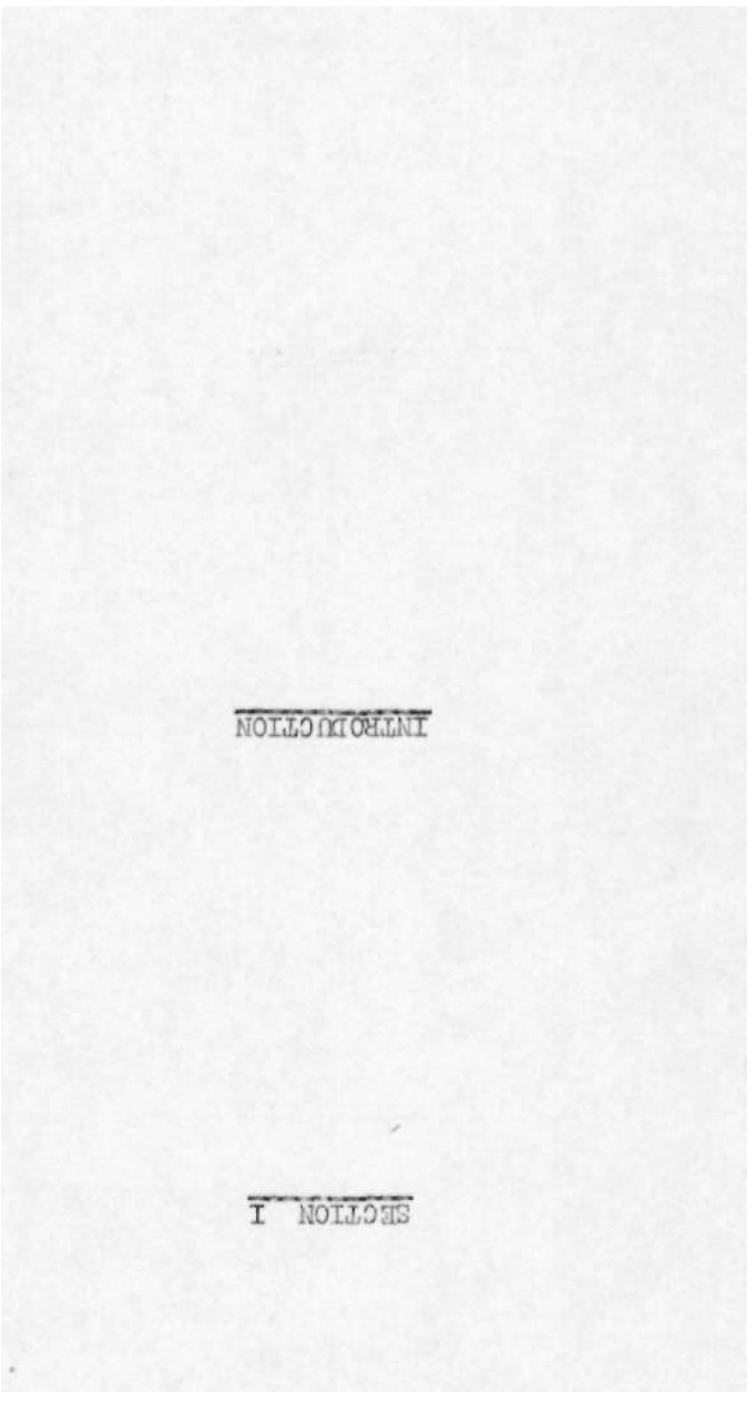
The effect of spraying carbaryl on flea beetles population resembled those described by other workers in Nigeria. The result demonstrated conclusively that spraying with carbaryl controlled flea beetles.

Studies showed that spraying with carbaryl did not significantly affect leaf production and leaf fall of okra plants. The total number of marketable okra pods were not affected as a result of spraying with carbaryl.

The effect of spraying on fresh weight of marketable okra pods were determined. It was suggested that levels of insect attack

encountered in this experiment was not high enough to reduce yield.

The evaluation of the effect of spraying on pod quality also resemble those of other workers in India. The three varieties examined showed that spraying improved pod quality.


INTRODUCTION
SECTION I

SECTION I: INTRODUCTION

Okra (Abelmuschus esculentus (L.) Moench) belongs to the family Malvaceae. It is said (Cobley, 1963) to be a tropical plant which grows well in the low-land tropics. Thompson and Kelly (1952) suggested that okra was probably not cultivated during ancient times as it has not been mentioned in ancient literature. It was however known to the Spanish Moors and Egyptians in the twelfth and thirteenth century (Thompson and Kelly, 1957). They suspect that okra was taken to other countries from Africa by the Portuguese.

Okra might have been brought to Nigeria for the first time by the Portuguese about the thirteenth century during their early visits to the west coast of Africa. The main centres for okra production in Nigeria are in the southern parts of the country. It is also grown in Benue and to some extent in Kaduna State. There is however no published estimate of the quantity of okra pods produced in Nigeria because much of the produce remains unrecorded as it is mostly consumed in the homes.

The cultivation of okra in most West African countries including Nigeria is done at the peasant level. It is mostly grown as an intercrop with yams, maize, cassava etc. It is

also grown as a garden crop in back yards. Okra can tolerate a wide range of soil and rainfall conditions and grows well during both dry and wet seasons. The okra plant continues to produce marketable pods for as long as 4 months.

In Nigeria the principal use of okra is in soups and stews in which meats form an important part. These are called "draw soups" because of their slimy texture. The pods are sometimes stewed and eaten as a vegetable either fresh or dried and seasoned with pepper, salt and palm oil. Okra is sometimes canned alone or in a soup mixture with or without other vegetables. It may also be frozen alone or with other vegetables. Dried okra powder is used for salad dressings, ice cream, cheese spreads and candies. The leaves of okra plant are cooked as pot herb and also used for treating peptic ulcer (Hartenson et al., 1964). The leaves and stems are shiny and are ground and used locally for dressing fresh wounds. The stems of okra plants contain fibre of considerable strength which may be used for domestic purposes such as making ropes, fish lines, traps and hammocks.

Many insects are found on okra plants throughout the year in Nigeria. Of these, two species of beetles, Podagrica sjostedti Jac. and P. uniform Jac. (Coleoptera : Chrysomelidae)

which feed on foliage seem to be most important. In badly affected crops whole leaves may be destroyed. This reduces the photosynthetic area of the plants and the yield may be reduced. These insects are also vectors of virus diseases in okra plants especially Nigerian okra mosaic virus (Lana and Taylor, 1975). The affected leaves become wrinkled, small and may have chlorotic areas.

Several varieties of okra are grown in Nigeria. They may be tall or short, early or late maturing types. Some of these varieties have bright yellow colours which may increase the attractiveness of the flowers to insects. Some have more hairs on them than others. Varietal differences may affect yield of okra, fruit quality and pest incidence.

