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Screening of 25 cowpea genotypes for resistance to *Megalurothrips sjostedti* Trybom in southern Ghana

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ABSTRACT

In sub-Saharan Africa, *Megalurothrips sjostedti* Trybom are the most destructive insect pest of cowpea. It causes approximately 100% reduction in cowpea yield. Synthetic insecticides are widely used in controlling this pest, however, health and environmental hazards are another challenge. This study sought to evaluate 25 cowpea genotypes from Ghana, Mali, Nigeria, Niger, Burkina Faso, Togo and South-Sudan for resistance to this pest under field screening using a 5 by 5 alpha lattice design with 2 checks at University of Ghana farms. The results revealed Laduni 1B as resistant, 20 moderately resistant and 4 susceptible genotypes were also identified in this study. In the determination of correlated and non-correlated variables, ten traits were reported important to the resistance of cowpea genotypes to flower bud thrips. The genotypes with resistance could be used to introgress the resistant trait into other preferred but susceptible cowpea varieties.

Key words: Damage rating, Genotypes, *Megalurothrips sjostedti* Trybom, Resistance, *Vigna unguiculata* L. Walp.

INTRODUCTION

Thrips species has been reported to be the most damaging insect pest of cowpea in West Africa (Hall *et al*. 1997). *Megalurothrips sjostedti* Trybom (Thysanoptera: Thripidae) is a destructive insect pest which attacks the flowers or racemes of cowpea and causes flower abortion; this directly affects the formation of pods. Under severe flower bud thrips infestation, a grain yield reduction of about 20% to 80% are recorded on cowpea fields (Singh and Allen 1980; Ngakou *et al*. 2008).

The use of insecticides has been extensively applied in controlling flower bud thrips on cowpea fields to increase yield (Omo-Ikerodah *et al*. 2009). But the continuous application of insecticides may result in some thrips species becoming resistant to insecticide use (Morse and Hoddle, 2006). Also, the cost of insecticides and its availability is beyond the economic reach of numerous cowpea small scale farmers in Africa. The identification and use of cowpeas with resistant traits to thrips is the best alternative because it is cost efficient and environmentally friendly. The objective of this research was to identify cowpea accessions with high resistance to flower bud thrips and to elucidate the bases for the resistance to flower bud infestation.

MATERIALS AND METHODS

Experimental site and materials

The study was conducted at the Crop Science farms, University of Ghana, Legon. Twenty five accessions of cowpea collected from Ghana, Nigeria, South Sudan, Togo, Burkina Faso, Niger and Mali were screened for flower bud thrips resistance on field. A resistant (CIPEA 82672) variety and a susceptible variety (Vita7) served as the checks.

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Experimental layout

The experiment was conducted during the early raining season of 2018 using a 5 by 5 alpha lattice design with three replications. Single rows of the susceptible variety (Vita 7) were sown earlier as infester borders along the experimental rows and blocks to attract flower bud thrips. The infester borders was sprayed twice against aphids and mealy bugs during the early stage of emergence.

Each plot within a block of each replicate were made up of four rows of length 3 m with five hills per row and a spacing of 0.75 m between the rows and an intra-row spacing of 0.20 m. After 3 weeks, three seeds from each genotype were sown per hill. The genotypes were thinned to single plant per hill after 20 days of sowing. The plants were later covered with insect proof nets during the early stage of flower bud initiation. The plants under protection were artificially infested by dropping 5 flowers picked from the infester borders. This procedure was continued for 10 days and the

genotypes were assessed and ranked (Table 1) after symptoms of damage was observed (Fig 1).

Collection of data

With the aid of the IBPGR cowpea descriptor data recorded were based on the number of days to emergence, number of days to reach 50% flowering (50%F), number of days to reach 50% maturity or first mature pods (50%MD), number of peduncles per plant (NPLP), number of pods per peduncle (NPPL), total number of pods per plant (TNPP), peduncle length (PL), number of adults' thrips (NAT) and number of larvae thrips (NLT) per flower.

