EVALUATION OF COWPEA GENOTYPES FOR RESISTANCE TO THE LEGUME POD BORER, *MARUCA VITRATA (FABRICIUS) (LEPIDOPTERA: PYRALIDAE)*

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ABSTRACT

16 cowpea varieties were screened for resistance to the legume pod borer, Maruca vitrata F. under natural infestation in the field. Plants were planted in a randomized complete block design in three replicates; each plot consisted of four rows, 3m long. Spacing was 1.5m between plots and 0.75m between rows. Intra- row spacing was 0.2m.Two weeks prior to planting experimental materials, a susceptible cultivar was planted perpendicular to every range of rows within a plot to serve as a reservoir of the test insect, M.vitrata. Plants were sprayed with Monocrotophos at 200g a.i /ha once at the vegetative stage and at the onset of flower bud initiation and later during podding to control other pests apart from Maruca. Larval density, flower damage, pod damage, seed damage, pod load (a measure of the degree of successful pod production) and Index of pod evaluation (Ipe), calculated as [PL X (9-PD)], (a measure of the varietal performance of the cowpea genotypes) were used to assess resistance in cowpea varieties. Significant variations were observed in the level of resistance among the cowpea genotypes in the field. The findings show that Tvu 4578 is resistant while Tvu 1544, IT97K-499-35, IT93K-452-1 and IT90K-76 show promising level of resistance. The probable factor contributing to resistance may be non- preference or host plant resistant factors.

***Keywords**: Cowpea (Vigna unguiculata), Screening, Maruca vitrata, index of pod evaluation (Ipe), Resistance*

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INTRODUCTION

Cowpea *(Vigna unguiculata)* is the most important food legume throughout the tropics and subtropics. Total worldwide annual production of cowpea is 6.5 million metric tons on 14.5 million ha (Boukar, O., Belko,N., Chamarthi, S., Togola, A., Batieno, J. Owusu, E. et al. (2018). Africa accounts for 84% of total world production, West Africa alone accounts for 86% of African production on 10.6 million ha (FAOSTAT, 2017). Bulk production of cowpea comes from Nigeria accounting for 61% of Africa's production and 58% worldwide (FAOSTAT, 2018). The traits that distinguish cowpea from many other crops are substantial adaptation to drought, high potential to biologically fix nitrogen in marginal soils, tolerance to high temperature during vegetative stage, tolerance to shade, rapid vegetative growth and tripurpose utilization, producing vegetable leaves, pods, dry grain and forage. Nutritionally, the mature grain of cowpea contains 22.9-32.5% protein (Nielsen *et al*. 1993), 50-67% starch, 5.0-6.9 crude fiber and 1.4-2.7 fat, B Vitamins such as folic acid which is important in preventing birth defects, essential micronutrients such as iron, calcium, and zinc.

Major constraints to cowpea production include abiotic constraints (drought, poor soil fertility), biotic constraints (arthropod pests, diseases, birds, rodents). Insect pest constitute the greatest constraint to cowpea production in Africa (Dugje *et al.,* 2009; N'Gbesso *et al*., 2013). The most damaging of all pests are those that occur during flowering and podding which include Flower thrips (*Megalurothrips sjostedti*), the legume pod borer (*Maruca vitrata*), a complex of bud suckers (*Clavigralla tomentosicollis*). *Maruca vitrata*, the legume pod borer has been identified as the most important Lepidoptera cowpea pests in tropical Africa (Anusha *et al*., 2016). Yield losses by this pest on cowpea has been estimated: 20-60% (Singh and Allen, 1980), , 80% (Afun et al., 1991), 25-40% (Ganapathy, 2010), 20-80% (Ba et al. 2019). Cowpea grain yield varies between 100kg/ha to 599kg/ha compared to potential yields of 1500 to 3000kg/ha (Gbaye and Holloway, 2011). Maruca vitrata is a major constraint in increasing the production and productivity of the crop. Host plant resistance is particularly appropriate for the resource poor peasant farmers who lack the capital to purchase inorganic fertilizers. Effective sources of resistance can be sourced among cultivated varieties of cowpea. The objective of this study was to screen cowpea genotypes to identify breeding lines that show levels of resistance to *M. vitrata* to be used directly or as parents in the breeding programme.

MATERIALS AND METHODS.

A field trial was conducted at the farm site of the Department of Agronomy, University of Ibadan between July and November. The site lies between latitude 7^0 24'N and Longitude $3^0$28'E. Ibadan is situated well with the derived savanna belt of Nigeria and has a mean annual rainfall of about 1250 mm (1000-1500 mm) and temperature of about 23-32 ºC and 19-35 ºC during the wet and dry seasons respectively. The study area has a bimodal rainfall pattern which gives rise to two cowpea cropping seasons. The first (early) season planting is done in April or early May and harvested in November/ December. There are climatological differences in the mean relative humidity (RH), temperature, rainfall, and solar radiation in the two seasons (IITA, 1975). Day length varies between 12h 3mins in mid-December and 12h 25 mins in mid-March.