Many chemicals have been used for the insect control of okra pests (see Literature Review). Engels (1976, 1977); Shanthakumar and Perumal (1973); Thirmala et al. (1954) have reported Carbaryl to be effective in controlling insect pests on okra plants. They noted that Carbaryl is relatively cheap, readily available and fairly safe to use.

The aim of this study was:

A. To determine the effect of Carbaryl (Vetox 85) spraying on Podagrica spp.

B. To determine the effect of spraying on yield and quality of fruits produced in three varieties of okra.

C. To determine whether there are any varietal differences with respect to pest infestation in the three varieties.

SECTION II

LITERATURE REVIEW

SECTION II: LITERATURE REVIEW

Vegetables have been grown in Nigeria for quite a long time, but little or no emphasis has been placed on entomological research on okra. The importance of okra as source of vitamins and minerals is yet to receive the attention it deserves.

Bionomics of insect pests:

There are several insect pests and diseases that are known to affect okra both in yield and quality. Adenuga (1971), observed that almost every part of the okra plant is attacked by one insect or another. In Nigeria field populations of both *P. sjostedti* and *P. uniforma* on okra are known to reach levels of infestation that can result in economic damage. Caswell (1962), reported that several insects that attack cotton also attack okra which is closely related. Lamborn (1914), noted that *Dysdercus superstitiousus* Fab. showed preference for okra and suggested the possibility of planting okra in the vicinity of cotton as a trap crop. Golding (1946), listed *Podagrica* beetles among many cotton insects as pest of okra.

Epehuijsen (1974), in Nigeria grouped pests of okra into two categories, namely, the stem/leaf and seed/fruit pests. This classification did not take into consideration the fact that some insects tend to live in the soil during the hot weather, only coming to the surface at night to damage okra plants. Epenhuijsen (1974), observed that leaves of okra may be attacked by many species of beetle, such as Syagarus calcaratus Fab. (Coleoptera : Chrysomelidae), Lagria villosa Fab. (Coleoptera : Lagriidae), P. sjostedti and P. uniforma. He further noted a number of Hemiptera, viz., Anoplocnemis curvipes Fab. (Heteroptera : Coreidae), Pophilus alustus (Homoptera : Cercopidae), Mirperus jaculus Thnb. (Heteroptera : Coreidae). Among the lepidoptera he recorded the larvae of Sylepta derogata Fab. (Lepidoptera : Pyralidae) as feeding on the leaves and causing them to roll. He also reported that seeds and fruits of okra are attacked by Earias biplaga Wlk. (Lepidoptera : Noctuidae) E. insulana Boisd. (Lepidoptera : Noctuidae) and Pectinophora gossypiella Saund. (Lepidoptera : Gelechiidae). He noted that the larvae of P. gossypiella attack flower buds and eat into the pods destroying the seeds.

Adenuga (1971), also listed a number of insect species that attack okra in the field and reported that these insects caused loss in yield of okra. Ewete (1974), in Nigeria listed as many as 100 different insects associated with okra and classified them according to the plant part attacked. He thus listed them as leaf, stem, bud, flower, and fruit eating pests. He did not however list any root attacking insect pests. This classification seems to be unsatisfactory because pests of okra are not restricted to damaging a particular part of okra plant thus Podagrica beetles feed on buds, flowers, leaves, while the larvae feed on okra roots. Libby (1968), listed ten pests of okra as being important in okra in Nigeria, but that P. sjostedti and P. uniforma, and S. derogata which attacked the leaves appeared to be the most damaging. Adenuga (1971) pointed out that the leaves and the growing points of okra are attacked by Podagrica beetles S. calcaratus, and Zonocerus variegatus Fab. (Orthoptera : Acrididae). He reported that the attack by the lepidopterous larvae, mainly those of P. gossypiella, E. biplaga, and E. insulana was concentrated on flower buds leading to reductions in yield. Some of these larvae he observed bored into developing pods leading to the entry of rot organisms.

Apart from insects, okra plant is vulnerable to attack by nematodes, viruses, and fungi. Epenjuijsen (1974), mentioned yellow vein mosaic as a serious viral disease of okra which often results in crop failure. Lana et al., (1974) have observed at Ibadan a previously undescribed mosaic disease of okra which is also insect transmitted. In 1975 Lana et al., showed evidence of possible soil transmission of the Nigerian okra mosaic virus. They pointed out that in the field, mosaic disease spreads rapidly in okra and that the virus is readily transmitted by the beetles S. calcaratus and P. uniforma. Taylor (1975) studied insect transmission of the Nigerian okra virus. He reported that three beetles P. sjostedti, P. uniforma, and S. calcaratus and a white fly Bemisia tabaci Genn. (Homoptera : Aleyrodidae), transmitted a Nigerian isolate of okra mosaic virus (OMV) in okra, cowpea, cotton and green gram Phaseolus aureus Roxb. He added that this was the first report of these beetles as vectors of a plant virus. Subarayudu (1976), observed that about 50% of okra at Kadawa Irrigation Scheme in Kano State had okra leaf curl virus transmitted by aphids. Epenhuijsen (1974), reported a fungal disease of okra which causes sudden wilting of the plant. He suspected that this might be caused by Fusarium spp.

Huan and Jamil (1975), noted that okra pods in Malaysia suffered from the rot organisms Rhizoctonia sp., and Choanephora spp. Silveira (1947), Jackson (1964), and Noble (1968) have recorded Ascochyta abelmoschi and Fusarium solani on several varieties of okra grown in Nigeria.

Podagrica beetles as pests of okra:

A survey of literature shows that two species of Podagrica (P. sjostedti and P. uniforma) are by far the most important pests of okra. These beetles are known to attack mainly the leaves but other parts of the plant such as the flowers, stems, and roots may also be attacked (Golding 1946, Ademuga 1971 and Ewete 1974). Libby (1968) described these beetles as being small and measuring about 3.5mm long. He observed that P. sjostedti has a brown head, thorax, and underside and that the elytra are shiny dark bluish-black, while P. uniforma is shiny brown throughout. The female beetles lay their eggs in the soil, and the larvae feed on plant roots. Pupation takes place in the soil, the dry season being passed as a resting adult in the soil. The emergence of these adults beetles occurs with the early rains.

Libby (1968), described the larvae of the beetles as feeding mainly on plant roots, and adults mainly on leaves leaving numerous small holes in them. He pointed out that their feeding injury may retard plant development especially when young plants are attacked thus reducing yield. He also reported these beetles as being distributed throughout Nigeria. Lewis and Taylor (1965), studied the flight activity of P. sjostedti and P. uniforma on a malvaceous plant; Urena lobata which is commonly attacked by these beetles. They concluded that their peak activity was during the day. This observation is contarary to Taylor (1970) who reported these beetles as having their peak flight activity at dawn and dusk and flying intermittently during the day and night.

