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Artificial defoliation of cowpea [*Vigna unguiculata* [L.] Walp.] cv. Ife Brown to simulate insect damage: effects on crop performance

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Abstract

The effects of defoliation on cowpea, *Vigna unguiculata* (L.) Walp cv. Ife Brown, were studied in the screenhouse by removing varying proprotions of the laminae of leaflets along the transverse plane, to give varying nominal levels of defoliation.

Plants subjected once to 25%, 50%, 75% and 100% defoliation at either the primary leaf stage, the first trifoliate leaf stage or the second trifoliate leaf stage, were not adversely affected with respect to days to peak flowering, number of flowers per plant, number of pods per plant as well as number and weight of seeds per plant. However, 100% defoliation significantly delayed the days to first flower production.

When plants were subjected to 25%, 50% and 75% nominal defoliation once a week for a period of three weeks, commencing at the first trifoliate leaf stage, significant treatment effects were observed with the 75% defoliation adversely affecting the number of pods per plant, number and weight of seeds per plant. It was also observed that defoliated leaflets tended to compensate by increasing their widths.

The importance of the results are discussed in relation to the impact of defoliators and recommendations for their control in cowpea production.

Introduction

Cowpea, *Vigna unguiculata* (L.) Walp. is an important grain legume crop in Tropical Africa where it serves as a major source of dietary protein. One very important limiting factor for its production in Nigeria, is its insect pest complex and numerous studies have showed that the usually low seed yield associated with the crop, could be increased several-fold when insect pests are controlled (e.g. Booker, 1965 Dina, 1977 and Taylor, 1964 and 1968).

Conventionally, the insect pests of cowpea in Nigeria have been grouped into three main categories based on the sequence of their

incidence in relation to the crop's phenology. Thus, there are: (a) Pre-flowering pests which are mostly defoliators (b) Flowering pests and (c) Post-flowering pests. One major pre-flowering pest is the flea beetle, *Ootheca mutabilis* (Sahlberg) which usually causes severe defoliation on cowpea within the first three weeks after planting in the field. Others include the flies, *Ophiomyia* spp. which cause numerous shot holes through their oviposition punctures. on the leaves of cowpeas during the dry season.

Apart from visual assessment, cowpea defoliation by the pre-flowering pests has hardly ever been subjected to quantitative analysis even though this is a primary requirement of a sound pest management programme. Hence, even though it has regularly been showed that insecticidal control of the pre-flowering pests does not result in significant yield increase, farmers in southern Nigeria are still advised to apply one insecticidal spray to control *O. mutabilis* (Anon., 1979). In an earlier study on the quantitative effects of damage by *O. mutabilis* on Ife Brown cowpea (Akingbohungbe, 1978), it was noted that a beetle infestation level resulting in up to 30% defoliation, was tolerated without adverse effects on flowering and podding. It was also observed that plants subjected to lower infestations resulting in less than 20% defoliation, tended to flower earlier.

Manipulative leaf removals have been carried out on cowpea by various workers, essentially to explain source-sink relationships in the plant (Mehta, 1971. Ezedinma, 1973; Enyi, 1975; Huxley and Summerfield, 1976 and Stewart *et. al.*, 1978). These studies revealed that there is an optimum leaf area for best performance in terms of seed yield and that the plant tended to develop leaf area in excess of the optimum value. Most of these studies were, however, confined to the late vegetative and reproductive phases of crop growth when defoliators exert far less influence on the crop.

The present study was carried out to assess the effects of defoliation during the first three weeks of growth, on subsequent performance of Ife Brown cowpea. This period coincides with the peak period of damage by defoliators on the crop in southern Nigeria.

Materials and Methods

The studies were conducted in a screenhouse to ensure that the cowpea plants did not suffer from any other type of damage except the defoliation treatments applied.

Two main defoliation treatments were applied viz:- (a) single defoliation (SD) and (b) Continuous defoliation (CD). The SD treatments involved the removal of a proportionate part of each leaflet along the transverse plane of the lamina to give any of the following nominal defoliation levels:- 0% (control), 35%, 50%, 75% and 100%. This was done for three different stages of growth – the primary leaf stage (ca. 9 days after planting), the first trifoliate leaf stage (ca. 17 days after planting) and the second trifoliate leaf stage (ca. 24 days after planting). The CD treatment also involved the removal of a proportionate part of each leaflet to give 0%, 25%, 50% and 75% nominal defoliation levels but it was commenced at the first trifoliate leaf stage and repeated once weekly on all subsequently formed leaflets for three weeks (cf. the SD treatments in which after the first defoliation, the plants were left to grow on to maturity without any further defoliation). All defoliations were carried out with a pair of scissors.