The modified damage score (DS) of Jackai and Singh (1988) was used to measure the rate of damage caused by the thrips specie (Table 1). The number of thrips and larvae per flower were counted after randomly collecting ten infested flowers from each genotype between the hours of 8:00 a.m. to 10:00 a.m. (Taylor, 1969) and dropping it into plastic vials containing 40% ethanol (Abudulai *et al*. 2006).

Data analysis of morphological traits

Data were subjected to Analysis Of Variance (ANOVA) and the Least Significance Difference (LSD) at 5% probability was computed using GenStat 18th. Principal Component Analysis was generated using XLSTATS Software.

RESULTS AND DISCUSSION

Result of the study, showed Laduni 1B as resistant (Table 2) because it had the least browning on its leaves, stipules, stems, flowers and it also had no bud abscission in spite the high number of thrips in its flowers (Fig 2). In addition, the most pigmented genotype was Laduni 1B and its resistance may be attributed to anthocyanin pigmentation found on the flower, branches, immature pods, peduncle, stem and petiole (Data not shown). Makoi *et al*. (2010), reported that the high levels anthocyanin in cowpea seed extracts lowered insect pest damage, this phenomenon could also be the reason for the variations in damage observed among studied genotypes.

Two Malian genotypes namely CIPEA 82672 and IT82E-32 were reported as highly resistant and resistant respectively by Doumbia (2016) but CIPEA 82672 was moderately resistant and IT82E-32 was susceptible to flower bud thrips in this study.

Data from Table 3 show that the correlation between the damage score and the number of adult thrips, number of larvae were 0.001 and -0.18 respectively indicating a weak correlation. This pattern only means that there was no linear relationship between these two variables but actually there is some level of interaction which exists between these two variables. But in contrast, Agbahoungba *et al*. (2017) recorded a non-significant but positive correlation between

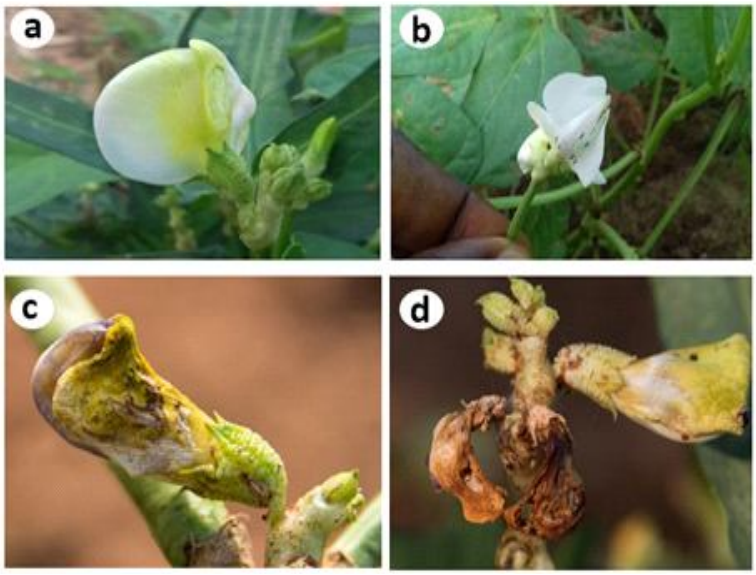

Fig 1: a) A healthy cowpea flower b) Cowpea flower infested by thrips c) Initiation of browning on flower petals d) Damaged cowpea flowers .

Table 1: Modified damage scoring procedure for flower bud thrips (Jackai and Singh, 1988).

Scale	Damage Score	Rating Appearance
9	Highly resistant	No browning or dying of stipules, leaves or flower buds; no bud abscission
7	Resistant	Initiation of browning of stipules, leaves or flower buds; no bud abscission
5	Moderately Resistant	Distinct browning of stipules and leaves or buds; some bud abscission
3	Susceptible	Bud abscission accompanied by browning of stipules and buds; non-elongation of peduncles
1	Highly susceptible	Very severe bud abscission, heavy browning, drying of stipules and buds; distinct non-elongation of most peduncles.

thrips count per flower and thrips damage score in Uganda. Alabi *et al*. (2003) and Doumbia (2016) also recorded a strong but positive correlation between thrips damage and thrips count per flower in Nigeria and Mali respectively. The variations that exist among these two studies could be linked to the differences in selected genotypes and the agro-ecological zones in which these studies were conducted. Both factors may have had adverse effect on the population of thrips.