Insect control:

An appreciable amount of study has been carried out on the control of okra pests especially in India and some other tropical countries. Regapathy and Tayaraj (1973), in India showed that the okra plant could be protected from the attack of the aphid - Aphis gossypii, Glover. (Homoptera : Aphididae) and the leaf hoppers with systemic insecticides. They observed that systemic insecticides when applied through the soil were more effective than when applied on the foliage, and that a

relatively quick knock-down effect and large residual toxicity were noticed with increased dosage of the chemicals under controlled conditions.

Jotwani et al. (1960), studied the control of Jassids - Empoasca fascialis Jacobi. (Homoptera : Jassidae) on okra seedlings by treatment of the seeds with different insecticides. They stated that among insect pests affecting okra, the cotton jassids are considered to be the most serious pests, and that an attack by these pests in the seedling stage may result in complete crop failure.

Other workers on various aspects of pest control on okra in India include Bindra and Goyal (1966), Capoor and Varma (1950), Manahar (1969), Purewal (1944, 1947), Srinivasan and Gowder (1957) and Varma (1952). Thirmala et al. (1954), in Madras found that the application of DDT to okra increased yield.

Recent work done in Nigeria on the control of pests and diseases of okra include those of Adenuga (1971), Ewete (1974), Taylor (1970), Lana et al. (1974), Engels (1976, 1977). Adenuga used four insecticides to control insect pests on okra. These were Aldrin, Diazinon, Lindane and Carbaryl. He found that Carbaryl was most effective and that it was particularly effective in controlling both larvae and adults

of most insects. He observed that the use of Carbaryl at 1-2 lbs in 50 gallons of water per acre (1.1 - 2.2 kg/ha in 227.5 litres) for the control of flea beetles gave good results. Engels (1976), in Nigeria used Carbaryl to spray an okra field at Kadawa, Kano State but recorded very low yield of 1.6 nd 1.8 t/ha for unsprayed and sprayed plots of okra respectively. However in a later trial in 1977 when he used the same insecticide, he recorded 3.4 and 5.4 t/ha. for unsprayed and sprayed plots of okra respectively.

Spraying of okra plants with insecticides has been found to improve the quality of the seeds (Ewete, 1974). However, little or no work has been done in Nigeria to test the effect of some insecticides on the quality of okra pods or the number of flowers and fruits produced. Thirmala et al. (1971), observed enhanced quality of okra fruits due to foliar application of four insecticides.

SECTION III

DESIGN OF EXPERIMENT

SECTION III : DESIGN OF EXPERIMENT.

An experiment to study the effect of spraying three different levels of Carbaryl on three different varieties of okra was conducted at the Ahmadu Bello University Farm during the 1976 dry season(16th January to 14th June, 1976). Water was supplied by irrigation at weekly intervals.

Layout of experiment

A site close to the University Farm was selected for this experiment. The area had not had any okra grown on it before. The previous crop was maize.

The experiment was conducted in a randomised block design with nine treatments replicated three times (Table 1.1). The field plan for the experiment is shown in Fig. 1.1.

Planting

There were three varietal treatments V_1, V_2, V_3. The seeds for variety V_1 known as "white velvet" were obtained from the School of Agriculture, Samaru, Zaria. The seeds of variety V_2 were obtained from the Market Garden Enugu, Ministry of Agriculture. This variety is called "Local Twin" because of its ability to produce two pods on one flower stalk (Plate 1.1). The third variety V_3 was obtained from the University of Ibadan Farm. No chemical

seed treatment was given, the seeds were however immersed in water and seeds that sank to the bottom were selected for planting. Planting was done on ridges 9cm - 12cm high. Water was then let into the field. Sowing was done on 23rd, January 1976 at the rate of three seeds per hole and later thinned down to one stand. The spacing was 61cm between and 46cm within rows. Seeds were sown to depth of 1.5cm - 2.0cm. There were nine plants per plot and each plot was seperated by two ridges while each block was seperated by four ridges. The plot size was 7.6 X 34.3m. The seeds germinated between 5 - 6 days after planting, and the missing stands were supplied.

Fertilizer application

250.9 kg/ha of sulphate of ammonia was applied in two doses. The first dose of 175.5 kg/ha was two weeks after germination and the second dose of 175.5 kg/ha was at the first set of fruits(Anon. 1976, Samaru Extension Guide No. 61).

Spraying

The insecticide used in spraying treatments was carbaryl (1 - naphthyl methlcarbamate). A 85 % wettable powder(Vetox 85)* was mixed with water at the rate of 150 litres per hectare for spraying.

* Sold in Nigeria by National Oil & Chemical Marketing Co. LTD., Nigeria.

The first application of carbaryl was carried out on 8th February, 1976 when the plants were two weeks old. Spraying was repeated at weekly intervals and a total of 14 applications were made. A Falcon Knapsack sprayer (Plate 1.2) was used for the application of the chemical (carbaryl).

Weeding

This was done when necessary throughout the growing period of the okra plants.

Table 1.1 : Variety and Spraying treatments.

Spraying	Varieties		
	V_1	V_2	V_3
S_o	**Vi**	S_oV_2	S_oV_3
S_1	**S_1V_1**	S_1V_2	S_1V_3
S_3	S_3V_1	S_3V_2	S_3V_3

Varieties : V_1 . "White velvet"
V_2 = "Local twin"
V_3 = "U.I. 92"

Spraying levels; S
= Control (spraying with water)
= 1.7 gm(a.i) carbaryl in 4.5 litres of water(2gm Vetox 85)
= 3.4 gm(a.i) carbaryl in 4.5 litres of water(4gm vetox 85).