The experimental design involved randomised blocks arranged to minimise the effects of any temparature gradients and shading along the screenhouse. Each treatment had three replicates of 20 plants each, sown in 0.79 litre plastic cups filled with sterilised soil to about 75% capacity. To obtain six replicates per treatment, each trial had to be repeated because of inadequate screenhouse space. Details of dates of planting of each trial are as in Table 1. No fertiliser was applied and watering was done as necessary. The plants were also routinely sprayed with Lindane (25ml/4.51 of water) and Maneb (4.5g/4.51 of water) to protect them against thrips injury and fungal attack respectively. All plants were staked by the end of the fourth week after planting while the number of flowers and pods produced per plant was recorded every other day, starting from the day the first flower production was observed. From the latter, the following were estimated:

(a) Days to first flowering
(b) Days to peak flowering
(c) Number of flowers produced per plant
(d) Number of pods set per plant.

At maturity, seed yield (g) per replicate was also taken.

During the trials, it was observed that the defoliated leaflets tended to compensate for their loss. Therefore, in the second trials of the CD treatments, the length and width of each leaflet on all plants were measured, for the purpose of comparison, two weeks after the last defoliation treatments were carried out.

TABLE 1: DATES OF PLANTING OF THE DIFFERENT DEFOLIATION EXPERIMENTS

Date of Planting	Stages of growth *	Type of defoliation treatment
24/8/76	1st trifoliate leaf	SD
7/12/76	Primary leaf	SD
25/3/77	2nd trifoliate leaf	SD
25/3/77	1st trifoliate leaf	CD
8/9/77	2nd trifoliate leaf	SD
26/10/77	1st trifoliate leaf	SD
21/7/78	Primary leaf	SD
14/8/78	1st trifoliate leaf	CD

* Refers to stage of growth at which defoliation was commenced.

TABLE 2: POOLED MEANS OF VARIOUS PARAMETERS IN IFE BROWN COWPEA SUBJECTED TO VARIOUS LEVELS OF SINGLE DEFOLIATIONS (SD) AT DIFFERENT STAGES OF GROWTH

Treatment %SD	Days to 1st flower	Days to peak flowering	No. flowers per plant	No. Pods per plant	No. seeds per plant	Yield*
25	43.22	51.56	5.05	3.84	11.51	32.17
50	43.33	51.28	4.46	3.53	10.87	29.37
75	43.72	50.67	4.72	3.73	10.78	29.05
100	45.56	52.22	4.64	3.72	10.57	29.43
Control 0%	42.56	50.56	4.88	3.82	11.53	33.06
L.S.D. 0.01	2.86	N.S.	N.S.	N.S.	N.S.	N.S.

*gms. per replicate

TABLE 3: MEANS OF VARIOUS PARAMETERS IN IFE BROWN COWPEA SUBJECTED TO VARIOUS LEVELS OF CONTINUOUS DEFOLIATION (CD) THRICE STARTING FROM THE 1ST TRIFOLIATE LEAF STAGE

Treatment %CD	Days to 1st flower	Days to peak flowering	No. flowers per plant	No. Pods per plant	No. seeds per plant	Yield
25	45.67	53.17	3.78	3.69	13.60	32.38
50	43.67	51.00	3.64	3.28	11.59	34.50
75	43.50	51.00	3.35	2.94	10.04	28.99
Control (0%)	45.00	51.50	3.73	3.57	12.62	39.47
L.S.D.	N.S.	N.S.	N.S.	0.46*	2.24**	6.26*

* At 5% level of significance

** At 1% level of significance

TABLE 4: MEAN LENGTHS AND WIDTHS OF THE LEAFLETS OF IFE BROWN COWPEA SUBJECTED TO 50% AND 75% CONTINUOUS DEFOLIATION (CD) STARTING AT THE 1ST TRIFOLIATE LEAF STAGE, EXPRESSED AS PERCENT OF CORRESPONDING LEAFLETS ON THE UNDEFOLIATED PLANTS.

Treament	Lengths %					Widths %				
	Primary Leaf	1st T	2nd T	3rd T	4th T	Primary Leaf	1st T T	2nd T T	3rd T T	4th T T
50% CD	42.86	42.12	43.01	42.90	82.46	108.44	106.68	110.18	99.38	109.81
75% CD	26.72	24.84	25.69	26.45	48.29	104.50	101.48	107.74	99.26	112.30

T = trifoliate

Results

The results are presented in Tables 2 to 4. For the SD treatments, analysis of variance test did not show any significant interactions for all the parameters, between the stage at which plants were defoliated and the different levels of defoliation applied. Also, there was no significant season x treatment interactions. Therefore, only the pooled treatment means for all stages of development are shown in Table 2. The table shows that 100% defoliation delayed the onset of flowering significantly with the undefoliated plants starting to flower about 3 days earlier (3.33 days earlier than plants defoliated at the primary leaf stage, 2.17 days earlier than plants defoliated at the first trifoliate leaf stage and 3.50 days earlier than plants defoliated at the second trifoliate leaf stage.