It can be deduced from Table 4 that the thrips damage ratings were significantly different among genotypes but in contrast there was no significant differences among the resistant, moderately resistant and susceptible cowpea genotypes in relation to the number of adult thrips and larvae counted. This suggests that all genotypes were expose to almost similar number of thrips and the defence mechanism exhibited by the resistant and moderately resistant genotypes maybe tolerance. These findings were similarly reported by Abudulai *et al*. (2006) and Agbahoungba *et al*. (2018). Also from previous studies by Ta'ama *et al*. (1981) and Abudulai *et al*. (2006), the resistant and susceptible genotypes were selected based on the number of thrips

Table 2: Damage ratings and grouping of genotypes based on the modified scale of Jackai and Singh (1988).

Genotypes	Scale Rating	Damage Score	Source of Material
Laduni 1B	7.2	Resistant	South Sudan/Equatoria
Rec 014/Vu	5.6	Moderately Resistant	Togo/Northern Togo
Burkina Niebe	5.5	Moderately Resistant	Mali
CIPEA 82672	5.2	Moderately Resistant	Mali
WAC 32	5.2	Moderately Resistant	Ghana/Legon
Beledi C	5.2	Moderately Resistant	South Sudan/Equatoria
Beledi A	5.1	Moderately Resistant	South Sudan/Equatoria
Sho Soumalen	5.0	Moderately Resistant	Mali
Wiberebolimasso	5.0	Moderately Resistant	Mali
TVu7710	5.0	Moderately Resistant	Mali
Songotra	4.8	Moderately Resistant	Ghana/ Eastern Region
TVu7677	4.8	Moderately Resistant	Mali
Laduni 1A	4.7	Moderately Resistant	South Sudan/Equatoria
IT98K-503-1	4.7	Moderately Resistant	IITA/Nigeria
Mouride	4.6	Moderately Resistant	Burkina Faso
Diaye	4.5	Moderately Resistant	Mali
KV	4.0	Moderately Resistant	Burkina Faso
TVu7648	3.9	Moderately Resistant	Mali
Bengpla	3.7	Moderately Resistant	Ghana
Danila	3.7	Moderately Resistant	Niger/INREA
Asontem	3.6	Moderately Resistant	Ghana
Vita7	3.4	Susceptible	Ghana
Makurudibi	3.4	Susceptible	Mali
IT82E-32	3.3	Susceptible	IITA/Nigeria
AGRAC-216	2.6	Susceptible	South Sudan/Equatoria



Fig 2: Comparison of resistant genotype Laduni 1B (Left) to the susceptible check Vita7 (Right).

counted per flower. But in this study it was clearly observed that there was no significant differences among most genotypes in relation to the number of thrips count. This observation was in line with the findings of Agbahoungba *et al*. (2017), suggesting that resistant cowpea genotypes should not be selected solely on the number of thrips counted per flower. It is therefore important to consider the use of multiple techniques for measuring resistance of genotypes to insect pest.

There was a strong but positive correlation (r=0.70) between 50% flowering and 1st mature pods, this indicates that early flowering genotypes are also early maturing as observed in this study (Table3). This observation affirms the reports by Aliyu *et al*. (2016) and Doumbia (2016) who observed a strong correlation between 50% flowering and 1st mature pods. These authors added that farmers' prefer early maturing cowpea due their vigorous growth. Early maturity is a desired trait for crop improvement programmes by breeders.

The correlation between the damage score and number of days to reach 50% maturity was r= -0.21. This phenomenon was similar to the findings of Omo-Ikerodah

Table 3: Pearson's correlation coefficient for quantitative traits of the cowpea genotypes.

