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**Intercropping of Okra (*Abelmoschus esculentus* (L.) Moench) with
some Selected Crops for the Control of *Podagrica* spp.
(Coleoptera: Chrysomelidae) in Bauchi, Nigeria.**

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ABSTRACT

Field experiments were conducted at the Teaching and Research Farm of Abubakar Tafawa Balewa University, Bauchi during the farming seasons of 1997-1999 (June-September) to investigate the effects of intercropping two varieties of okra (Indian long white variety and Kwando short local variety) with cotton, cowpea and groundnut in reducing the population of *Podagrica* spp. The experiments consisted of eight treatments arranged in a randomized complete block design and replicated three times. Results of the experiment indicated that intercropping Indian long white variety or Kwando short local variety of okra with cotton, cowpea or groundnut significantly reduced the population of *Podagrica* spp. on okra and at the same time increased the yield of okra. The intercropping of okra with cotton, cowpea or groundnut for protection of okra against *Podagrica* spp. is therefore recommended.

INTRODUCTION

Attempts by the previous and present administrations of Nigeria at realizing the goals of increasing agricultural production for enhanced self-sufficiency in food have always been hindered by the activities of insect pests and diseases, lack of adequate rainfall, fertilizer and proper farm sanitation.

B.I., AHMED, I. ONU, B.M. HAMIDU, and J.A. OGIDI

Insect pests play a vital role in limiting crop production especially in the tropics where man is always in competition with them for available natural resources. The Food and Agriculture Organization of United Nation (FAO, 1997) reported that the estimated annual losses due to insect pests alone stands at about 15-20% during production and 18-20% during storage. Such losses are even higher in developing countries. For example, the Federal Department of Agriculture in Nigeria estimated that about 60% of the total food and fibre currently being produced is lost to insect pests (Uvah, 1978). This figure clearly shows how insect pests are devastating crops both in the field and storage.

Okra, in particular, is attacked by a large number of insect pests in different parts of the world. According to Hills (1987) there are nine major and 30 minor insect pests attacking okra in different parts of Africa and *Podagrica* spp. on which the present investigation is centered have been reported to be the most serious insect pest causing damage to okra (Egwuatu, 1982). The pest is known to cause damage to okra plant by eating the leaves and thereby making numerous holes, which results in yellowing, drying and abscission of the leaves. This reduces the photosynthetic activity of the leaves as well as plant growth and pod yield especially when the terminal shoots are destroyed. Some of the early attacked plants stop growing and do not bear fruits. The adult beetle also feed on mature fruits, thereby making numerous scarifications and reducing the fruit quality. Under heavy infestation, the whole plant may be withered (Iremiren, 1988).

Although infestation could be controlled through the use of agrochemicals, an important observation is that the uncontrolled use of agrochemicals has led to the prevalence of adulterated and expired products in the market.

The result is heavy reduction in quality and quantity of both the crops and animal products, increased pollution of water, destruction and killing of soil microorganisms as well as bees and butterflies which are important for the pollination of flowers and the final consequences is the reduction of important wildlife population. Okra is consumed as green pods, and most of the insecticides have residues of high persistence. The socio-economic implications of such phenomenon are food poisoning leading to health problem of people, food storage that could increase crime rate, reduced raw materials for agro-allied industries and the general decline in productivity. These could lead to poor economic development arising from low foreign exchange earnings. It is because of the afore-mentioned facts that it was considered unwise and unhealthy to always depend on agrochemicals as means of controlling the insect pests in the fields. From the afore-mentioned consequences of agrochemicals used in the

B.I., AHMED, I. ONU, B.M. HAMIDU, and J.A. OGIDI

Assessment of *Podagrica* spp. on okra plant was made on five plants randomly sampled from each of the 24 plots. Number of *Podagrica* spp. on both the upper and lower surfaces of the leaves of the sampled plants were counted at 20, 30, 40, 50, 60, 70, and 80, DAP as recommended by Rao and Willey (1989).

Similarly, numbers of leaves per plant were recorded on the same plant at the same interval.

Harvesting of fresh fruits started when they were due and continued until when the crops started drying and no more fruits were produced.

Fresh fruits from five randomly selected plants in each plot were picked once a week and summed up at the end of the crop's life. Also, number of fruits per plant was also recorded. Data obtained were subjected to analysis of variance. Least significant difference (LSD) was used to differentiate between and among the treatment means (Steel and Torie, 1981).