Table 3 shows the results obtained for the CD trials. There were significant treatment effects on the number of pods per plant, the number of seeds per plant and the seed yield. Generally, the 75% CD treatment adversely affected these parameters while the 25% CD and 50% CD treatments did not, except in case of seed yield where the 25% CD gave a significant yield decrease compared with the control.

Table 4 shows the mean lengths and widths of each leaflet on the defoliated plants (50% CD and 75% CD) expressed as a percentage of same parameters on the corresponding leaflets of the undefoliated plants. The results show that compensatory growth occurs along the width of the defoliated leaflets; with greater than 100% width of the corresponding leaflets on undefoliated plants, generally being recorded.

Discussion

These results help to explain why chemical control of pre-flowering pests of cowpea in southern Nigeria, especially *O. mutabilis*, does not lead to a significant increase in seed yield. The plants were able to tolerate the various levels of defoliation from 25% to 100%, applied once at either the primary leaf stage, the first trifoliate leaf stage or the second trifoliate leaf stage without adversely affecting seed yield, days to peak flowering, number of flowers per plant, number of pods per plant and number of seeds per plant. However, the 100% defoliation delayed flowering by a few days. This is perhaps because, as suggested by Enyi (1975), assimilates produced by the leaves during early growth stages are used in the growth of stems and leaves while assimilates produced during the reproductive phase

are used mainly for the growth of pods. That the plants subjected to the 25%, 50% and 75% SD treatments did not show delayed flowering, is probably due to the ability of the partially defoliated leaflets to compensate for their loss by increasing in size (Table 4) or as reported by Treharne (1972), by increasing the rate of photosynthesis of the left-over parts.

Floral bud initiation usually commences in greenhouse-grown Ife Brown cowpea at about the third to fourth trifoliate leaf stage, and thus one would have expected that the 100% defoliation imposed on the plants at the second trifoliate leaf stage would adversely affect the yield components. The plants however readjusted rapidly and did not show any adverse treatment effects on flowering, podding and seed yield. This is probably because as observed by Huxley and Summerfield (1976) for the cowpea cultivar K2809, leaves which had completed expansion and which were only 2-3 weeks old, contributed little to the dry matter increment of the rest of the plant; and thus their removal hardly affected growth. At the time the plants were defoliated, five of the leaflets were already 2-3 weeks old and most likely fully expanded while the other three leaflets were about one week old. Since the plants were not topped, rapid development of the apical shoot and production of additional young leaves occurred and these presumably were adequate for the production of assimilates required for flowering, podding and seed production.

The experiment on continuous defoliation more closely approximates what is likely to happen in the field with varying proportions of the plant foliage being consumed by defoliators. In general, the treatment effects showed some agreement with the suggestion by Akingbohungbe (1978) that Ife Brown cowpea can tolerate beetle infestation level resulting in up to 30% defoliation without adversely affecting flowering and podding; as well as the earlier observation by Ezedinma (1973) on the cowpea cultivar Mezed, that no significant differences existed between plants subjected to 33% continuous defoliation prior to flowering and the control plants with respect to yield and yield components such as number of pods set. Indeed, in the present study, up to 50% defoliation was tolerated without any significant adverse effect on seed yield, number of flowers per plant and number of pods per plant. The results of the 25% CD also confirm the suggestion by Akingbohungbe (1978) that low levels of defoliation might stimulate the plant either to flower early or

produce more flowers. The plants subjected to 25% continuous defoliation flowered earlier than the control plants by one day and produced slightly more flowers; these were however not reflected in the seed yield.

In conclusion, the present results show that cowpea can still produce satisfactory yield with only about 50% to 75% of its potential leaf area present, during the first three weeks of growth. Therefore, defoliation by pests such as *O. mutabilis* should not normally call for serious concern except where leaf damage exceeds 50% or where there is destruction of the shoot apex. The beetle usually attacks seedlings in the first 2 - 3 weeks of life in the field and does not attain sufficiently high infestation level to cause over 50% defoliation on individual plants. Thus, there may be no justification for insecticide application to control the beetle unless in cases of iminent epiphytotic of Cowpea Yellow Mosaic Virus, for which it is a known vector (Whitney & Gilmer, 1974).

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