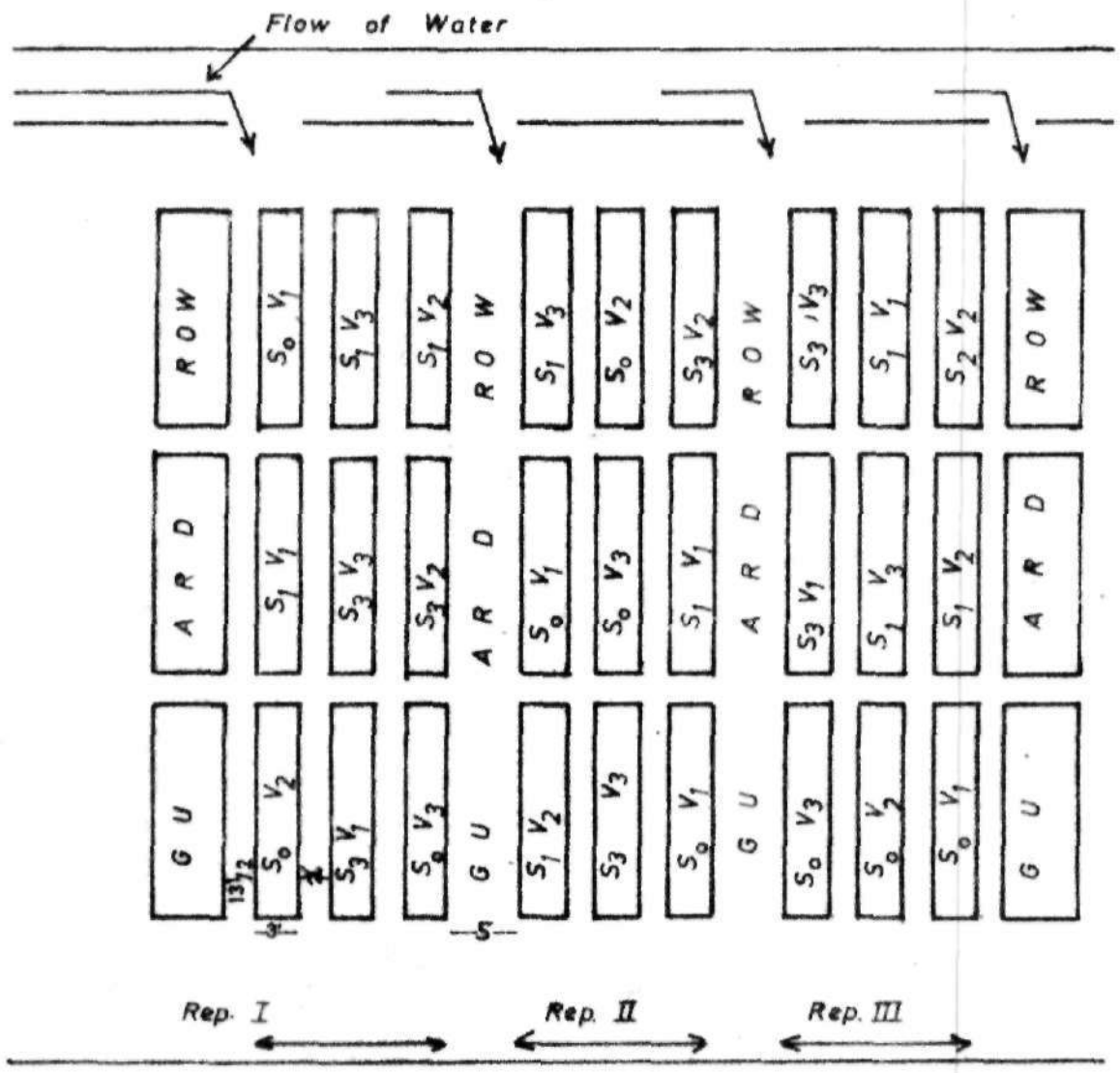


Fig II Lay out of Experiment
Randomized Block design with three replicates I, II, III.



Plate 1.1: "Local twin" (Okra varietv)



Plate 1.2: Falcon Knap-sack
Sprayer in use

SECTION IV

LEAF PRODUCTION

SECTION IV: LEAF PRODUCTION

A great number of insect species attack okra plants especially the leaves. Those insects on the leaves include P. uniforma, P. sjostedti, D. superstitiosus, S. calcaratus, Z. variegatus, A. curvipes and different species of aphids.

Of all these only Podagrica spp. appear to be causing much damage by eating up the leaves of okra and consequently reducing the photosynthetic area(Plate 2.1). Thirumala et al. (1954) have reported an increase in number of leaves as a result of spraying okra plants with insecticides.

A. Effect of spraying on Podagrica spp. population

Materials and Methods

The population of Podagrica spp. was estimated in the three replicates by counting the number of beetles on each okra plant one day after spraying. This was done at weekly intervals till the end of the growing season which was about the seventeenth week from planting. The counts were always done in the mornings (about 9.00 am) because the beetles are most active at this time. Similar observations have also been made by Lewis and Taylor (1965).



Plate 2.1: Leaf damage due mainly to Podagrica spp.,

Results and Discussion

The mean number of beetles per plant in the different treatments is presented in Table 2.1. The results of the statistical analysis (Table 2.2) shows that the different levels of spraying (S_0, S_1, and S_3) reduced significantly the population of the beetles. It also showed that the three varieties of okra (V_1, V_2 and V_3) did not significantly affect the population of these beetles. Earlier workers (Ademuga, 1971; Ewete, 1974; Srivastava et al., 1975; Bindra, 1966; Engels, 1976) have recommended the use of Carbaryl for the control of pest complexes on okra plant. Dadheech(1973), showed that carbaryl was more effective than Malathion in the control of pest of okra. According to Srivastava et al. (1975), Carbaryl has a quick knock down effect on Podagrica spp. Carbaryl residues they observed dissipated fast during the first 2-3 days and that the residues from 0.25% spray on normal marketable fruits were below 10 ppm within 24 hours after spraying. They further observed that Carbaryl residues were found in the seeds of okra and that this was indicative of a mild systemic nature of Carbaryl.

Conclusion

Spraying with Carbaryl significantly reduced the population of Podagrica beetles. The loss attributable to the reduced population of these beetles will be discussed in Section V .

Table 2.1 : Effect of spraying on population of *Podagrica* spp. (Beetles/Plant).

SPRAYING	VARIETIES			SPRAYING MEAN
	V_1	V_2	V_3	
S_0	9.3	4.6	16.3	10.1
S_1	3.6	2.0	2.6	2.7
S_3	1.0	2.0	0.6	1.3
Variety mean	4.6	3.0	6.5	

S.E for spraying = 1.7

S.E for variety = 1.7

Table 2.2: Analysis of variance table for population of *Podagrica* spp.

Source of Variation	DF	SS	MS	F
Reps.	2	60.5	30.2	1.1
Variety	2	56.9	28.4	1.0
Spraying	2	398.7	199.3	7.0 *
Variety X Spraying	4	158.8	39.7	1.4
Error	16	454.1	28.3	
Total	26	1129.1		

* Significant, P= 0.05

B. Effect of spraying on leaf production and leaf fall

Materials and Methods

The total numbers of okra leaves produced in the three replicates were counted weekly. The leaves were counted only when they were fully opened. The leaves that had fallen from the okra plants were also recorded.

Results and Discussion

The mean of the total number of leaves produced is given in Table 2.3. The analysis of variance (Table 2.4) shows that the levels of spraying with Carbaryl did not significantly affect the number of leaves produced. However, in the first and second varieties (V_1 and V_2), the leaves produced were more in the unsprayed plot (S_o) than in the sprayed plots (S_1 and S_3). In variety one (V_1) and two (V_2) it appears that spraying with Carbaryl suppressed leaf production. In variety three (V_3) whereas spraying with 2gm/4.5 litres (S_1) increased the leaf production, spraying with a higher dosage of 4gm/4.5 litres (S_3) reduced the number of leaves produced.

These observations however do not agree with earlier findings of Thirumala et al (1954), who reported that the insecticidal application of DDT on okra resulted in an increased

vegetative growth.