RESULTS AND DISCUSSION

Population of *Podagrica* spp. on okra plants obtained during the rainy seasons of 1997, 1998 and 1999 are presented in Tables 1, 2 and 3 respectively. Statistical analysis of the results show that the population of *Podagrica* spp. in some treatments was significantly reduced as a result of intercropping. All the okra intercropped plots of 1997-1999 experiments had lower population of *Podagrica* when compared with sole okra. This clearly shows that intercropping okra with cotton, cowpea or groundnut markedly reduces *Podagrica* population on okra. The reduction of *Podagrica* spp. in the okra-intercropped plots could be expected because there was no freedom of movement of *Podagrica* spp. in okra intercropped plots as in okra sole crop treatments. The lack of freedom of movement of *Podagrica* spp. under intercropping condition is known to create a very unfavourable condition for *Podagrica* spp. This is because the continuous feeding attitude of *Podagrica* beetles in sole cropping is disrupted in intercropping plots as the insects have to fly or crawl a longer distance over the intercropped plants. Rao and Willey (1989) had earlier reported that such arrangements have been observed to significantly influence the population of the insect in the sense that it makes it very difficult to multiply rapidly under such conditions. Absence of alternate host plant in okra sole crop treatments could be another reason for the high population of *Podagrica* spp. among the years. This was because population of the pest in 1997 was lower than that of 1998 while that of 1998 also was lower than the population of 1999. The possible explanation for this kind of variation in population trend could be attributed to the fact that 1997 was the first year when okra and other

Intercropping Okra for the control of *Podagrica*

control of insect pests, the use of cultural practices has been considered as one of the options for the reduction of insect pests' infestation. Multiple cropping is reported to have numerous advantages, one of which is regulation of insect pest population (Umaru *et al.*, 1998). Factors such as increased parasitoid, predator population, availability of alternate prey, decreased colonization and reproduction in pests, chemical repellency, masking, feeding inhibition by odour from non-host plants, prevention of immigration and optimum synchrony between pests and their natural enemies are likely to be involved in pest regulation during intercropping (Bhatnagar and Davies, 1981). Similarly, Van Emden and Williams (1974) reported that cowpea damage by insect pests is always observed to be low when intercropped with sorghum.

Although okra farmers have not adopted intercropping okra with other crops frequently as a control measure, attempt was made in this study to investigate the effects of intercropping okra with some selected crops (cotton, cowpea and groundnut) in reducing the population of *Podagrica* species in Bauchi.

MATERIALS AND METHODS

Field experiments were conducted for three consecutive seasons (1997-1999) to establish the effects of intercropping okra with some selected crops in reducing the population of *Podagrica* species in Bauchi. Two varieties of okra namely Indian long white variety and kwando short local variety were intercropped with cotton, cowpea and groundnut. In addition, the two varieties were each planted sole on different plots as control. The plot size was 4.2 m x 3.6 m separated by a border of 1 m path and 2 m between each replication. There were eight treatments with each replicated three times. During each planting season, the land was cleared, ploughed and harrowed twice. Seeds of Indian long white variety and kwando short local variety were soaked in water for 24 hours before they were sown. This was done in order to promote germination (Tindail, 1986). Seeds were sown 30 cm within rows and 60 cm between rows. The two okra varieties were each planted sole in separate plots to serve as control while groundnut, cotton and cowpea were each intercropped with the two varieties of okra at a ratio of 1:1 per plot. At 15 days after germination, okra seedlings were thinned to one per stand and missing stands were replaced with seedlings sown on the same date so as to ensure uniform plant population in all the plots. At 20 and 60 days after planting (DAP), NPK and Urea fertilizers were applied respectively to okra plants each at the rate of 50 kg/ha as recommended by George (1985). Other agronomic practices such as weeding and proper management measures were observed.

Intercropping Okra for the control of *Podagrica*

Table 1: Population of *Podagrica* spp. on okra at different intervals as influenced by intercropping during the rainy season of 1997

Treatments	Population of <i>Podagrica</i> spp.						
	20DAP	30DA	40DAP	50DAP	60DAP	70DAP	80DAP
SLV	9.20	20.33	27.83	27.33	25.66	23.66	9.93
ILWV	18.80	22.33	29.10	29.56	23.03	24.43	10.10
SLV and Cotton	4.80	14.66	13.66	10.26	6.25	6.26	5.40
ILWV and G/nut	3.60	10.73	12.83	11.83	4.53	5.20	5.90
SLV and Cowpea	4.66	11.20	11.66	10.66	6.53	7.93	4.66
ILWV and Cotton	4.40	7.96	10.33	10.33	6.66	6.20	5.20
SLV and G/nut	4.20	5.16	11.50	1.50	7.33	7.20	5.40
ILWV and Cowpea	2.53	5.33	6.21	7.10	3.30	3.03	2.23
SE (p=0.05)	0.22	4.06	0.72	0.80	0.64	0.64	1.11
ILWV =	Indian long white variety						
SLV =	Short local variety						
DAP =	Days after planting						

Table 2: Population of *Podagrica* spp. on okra at different intervals as influenced by intercropping during the rainy season of 1998