The cowpea varieties were each planted in Nylon pots using a randomized block design, each treatment replicated three times. The pots were arranged in plots consisting of three rows, 4m long. Spacing was 1.5m between plots and 0.75m between rows with 20cm intra-row spacing. Two weeks prior to planting the experimental materials, a susceptible cowpea cultivar, TVu 14195 was planted at an angle 90^o to every range of rows within the plot to serve as multiplication foci (spreader row) for the insect. Single super phosphate (SSP) was applied at rate of 30 kg/ha. Six weeks later, the spreader rows were uprooted and placed along rows of test lines to allow movement of M.vitrata larvae into test lines, thus increasing the pest incidence. Monocrotophos (Nuvacron 40 EC) at 200g a.i/ha was applied once at the vegetative stage to control leaf feeding beetles, aphids, thrips, and at 500g a.i/ha once at the reproductive stage to control Hemipteran pests during podding phase of the crop. This was intended to ensure that these pests did not mask the effect of *M. vitrata* on the crop. Monocrotophos has been reported to control other cowpea pest without any detectable effect on *M.vitrata* (Jackai, 1983).

Flower damage was evaluated twice weekly for three weeks after flower bud initiation using rapid visual evaluation (RVE) method of Oghiakhe *et al*. (1992). This method involves a random selection of 20 flowers per plot and opening them immediately and recording the number of damaged flowers (i.e. flowers with *M. vitrata* larvae or frass). The average flower damage for each week was calculated from the two records. The treatments were scored at the podding stage on pod load (PL) (which measures the degree of successful pod production) and pod damage

(PD) as represented by entry holes and the presence of frass, both using a scale of 1-9 (Jackai and Singh, 1988) (Table 1). From these scores, a pod evaluation index (Ipe) was calculated [PL X (9-PD)]. This index was used mainly to express the varietal performance of the test varieties.

Data collected were subjected to Analysis of Variance (ANOVA) (with Proc. GLM in SAS 9.2 version) (SAS institute, 2008). Significant F-values were separated by Students Newman Keuls (SNK) test. Pearson linear correlation was used to test for significant association between parameters evaluated. Counts and scores were normalized using log transformation while percentages were normalized using square root transformation.

RESULTS AND DISCUSSION

The results of the physical and chemical properties of the soil used for the study showed that the soil type was sandy clay loam, with 72.6% sand, 21.4% clay and 6% silt. The (pH) was moderately acidic (5.2). The nitrogen content of the site was 0.60g/kg while the available phosphorus content was 16g/kg. The copper, Zinc, Iron, and Manganese contents were 2.10, 5.61, 112.0 and 197(g/kg) respectively while the potassium was 0.25 Cmol/kg.

For the field trial, the results for the percentage flower damage, pod damage, pod load and index of pod evaluation are shown in Table 3. Flower infestation varied among the varieties used for the study, flower damage ranged between 5.0 and 21.67 in the first week, 13.33 and 36.67 in the second week and 21.67 and 46.67 in the third week (Table 3). Tvu 1641 had the highest flower damage in the first week, second and third week. Tvu 1509 had the least flower damage in the first and second week, while in the third week, Tvu 109 had the least. However, there were significant differences among these varieties for this trait. For the number of larvae recovered per plant, Tvu 1641 had the highest value (12.00) while Tvu 4578 had the least value (8.67). There were significant differences observed for the pod damage among the varieties. Pod damage was significantly higher (p=0.592) on Tvu 15895, Tvu 109, Tvu 14195, Tvu 2653, IT03K-369-3, Tvu 13055, Tvu 1641), when compared with varieties such as IT93K-452-1, Tvu 2377, and Tvu 4578. Also significant differences were also observed among the varieties for pod load. Pod load was significantly higher in Tvu 4578, IT99K-499-35, and Tvu 15895, though high significant values were generally observed in most of the varieties for pod load but Tvu 2653, IT03K-368-3 and Tvu 1509 had significantly (p= 0.088) lower values than all other varieties. Low Ipe values were obtained from IT03K-369-3 (30.00) and Tvu 2653 (35.00). Five varieties: Tvu 1641, Tvu 14195, Tvu 13055, Tvu 1509 and Tvu 109 had Ipe values ranging between 42.33 and 49.00 while three varieties: IT98-205-8, Tvu15895 and Tvu 2377 had Ipe values between 51.33 and 57.00. The highest Ipe value was recorded for Tvu 4578 (72.00).