A study of the effect of spraying on leaf fall was conducted, by taking weekly counts of all fallen leaves in the three replicates throughout the production period which was approximately 14 weeks. The mean number of fallen leaves is presented in Table 2.5. The analysis of variance (Table 2.6) however showed that spraying with Carbaryl did not significantly affect leaf fall. It also showed that the three varieties did not significantly differ from one another in terms of leaf fall.

Conclusion

The results of these experiments show that spraying with insecticidal Carbaryl did not significantly affect either the number of okra leaves produced or the number of leaves that fell off the plant.

Table 2.3: Total leaf production (Leaves/Plot)

VARIETIES		SPRAYING			VARIETY	
		S_0	S_1	S_3	Mean	S.E.
V_1		1480.0	1212.0	1343.0	1345.0	135.2
V_2		1436.7	1319.7	1191.7	1316.0	
V_3		1677.7	1849.7	1348.0	1539.8	
SPRA-YING	MEAN	1531.4	1375.1	1294.2		
	S.E.	135.2				

Table 2.4: Analysis of variance for effect of spraying on okra leaf production.

Source of variation	DF	SS	MS	F
Replication	2	1.47	0.73	4.48
Spraying	2	0.26	0.13	0.80 N.S
Varieties	2	0.26	0.13	0.81 N.S
Interactions	4	0.11	0.02	0.17
Error	16	2.63	0.16	
Total	4.7			

N.S = No significant difference.

Table 2.5: Mean leaf fall per plot.

VARIETIES		SPRAYING			VARIETY	
		S_o	S_1	S_3	Mean	S.E.
V_1		228.3	256.7	284.5	256.5	30.1
V_2		258.0	299.7	306.7	288.1	
V_3		204.3	280.7	228.3	273.7	
SPRAYING	MEAN	230.1	279.0	273.2		
	S.E.	30.1				

Table 2.6: Leaf fall analysis of variance.

Sources of variation	DF	SS	MS	F	
Replication	2	59733.9	29866.9	3.65	
Spraying levels	2	12784.9	6392.5	0.78	N.S
Varieties	2	11645.4	5822.7	0.71	N.S
Interaction	4	5270.4	1317.6	0.16	N.S
Error	16	130751.5	8171.9		
Total	26	220186.1			

N.S = No significant difference.

SECTION V

INSECTS ON FLOWERS AND POD PRODUCTION

SECTION V : INSECTS ON FLOWERS AND POD PRODUCTION

A. INSECTS ON FLOWERS

A few insects were found feeding on the flowers. These include Pachnoda cordata Dry. (Coleoptera:Scarabaeidae), Mylabris farquharsoni, Bla. (Coleoptera:Meloidae),E. biplaga, D. superstitiousus and D. melanoderes Karsch.(Hemiptera:Pyrrhocoridae), A. curvipes, P. sjostedti and P. uniforma. The population of these insects on flowers was very low and it seems unlikely that they were causing any direct loss of flowers.

POD PRODUCTION

B. Effect of spraying on the total number of marketable okra pods produced.

From the literature reviewed in Section 2, it is seen that spraying okra plants can increase the yield of okra significantly. It is not unreasonable to associate increase in yield with total number of pods produced. This experiment was therefore conducted to find out if spraying with carbaryl significantly increased the total number of marketable okra pods produced.

Materials and Methods

Harvesting of mature okra pods was done weekly with a sharp knife. The harvested pods were bagged according to the various treatments and brought to the laboratory in polythene bags.

All pods were counted in the laboratory irrespective of their physical appearance and or disease conditon.

Results and Discussion

The total number of pods produced under different varieties and spraying treatments are shown in Table 3.1. The statistical analysis shown in Table 3.2 indicates that there were no significant differences in the total number of marketable okra pods produced either as a result of spraying or as a factor of variety. This result was not expected because variety two(V_2) has the capacity to produce two pods between the stem and the leaf-stalk.

Although spraying did not result in significant increases in the number of marketable pods produced by these varieties, Fig.4.1 shows that there are slight differences in pod production in varieties V_1 and V_3. In variety two(V_2) however, the high insecticidal treatments of 4gm/4.5litres (S_3) resulted in the production of higher number of pods i.e. 158.7 pods/plot in S_3 as against 109.3 pods/plot in S_1 and 112.7 pods/plot in S_o.

Conclusion

The result of this study shows that spraying of okra plants at the three levels of carbaryl as used in this experiment did not significantly differ from one another in terms of the total number of marketable okra pods produced.

Table 3.1 : Mean number of total marketable pods produced/plot.

VARIETIES		SPRAYING			VARIETY	
		S_0	S_1	S_3	MEAN	S.E.
V_1		86.7	70.0	95.0	83.9	15.9
V_2		112.7	109.3	158.7	126.9	
V_3		84.0	109.3	92.0	95.0	
SPRA-YING	MEAN	94.5	96.1	115.2		
	S.E.	15.9				

Table 3.2: Analysis of variance for number of marketable okra pods produced.

Source of variation	DF	SS	MS	F
Replication	2	6112.3	3056.1	1.33
Leave of spraying	2	2399.2	1199.6	0.52^{NS}
Varieties	2	8968.1	4484.0	1.95^{NS}
Interaction	4	4111.9	1028.0	0.45
Error	16	36806.4	2300.4	
Total	26	58397.9		

NS = No significant difference.