Variables	50%MD	50%F	DS	EM	NPLP	NAT	NLT	NPPL	TNPP	PL(mm)
50%MD	**1**									
50%F	**0.70**	**1**								
DS	-0.21	-0.02	**1**							
EM	-0.01	0.10	-0.01	**1**						
NPLP	**0.63**	0.28	0.17	0.13	**1**					
NAT	0.12	0.21	0.00	0.03	0.10	**1**				
NLT	-0.42	-0.36	-0.18	0.18	-0.41	0.06	**1**			
NPPL	**-0.55**	-0.35	0.32	0.03	**-0.45**	0.06	0.16	**1**		
TNPP	**-0.58**	-0.35	0.30	0.13	**-0.53**	0.14	0.21	**0.92**	**1**	
PL(mm)	-0.28	-0.23	0.39	0.09	0.04	-0.02	0.06	0.31	0.26	**1**

Values in bold are different from 0 with a significance level alpha=0.05.

Table 4: Mean performance of 25 cowpea genotypes for resistance to *Megalurothrips sjostedti.*

Genotype	50%MD	50%F	DS	EM	NPLP	NAT	NLT	NPPL	TNPP	PL(mm)
AGRAC 216	61.3	40.3	2.6	4.0	78.4	305.7	182.0	0.8	3.6	244.7
ASONTEM	60.3	46.3	3.6	4.0	50.4	430.7	189.3	0.9	3.7	177.0
BELEDI A	61.0	40.0	5.1	4.0	109.2	356.0	120.3	1.7	6.7	233.1
BELEDI C	58.0	40.7	5.2	4.0	95.7	239.0	178.0	1.5	4.1	255.1
BENGPLA	61.7	40.7	3.7	4.0	67.3	354.0	166.7	2.1	11.1	160.7
BURKINA NIEBE	66.0	48.0	5.5	4.0	115.0	336.3	46.0	1.6	5.4	200.6
CIPEA 82672	54.3	40.3	5.2	4.3	51.4	264.7	231.7	2.1	12.9	219.4
DANILA	68.7	43.3	3.7	3.7	98.2	372.0	130.7	0.7	2.4	190.3
DIAYE	68.3	49.7	4.5	4.3	58.8	328.3	74.0	1.4	7.4	184.9
IT82E-32	58.0	41.7	3.3	4.0	54.9	280.0	194.0	1.2	5.8	264.6
IT98K-503-1	60.3	42.0	4.7	5.3	97.8	330.0	140.3	1.3	7.1	315.9
KV	61.0	41.3	4.0	4.0	94.1	417.7	106.3	1.4	7.1	219.3
LADUNI 1B	56.0	40.7	7.2	4.0	74.4	314.7	102.0	1.2	8.0	272.3
MAKURUDIBI	57.7	40.0	3.4	4.0	52.5	221.7	56.3	1.0	3.5	92.7
MOURIDE	59.7	41.7	4.6	4.0	82.9	374.3	130.0	1.2	4.0	161.0
REC 014/VU	57.0	40.0	5.6	4.0	62.4	383.0	68.3	2.7	16.0	297.7
SHO SOUMALEN	56.0	41.3	5.0	4.3	71.2	439.0	280.7	1.5	11.1	148.5
SONGOTRA	67.0	44.0	4.8	4.7	114.9	301.3	101.7	0.9	4.1	151.6
TVU 7648	57.0	39.7	3.9	4.0	41.2	212.0	182.0	2.1	12.9	158.1
TVU 7677	51.7	39.7	4.8	4.0	26.2	412.7	162.3	2.4	13.9	253.4
TVU 7710	55.3	41.3	5.0	4.0	45.2	316.3	128.3	2.4	14.9	246.6
VITA 7	56.0	41.0	3.4	5.0	51.1	358.3	267.0	2.1	11.9	199.4
WAC 32	57.0	40.7	5.2	4.0	70.3	257.3	191.7	2.0	9.1	334.7
WIBEREBOLIMASSO	60.3	40.3	5.0	4.0	46.2	347.7	280.7	1.8	7.9	235.2
MEANS	59.5	41.8	4.6	4.2	70.5	327.4	155.5	1.6	8.0	217.0
GENOTYPE	0.01	0.001	0.01	0.001	0.001	0.7	0.07	0.001	0.001	0.001
LSD (0.05)	8.3	2.33	1.8	0.5	43.5	208.2	145.0	0.72	4.95	73.8
SE	5.0	1.42	1.1	0.3	26.5	126.8	88.3	0.44	3.02	45.0
CV%	8.5	3.40	24.2	8.0	37.6	38.7	56.8	27.77	37.85	20.7

Table 5: Principal components, eigenvalues and cumulative variability among variables.