Treatments	Population of <i>Podagrica</i> spp.						
	20DAP	30DAP	40DAP	50DAP	60DAP	70DAP	80DAP
SLV	9.90	21.10	26.30	30.33	30.33	30.60	31.16
ILWV	14.06	27.53	28.80	37.06	39.26	38.53	38.16
SLV and Cotton	5.83	14.56	12.40	11.66	14.16	15.26	14.66
ILWV and G/nut	5.69	13.30	12.23	11.50	14.26	15.26	15.06
SLV and Cowpea	4.76	9.63	10.13	10.03	9.63	11.00	11.50
ILWV and Cotton	5.73	8.86	11.76	11.53	14.66	15.56	15.83
SLV and G/nut	4.46	12.13	12.50	12.33	14.46	15.13	16.00
ILWV and Cowpea	2.60	9.70	8.80	9.06	9.90	9.56	10.20
SE (p=0.05)	0.71	1.17	0.34	0.63	0.87	1.34	1.35
ILWV =	Indian long white variety						
SLV =	Short local variety						
DAP =	Days after planting						

Table 3: Population of *Podagrica* spp. on okra at different intervals as influenced by intercropping during the rainy season of 1999

Treatments	Population of <i>Podagrica</i> spp.						
	20DAP	30DAP	40DAP	50DAP	60DAP	70DAP	80DAP
SLV	8.36	19.93	24.46	30.98	31.50	31.33	12.53
ILWV	16.86	26.80	29.86	36.33	40.00	37.56	17.23
SLV ad Cotton	4.33	13.96	11.93	10.33	14.33	14.76	7.30
ILWV and G/nut	5.16	11.90	10.86	10.43	14.33	15.23	7.06
SLV and Cowpea	5.10	8.66	10.23	9.56	10.23	9.76	5.16
ILWV and Cotton	4.86	10.73	12.13	12.83	14.80	14.93	7.80
SLV and G/nut	3.10	10.70	10.83	13.30	14.26	14.20	7.86
ILWV and Cowpea	1.33	8.46	8.40	9.06	9.80	9.70	3.40
SE (p=0.05)	0.83	1.05	0.84	0.59	0.77	1.63	1.13

ILWV = Indian long white variety
 SLV = Short local variety
 DAP = Days after planting

crops were introduced into the experimental plots as such the population was lower, but by 1998 the eggs and adults of *Podagrica* spp. which hibernated either in the soil or crop residue had increased. This made it possible for the 1998 to be higher than that of 1997 and 1999 to be higher than all of them. Variation in rainfall within the three years of experiments could be another factor. This is because high intensity of rainfall is known to significantly reduce the population of insects. (Hills, 1987 and Tindall, 1986).

Although the population of the pest was lower in okra intercrop plots when compared with the sole crop plots, it is however, important to note that even within the okra intercrop plots, population of the pest was lower in plots where okra was intercropped with cowpea. This clearly indicates that *Podagrica* spp. show more preference to cowpea, probably due to greater oviposition site and or presence of succulent plant tissues on cowpea plant. The low population of *Podagrica* spp. in okra/cowpea mixture could also be attributed to the possibility of existence of natural enemies of *Podagrica* spp. among the pest spectrum of cowpea as many other insect pests of cowpea were observed in the okra/cowpea mixture.

Intercropping Okra for the control of *Podagrica*

Similarly, effects of intercropping on okra leaves during the cropping seasons of 1997 to 1999 are presented in Tables 4, 5 and 6 respectively. Number of leaves per plant in okra-intercropped plots was observed to be consistently higher than the sole crop plots throughout the three years of experiment. There were no significant differences between the sole crop plots throughout the periods of the experiment. The high number of okra leaves observed in the intercrop maybe attributed to the fact that the leaves and stems of the minor crops (cotton, cowpea and groundnut) served as protection or breaks against the effect of wind on the leaves of the main crop (okra) which could have resulted in serious defoliation. Iremiren (1988) had earlier reported that leaves being the site of photosynthesis contribute immensely to the performance of plants. The good performance of okra plant in terms of leaves production under intercropping could also be attributed to the nitrogen fixation property of groundnut and cowpea, even though nitrogen fixation of these two crops was not assessed during the experiment.