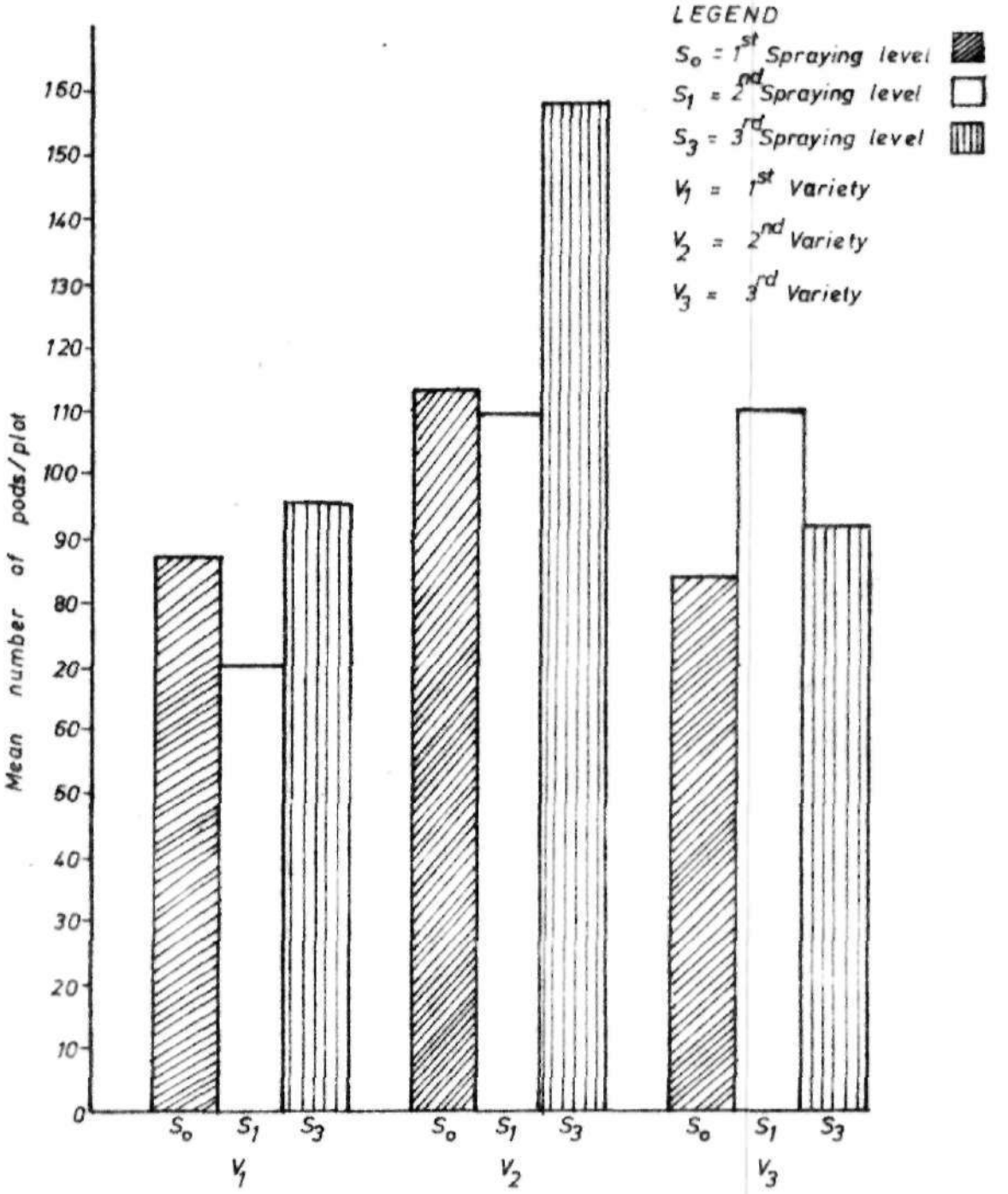


Fig 4.1 Mean number of pods produced per plot

C. Effect of spraying on weight of marketable pods

There are contrasting views on the effect of spraying insecticides on the yeild of marketable okra pods. Engels(1976), reported that spraying okra plants with carbaryl did not significantly increase the yeild of marketable okra pods, however Engels (1977), repotted that thesame treatment significantly increased yeild. Naveneethan(1970), and Shanthakumar (1975) have also reported increase in yield of marketable okra pods as a result of insecticidal application on okra plants. Adenuga(1971), Ewete(1974), however found in Nigeria that spraying okra plants with insecticides did not significantly increase the yield of marketable okra pods. Experiment was therefore carried out to determine the effect of spraying carbaryl at the three levels on the yield of marketable okra pods produced.

Materials and Methods

Fresh okra pods were harvested every five days from the three replicates by using a sharp knife. The pods were bagged according to treatments and then weighed.

Results and Discussion

The mean yield for the three spraying levels and the three varieties are shown in Table 3.3. Although the application of

Carbaryl reduced significantly the population of Podagrica beetles (Section IV A), the statistical analysis (Table 3.4) shows that spraying with insecticidal carbaryl at the three levels(S_0 , S_1, and S_3) did not result in significant increase in the weight of the marketable okra pods. Adenuga(1971), had earlier observed that although carbaryl was observed to be particularly effective in controlling both larvae and adults of most insects attacking okra, this did not result in significant increases in yield of treated over the untreated plots.

Table 3.4 also shows that the three varieties did not differ significantly in their yields of marketable okra pods. This result is similar to the result obtained by Engels(1977). He tested six varieties of okra for yield of marketable pods and found no significant differences between the varieties. Some workers (Perkin et al., 1952; Shanthakurma, 1973; Naveneetham, 1970) however have reported an increase both in the vegetative growth of okra plants as well as in the yield of the marketable okra pods as a result of spraying okra plants with insecticides. According to these workers application of insecticides results in increased vegetative growth which causes continous fruiting resulting in higher yields.

Conclusion

Spraying of okra plants with carbaryl did not result in significant increase in weight of the marketable okra pods produced. This experiment also showed that the three varieties of okra tested did not differ significantly from one another in terms of yield of marketable okra pods.

It can be concluded that the levels of insect attack encountered in this experiment was not high enough to reduce the yield of marketable okra pods. However, from the literature reviewed it is clear that levels of attack high enough to cause significant loss in yield of marketable okra pods can occur.

Table 3.3: Marketable yield (Fresh wts.) of okra in Tonnes/ha.

VARIETY		Wt. (Tonnes) of Fresh Pods/ha.			VARIETY	
		S_0	S_1	S_3	Mean	S.E.
V_1		8.5	6.9	10.9	8.8	0.4
V_2		6.3	5.6	8.2	6.7	
V_3		6.6	8.0	6.1	6.9	
SPRA-	Mean	7.1	6.8	8.4		
XING	S.E.	0.4				

Table 3.4: Analysis of variance for yield of marketable okra pods (Fresh wts. in kg).

Source of variation	DF	SS	MS	F
Replications	2	6.4	3.2	1.4
Spraying levels	2	1.9	0.9	0.4 NS
Varieties	2	3.1	1.5	0.7 NS
Interaction	4	4.1	1.0	0.4
Error	16	36.7	2.2	
Total	26	52.3		

NS = Not significant.

D. Effect of spraying on pod quality

From the little available work done on the insecticidal pest control on okra for fruit production, Srinivasan and Powder (1957); Srinivasan and Narayanaswamy (1960) reported that Endrin (0.02%) effectively reduced the shoot and fruit borers, Earias fabia Stoll. (Lepidoptera:Gelechiidae) and E. insulana attacking okra. Bindra and Goyal (1966) indicated that Malathion(0.05%) and Dicofol (0.025%) controlled the vegetable mite Tetranychus telarius L.(Acarina: Tetranychidae) on okra but had no effect on its predator beetle Saymnus gracilis. Adenuga(1971), Ewete(1974) confirmed that the only study on okra pest control had been the production of the tender young fruits but not on fruit quality. Perumal et al.(1975), in India have however reported that spraying of okra plants with insecticides improved the quality of the okra pods. The larvae of H. armigera is known to damage okra pods. Raheja(1976), has observed that H. armigera could be a future pest of cowpea in northern Nigeria.

In this experiment, spraying of okra plants with carbaryl was conducted to evaluate its effect on the quality of the okra pods produced.

Materials and Methods

The harvested okra pods were individually examined for insect damage. Two types of damage were recognised. These were :

1. Damage to pods by the larvae of H. armigera recognised by a characteristic round hole on the pod. An example of such pods is shown in Plate 4.1
2. Abnormal curling of pods caused mainly by sucking insects. An example of such abnormally shaped pods is shown in Plate 4.2.