Flower, pod, seed damage, larval population and pod evaluation index (ratio pod load to pod damage) (Jackai, 1982; Valdez, 1989 and Oghiakhe et al., 1992a) have all been suggested as criteria to select for resistance to the pod borer. Findings in this study reveal that significant differences were observed for parameters used for evaluating the varietal susceptibility or resistance to M. vitrata (Table 3). Results of larval count tend to be a reflection of the distribution of M.vitrata larvae in this study. The number of larvae recovered from plants tends to reflect the ability of the larvae to bore into the flowers and infest them. IT99K -494-6 must have attracted the highest population of larvae due to the availability of high number of flowers. This is because the highest number of larvae was recovered from it. The high number of flowers produced by this variety may have yielded abundant food source for M.vitrata larvae. However, Tvu 4578 had the highest number of flower production and yet had a low percent flower damage of 25.13, showing that there may be some characters, either physiological, morphological or biochemical factors hindering larval feeding. This may probably be non-preference or host resistance.Tingey (1991) and Muyco and Chujoy (1995) suggested that glandular trichomes were responsible for the reluctance of potato tuber moth, *Pthtorimaea operculella Zeller* to oviposit on foliage of *Solanum berthaultii*. Other varieties also had flower infestation rate less than 30% i.e. IT97K-499-35 (25.33%), and Tvu 15895 (28.86%), Tvu 1544 had the least flower infestation rate of 22.54% but the number of flowers produced per plant was 8.67, however all these varieties may exhibit same host-plant resistance factor.

Low Ipe values indicate that there is no resistance to flower damage. Severe damage at the flowering stage results in poor pod production (Jackai, 1983). Tvu 4578 had the highest Ipe value of 72.00 which was significantly different from all other varieties, proving its superior performance. The high Ipe value obtained in Tvu 4578, suggest that this variety possess significant resistance to *M.vitrata*. This is clearly indicated in the result obtained in this experiment where its performance was distinct. This genotype possess certain characteristics such as small seed size, determinate growth habit, dark purple blotch seed pigmentation, these characteristics may have contributed to the reduced pod and seed damage observed in this study, though other factors may also be responsible. Other varieties which also had high Ipe include IT99K-499-35, IT93K-452-1, Tvu 1544, and IT90K-76.

Pearson coefficient of linear correlation of parameters evaluated on the 16 cowpea varieties for resistance under field conditions are presented in Table 4. In the study, significant positive correlation was observed between percent flower damage in week one and percent flower damage in week two (0.45**) and also in week three (0.33*). It also had a significant positive correlation with the number of larvae recovered per plot (0.41**). Significant positive correlation was also observed between percent flower damage in week two and week three (0.30*). Percent flower damage in week three had a significant positive correlation with the number of larvae recovered per plot (0.41**) and the percent pod damage (0.40**) respectively, indicating that larval density probably favoured flower damage. Number of larvae per plant however had a high positive significant correlation of unity with percent pod damage (1.00**), this clearly indicates that larval density highly affected pod damage. This is as a result of direct damage to flower buds and flowers as well as increased survival of the larvae which migrates to the pods. The same observation was made by Oigiangbe *et al*., 2006. The percent pod damage had a high negative correlation with the index of pod evaluation (-0.76**). However, significant positive correlation was observed between the pod load and the index of pod evaluation (0.75**).This gives an indication that pod damage may have lowered the index of pod evaluation (Ipe), while higher pod loads led to higher index of pod evaluation (Table 4). This clearly shows that increased pod damage led to reduction in the value of Index of pod evaluation which measures the varietal performance of the sixteen cowpea genotypes. Furthermore, pod load which is a measure of the pod production of the varieties contributed significantly to the Index of pod evaluation, indicating that high pod production led to an increase in the Index of pod evaluation.

CONCLUSION

Flower, pod, seed damage, larval population and pod evaluation index (ratio pod load to pod damage) suggested as criteria (Jackai, 1982; and Oghiakhe et al., 1992a) were effective in evaluating resistance in the sixteen cowpea varieties used for this study. The results of this study reveal that significant differences were observed for parameters used for evaluating the varietal susceptibility or resistance to *M. vitrata* of the cowpea genotypes. The highest number of pods produced by Tvu 4578 shows that this variety can be incorporated into any breeding program for high yield and increased production of cowpea. This variety showed high level of resistance to *M.vitrata*. However, the seeds of Tvu 4578 are small, and the pods have a sand-paper like skin, these may have contributed as resistance factors to *M.vitrata* feeding and oviposition, hence there is need to transfer genes for resistance from this variety to other cultivated varieties such as IT03K-369-3, IT99K-494-6, IT98K-205-8 which are early maturing but from the results of this study show susceptibility or low resistance to *M.vitrata*. This may give better yield as well as adequate resistance to cowpea growers.