Table 4: Population of leaves per okra plant at different intervals as influenced by intercropping during the rainy season of 1997

Treatments	Number of leaves per plant						
	20DAP	30DAP	40DAP	50DAP	60DAP	70DAP	80DAP
SLV	4.79	6.77	9.72	13.27	15.31	16.05	16.92
ILWV	3.31	7.21	10.41	12.60	12.97	19.35	17.58
SLV and Cotton	3.20	4.86	5.33	8.06	9.0	9.26	9.40
ILWV and G/nut	4.33	7.73	11.06	13.66	12.86	15.80	17.66
SLV and Cowpea	4.00	9.13	10.33	12.20	13.53	13.72	14.60
ILWV and Cotton	3.64	7.20	12.06	14.80	12.60	26.86	20.80
SLV and G/nut	3.60	5.06	7.06	10.26	11.93	10.93	10.93
ILWV and Cowpea	6.16	12.26	18.10	25.26	30.66	36.23	38.83
SE (p=0.05)	0.39	0.39	0.65	0.83	0.36	3.60	2.17
ILWV =	Indian long white variety						
SLV =	Short local variety						
DAP =	Days after planting						

B.I., AHMED, I. ONU, B.M. HAMIDU, and J.A. OGIDI**Table 5: Population of leaves per okra plant at different intervals as influenced by intercropping during the rainy season of 1998**

Treatments	Number of leaves per plant						
	20DAP	30DAP	40DAP	50DAP	60DAP	70DAP	80DAP
SLV	4.73	5.76	7.70	12.06	14.56	11.00	15.50
ILWV	5.30	7.56	10.06	14.36	21.33	13.26	22.16
SLV and Cotton	5.20	7.46	11.66	16.60	25.06	22.63	30.83
ILWV and G/nut	6.23	9.70	13.33	22.16	34.70	29.16	33.22
SLV and Cowpea	5.60	7.53	11.83	16.06	24.93	24.36	31.80
ILWV and Cotton	6.26	10.33	15.50	19.40	35.16	32.50	36.13
SLV and G/nut	5.33	7.40	11.33	18.96	23.46	27.43	30.56
ILWV and Cowpea	7.16	13.46	19.43	26.26	36.93	35.46	38.20
SE (p=0.05)	0.23	0.83	0.49	0.81	1.56	2.85	1.49

ILWV = Indian long white variety
 SLV = Short local variety
 DAP = Days after planting

Table 6: Population of leaves per okra plant at different intervals as influenced by intercropping during the rainy season of 1999

Treatments	Number of leaves per plant						
	20DAP	30DAP	40DAP	50DAP	60DAP	70DAP	80DAP
SLV	3.93	6.20	7.50	13.23	19.26	15.23	15.66
ILWV	4.80	8.00	9.90	15.20	21.86	19.60	21.16
SLV and Cotton	5.06	8.66	11.26	19.26	28.76	24.46	27.10
ILWV and G/nut	5.20	8.86	12.80	18.86	27.86	29.93	33.43
SLV and Cowpea	5.86	8.26	11.20	18.06	31.26	33.36	30.80
ILWV and Cotton	5.33	8.26	15.40	16.73	27.10	30.30	35.66
SLV and G/nut	6.00	9.30	11.00	17.23	33.06	28.33	28.13
ILWV and Cowpea	6.13	10.0	19.06	19.70	33.26	33.60	40.76
SE (p=0.05)	0.53	1.23	0.72	1.84	4.30	4.99	2.19

ILWV = Indian long white variety
 SLV = Short local variety
 DAP = Days after planting

Intercropping Okra for the control of *Podagrica*

by Yields obtained during the cropping seasons of 1997 to 1999 are presented in Table 7. The result shows that the yield obtained during the farming seasons of 1997, 1998 and 1999 corresponded with the performance of the plants during the years of 1997, 1998 and 1999, respectively. In other words, yields obtained in okra intercrop plots were significantly higher than the corresponding sole crop plots in all the years. The low incidence of *Podagrica* infestation and high number of leaves recorded in the okra intercrop plots are the major reasons for the high yield of the okra intercrop plots while low yield obtained in okra sole crop plots was as a result of increased number of *Podagrica* spp. in the sole crop plots.

Table 7: Effects of crop mixture on number of fruits per okra plant during the rainy seasons of 1997, 1998 and 1999

Treatments	Number of fruits per plant			
	1997	1998	1999	Mean
SLV	8.29	9.90	10.33	9.50
ILWV	10.73	12.66	14.73	12.70
SLV and Cotton	22.55	9.50	4.40	28.81
ILWV and G/nut	40.56	43.40	48.20	44.05
SLV and Cowpea	32.23	33.00	38.53	34.58
y ILWV and Cotton	39.01	41.10	45.86	41.99
SLV and G/nut	30.33	33.06	38.23	33.87
ILWV and Cowpea	45.13	46.86	52.00	47.99
SE (p=0.05)	0.73	0.91	0.88	0.84

ILWV = Indian long white variety
SLV = Short local variety

In conclusion, farmers stand a better chance of increasing okra production by intercropping it with cotton, cowpea or groundnut. This is because results of the present investigation show the importance of intercropping okra with cotton, cowpea and groundnut. The method is compatible with farmer's production and less complex because it does not involve the use of sophisticated equipment. However, much remains to be learnt about the range of interaction between pests and crop as well as the mechanism operating in mixed cropping. Extensive studies on the farmers' fields are therefore required.

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