On these basis the harvested pods were graded into four categories as follows:

Pod grades	Degrees of damage to the pods
A	Pods showing no damage.
B	Uncurled pods having only superficial damage but with no holes.
C	Pods with superficial holes, curled but marketable.
D	Curled pods with large holes, scarcely marketable.

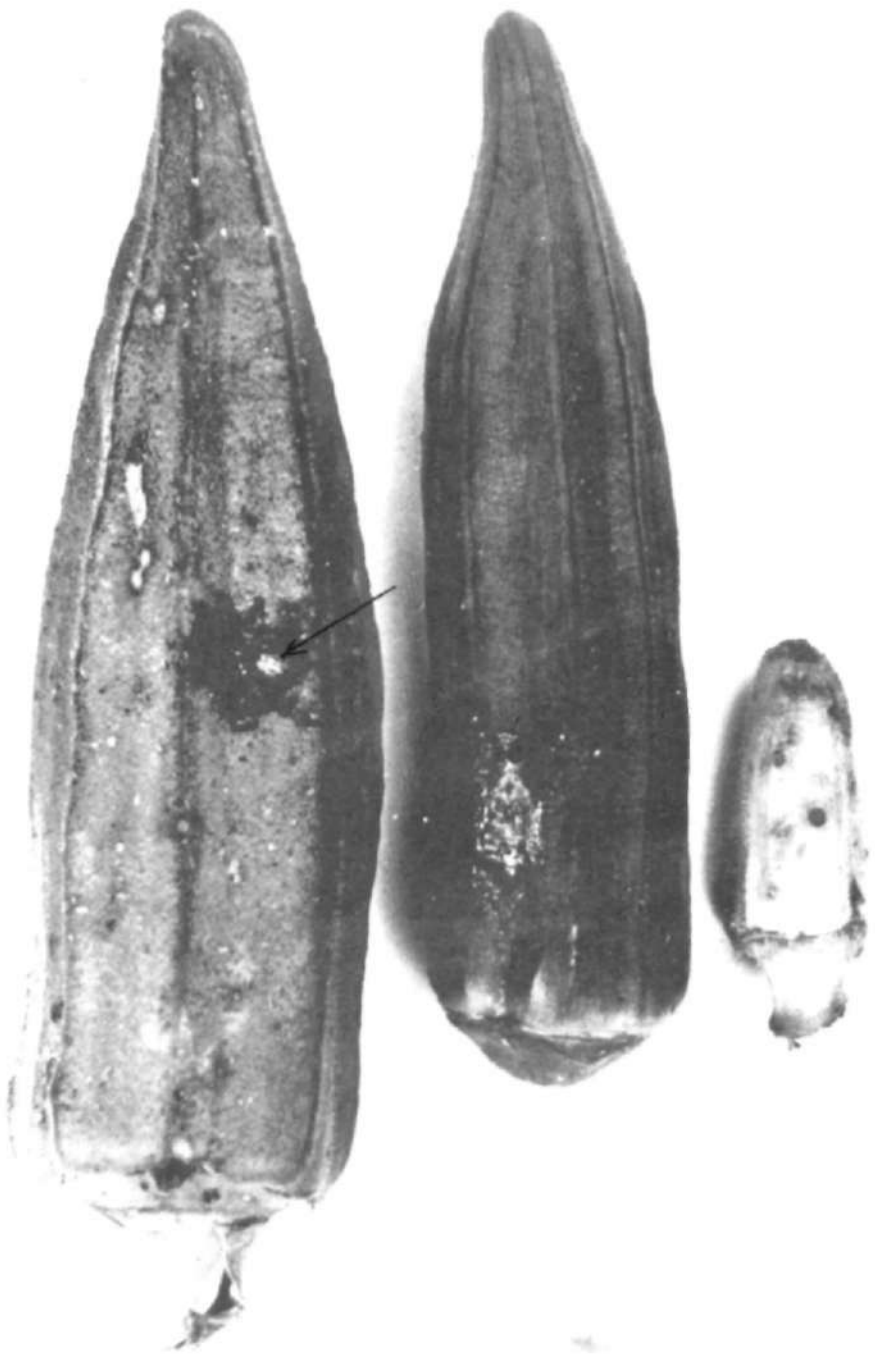


Plate 4.1: Heliothis armigera larvae (arrow) damage to pods



Plate 4.2: Pod shapes
Left - Normal pods
Right - Abnormal pods

Results and Discussion

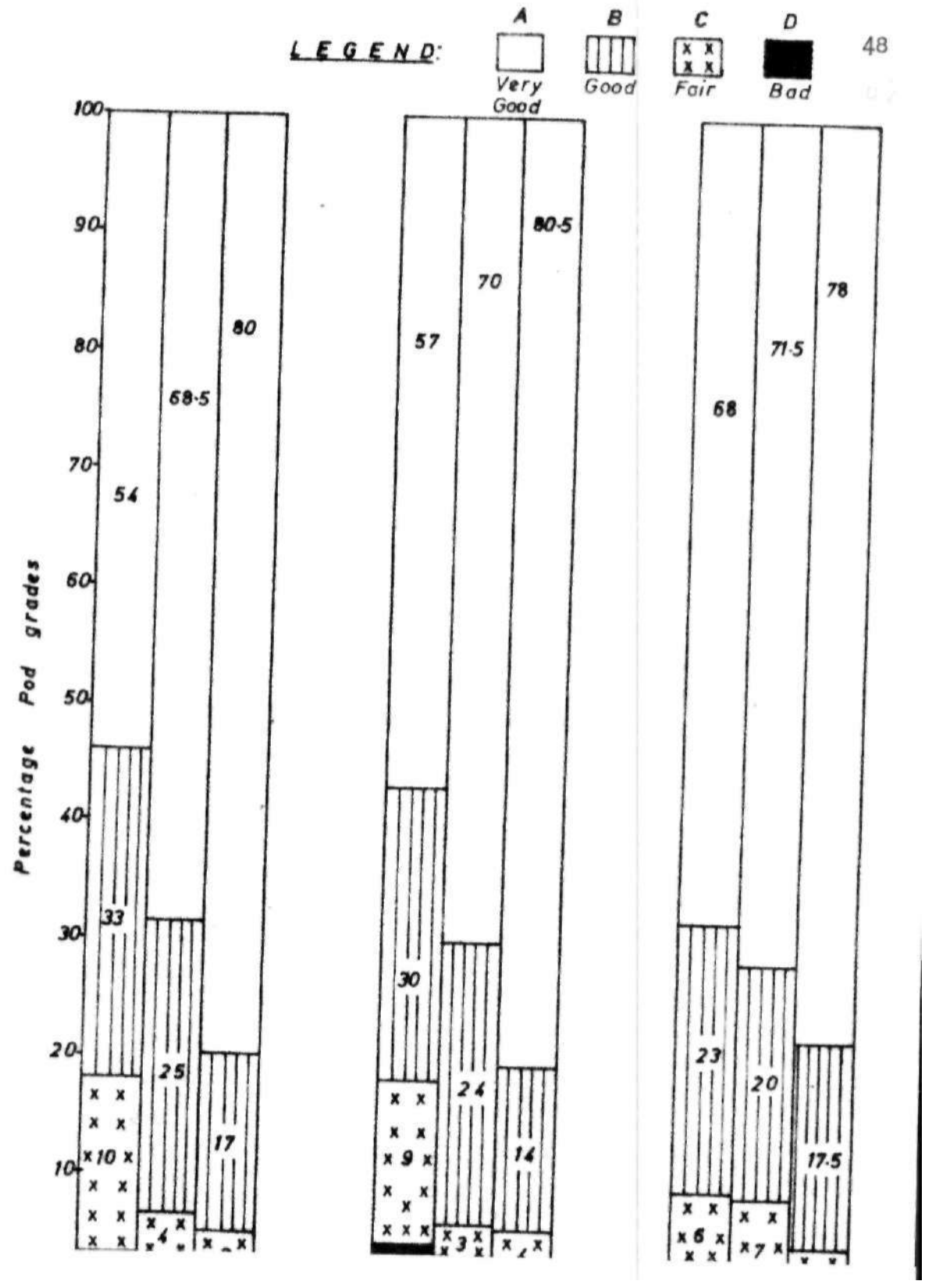
The percentage distribution of pods into quality grades is shown in Table 3.5 and Fig. 4.2. The result of this experiment shows that insecticidal application of carbaryl on okra improved the quality of okra pods. This was achieved by the reduction in the population of the fruit attacking pests principally Heliothis spp. and Podagrica spp. In all the varieties spraying with carbaryl resulted in the production of greater number of superior quality pods. It has been shown in Section IV that spraying with carbaryl significantly reduced the population of Podagrica beetles found on the plants. Since these beetles and some other fruit attacking pests were controlled it is reasonable to expect that the quality of the pods would also improve.