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APPENDICES

Table 1: Visual rating scale for legume pod borer damage to cowpea

Pod load (PL) Rating	Degree of podding	Pod damage(PD) Rating	Percent (%)
1	Most(>60%) peduncles bare(i.e. no pods)	1	0-10
		2	11-20
3	31-60% peduncle bare	3	21-30
		4	31-40
5	16-30% peduncle bare	5	41-50
		6	51-60
7	Up to 15% peduncle bare	7	61-70
		8	71-80
9	Occasional bare peduncles	9	81-100

Source: Jackai and Singh, 1988.

Table 2: Parameters used for assessment of 16 cowpea varieties for resistance to *Maruca vitrata* in the field.

Variable	Time of assessment	Mode of data Collection	Unit of measurement
No. of flowers damaged	50% flowering	By randomly selecting 20 flowers/plot and recording the number of damaged flowers	Number
% flower damaged	50% flowering	Expressing the number of damaged flowers as a percentage of 20 flowers	Number
Pod damage (PD) %	71 DAP	By scoring pod damage on a scale of 1-9.(Jackai,1988)	Number
Pod Load (PL)	71 DAP	By scoring pod load of plants on a scale of 1-9. (Jackai,1988)	Number
Index of Pod Evaluation (Ipe)	71 DAP	Calculated as [PL X (9 – PD)]. (Jackai, 1988).	

DAP-Days after planting

Table 3: Means of parameters evaluated on 16 cowpea varieties for resistance to *Maruca* under field infestation.

Variety	%flower damage/ Week I	%flower damage/ week II	% flower damage/ week III	No. of larvae Recov/plant	%Pod damage	Pod load	Index of pod evaluation
IT03K-369-3	13.33ab	20.00bcd	31.67abc	11.67ab	1.71ab	0.86c	30.00g
Tvu 2653	11.67ab	21.67abcd	33.33abc	11.33ab	1.72ab	0.78d	35.00g
IT97K-499-35	8.33b	16.67bcd	31.67abc	9.33ab	1.14ab	1.00a	69.00a
IT98K-205-8	10.00ab	13.33d	31.67abc	10.33ab	1.28ab	0.90bc	51.33bcdef
Tvu 15895	15.00ab	25.00abc	31.67abc	10.67ab	1.63ab	1.00a	57.00abcde
1T93K-452-1	11.67ab	20.00bcd	28.33bc	10.67ab	1.00ab	0.94abc	61.33abcd
Tvu 1641	21.67a	36.67a	46.67a	12.00ab	1.96a	0.97ab	42.33egf
Tvu 2377	15.00ab	25.00abc	40.00ab	11.33ab	1.00ab	0.90bc	56.00abcde
IT99K-494-6	13.33ab	18.33bcd	26.67bc	10.00ab	1.28ab	0.90bc	51.33bcdef
Tvu 1544	8.33b	25.00abc	28.33bc	11.00ab	1.00ab	0.97ab	66.67ab
Tvu 109	15.00ab	23.33abc	21.67c	9.67ab	1.63ab	0.94abc	49.00cdef
IT90K-76	16.67ab	28.33ab	35.00abc	11.00ab	1.14ab	0.97ab	64.33abc
Tvu 13055	13.33ab	28.33ab	33.33abc	10.00ab	1.82a	0.97ab	47.00def
Tvu 1509	5.00b	13.33cd	36.67ab	9.00ab	1.28ab	0.86c	46.00defg
Tvu 4578	10.00ab	23.33abc	26.67bc	8.67b	1.00ab	1.00a	72.00a
Tvu 14195 (SC)	8.33ab	20.00bcd	31.67abc	12.00ab	1.63b	0.90bc	44.33egf

*Means followed by different letter (s) in the same column are significantly different at probability of 0.05.

Table 4: Correlation relationship between parameters evaluated for resistance to Maruca under field infestation

		A	B	C	D	E	F	G
% flower damage Wk1	A	1	0.45**	0.33*	0.41**	0.41**	0.10	-0.06
% flower damaged Wk 2	B		1	0.30*	0.27	0.27	0.26	0.05
% flower damaged Wk 3	C			1	0.41**	0.40**	-0.03	-0.19
No. larvae/plot	D				1	1.00**	0.07	-0.09
%Pod damage	E					1	0-09	-0.76**
Pod load	F						1	0.75**
IPE	G							1

* IPE= Index of pod evaluation.