	Squared cosines of the variables			
Variables	**PC1**	**PC2**	**PC3**	**PC4**
50%MD	**0.770**	0.024	0.028	0.005
50%F	**0.438**	0.059	0.156	0.042
DS	0.071	**0.603**	0.043	0.000
EM	0.002	0.018	0.259	**0.522**
NPLP	**0.448**	0.226	0.006	0.085
NAT	0.002	0.038	**0.542**	0.070
NLT	0.219	**0.253**	0.075	0.153
NPPL	**0.690**	0.085	0.025	0.054
TNPP	**0.722**	0.050	0.079	0.045
PL(mm)	0.158	**0.293**	0.037	0.133
	PC1	**PC2**	**PC3**	**PC4**
Eigenvalue	3.518	1.647	1.251	1.108
Variability (%)	35.180	16.473	12.507	11.085
Cumulative (%)	35.180	51.653	64.160	**75.244**

Values in **bold** correspond for each variable to the factor for which the squared cosine is the largest.

EM = number of days to emergence, 50%F = number of days to reach 50% flowering, 50%MD = number of days to reach 50% maturity or first mature pods, NPLP = number of peduncles per plant, NPPL = number of pods per peduncle, TNPP = total number of pods per plant, PL =peduncle length, NAT = number of adults' thrips, NLT = number of larvae thrips per flower and DS = Damage Score

et al. (2009) and Agbahoungba *et al*. (2017). These authors screened for thrips resistant genotypes under field condition and also reported on the negative correlation that existed between damage score and 50% maturity. It can be deduced from Table 4 that both moderately resistant genotypes (Danila and Diaye) delayed in reaching 1st maturity but had a higher number of pods per peduncle contributing to higher numbers of pods per plant in spite of the large numbers of thrips counted per flower. This maybe be a defense mechanism adopted to escape from the damage caused on the floral parts by flower bud thrips. On the other hand, some authors also reported early flowering as a defence mechanism to escape thrips infestation (Alabi *et al*. 2003; Abudulai *et al*. 2006). From this study, TVU 7677, was classified moderately resistant and despite the large numbers of thrips count per flower it produced more pods per plant than the resistant check (CIPEA 82672).

From Table 5, four of the principal components had eigenvalues greater than one and contributed to a cumulative variability of about 75%. In comparison, this study disagrees with the finding of Doumbia *et al*. (2016) who observed three principal components contributing to 70% cumulative variations among the variables of eigenvalue greater than one. In addition, traits such as 1st mature pods, 50% flowering, emergence, number of peduncle per plant, number of pods per peduncle, total number of pods per plant contributed the highest eigenvalue (3.52) at Principal Component 1 (PC1) while damage score, number of adult thrips, number of thrips larvae and peduncle length represented an eigenvalue of 1.65 at Principal Component 2 (PC2).

The inertia obtained from the summation of both PC1 and PC2 variability percentages was 51%. This suggests that the ten variables (Table 5) are therefore important in the determination of correlated and non-correlated variables in relation to screening of cowpea genotypes for resistance to flower bud thrips.

CONCLUSION

Out of the 25 genotypes screened for flower bud thrips resistance; 1 was resistant, 20 were moderately resistant and 4 were susceptible. The resistant genotype (Laduni 1B) from south-Sudan also possess traits of consumer preference which could be adopted into Ghanaian cowpea breeding programmes to improve preferred local varieties which may be susceptible to thrips infestation. Therefore the identification and development of highly resistant cowpea genotypes could be the best alternative to control insect pest damage on cowpea compared to the use of insecticide which is environmentally unfriendly.

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