Conclusion

Although this result was not subjected to statistical analysis it can be seen from Table 3.5 and Fig. 4.2 that spraying did improve the quality of marketable okra pods produced.

Table 3.5: Percentage grades for okra pods.

POD GRADES	V_1			V_2			V_3		
	S_o	S_1	S_3	S_o	S_1	S_3	S_o	S_1	S_3
A	54	68.5	80	57	70	80.5	68	71.5	78
B	33	25	17	30	24	14	23	20	17.5
C	10	4	2	9	3	4	6	7	4
D	3	2.5	1	4	3	1.5	3	1.5	0.5


LEGEND:
A
Very Good
B
Good
C
Fair
D
Bad
Percentage Pod grades
100
90
80
70
60
50
40
30
20
10
54
68·5
80
57
70
80·5
68
71·5
78
33
25
17
10
4
30
24
14
9
3
23
20
17·5
6
7

SECTION VI

GENERAL DISCUSSION

GENERAL DISCUSSION

Podagrica population

The results obtained in this investigation are similar to other studies on Podagrica control with insecticides. This investigation has shown that even though spraying with the insecticide carbaryl reduced the population of Podagrica beetles significantly there was no corresponding increase in the yield of marketable okra pods.

As a general rule the foliage damage to plants rarely results in serious loss of yield. According to Southwood and Norton (1973), pest density threshold for severe loss in yields tends to be high for foliage and root attacking pests and low for product attacking pests. This is due to the ability of many crops to maintain the area of crop's photosynthetic tissues throughout the season and so maintain yield despite injury. Such compensation may be the result of the growth of new leaves on injured plant or greater number of leaves and shoots from adjacent plants, or by extension of the growing photosynthetic life of existing leaves.

Okra leaves

The result of this study shows that spraying with carbaryl did not significantly increase the number of okra leaves. This is in contrast to some earlier reports (Thirmala et al., 1954).

SECTION VII

APPENDICES

SECTION VII : APPENDIX I

List of insects found in association with okra in the field during the course of this experiment

Name of Insect	Order and Family	Stage	Plant part attacked
Anoplocnemis curvipes, F.	Hemiptera:Coreidae	Adult	Stems & Leaves
Alcidodes leucogrammus, Brichs.	Coleoptera:Buprestidae	Adult	Stems
Aspavia armigera, F.	Hemiptera:Pentatomidae	Adult	Leaves
Barombia humeralis, Lab.	Coleoptera:Chrysomelidae	Adult	Leaves
Catantops spissus spissus, Wlk.	Orthoptera:Acrididae	Adult	Leaves
Chloridea armigera Rubn	Lepidoptera: Noctuidae	Larvae	Fruit, terminal shoots.
Cosmophila erosa, (Hb.)	" "	"	Leaves
Dysdercus superstitiosus, (F)	Hemiptera:Pyrrhocoridae	Adult	Fruit & flowers
Earias biplana, Walk	Lepidoptera:Noctuidae	Larvae	Fruit, terminal shoots.
Earias insulana, Boisd.	" "	"	"
Empoasca fascialis, (Jacobi)	Hemiptera:Jassidae	Nymph & Adult	Leaves
Epilachna similis (Thunb)	Coleoptera:Coccinellidae	Adult & Larvae	Leaves & fruits
E. hirta, (Thunb.)	" "	"	" "

Appendix I (Contd.)

Name of Insect	Order and Family	Stage	Plant part attacked
Heliothis armigera(Hb.)	Lepidoptera:Noctuidae	Larvae	Fruits
Mirperus jaculus,Thunb.	Hemiptera:Coreidae	Adult	Stems&leaves
Mylabris farguharsone, Bla.	Coleoptera:Meloidae	Adult	Flowers
Myzus persicae(Sulz.)	Hemiptera:Aphididae	Adult	Fruits&Flowers
Oxycarenus dudgeoni, Dist.	Hemiptera:Lygaedae	Adult	Fruits
O. gossypinus, Dist.	" "	"	"
O. melanoderes Kars	" :Pyrrhocoridae	Adult	Fruits&flowers
Platyedra gossypiella, Saund.	Lepidoptera:Gelechiidae	Larvae	Flower buds
Pachnoda cordata,Dry	Coleoptera:Scarabaeidae	Adult	Flowers
Podagrica sjostedti,Jac	" :Chrysomelidae	Adult	Leaves&roots
P. uniforma, Jac	" "	"	Flowers&stems "
Pseudogrilus sophorae L.	" :Buprestidae	Adult	Stems
Syagrus calcaratus, F.	" :Chrysomelidae	Adult	Leaves
Sylepta derogata, F.	Lepidoptera:Pyralidae	Larvae	Leaves
Zonocerus variagatus,L.	Orthoptera:Acrididae	Nymph and adult	Leaves&Flowers

SECTION VIII

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LITERATURE CITED

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