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Research Application Summary

Sources of Cowpea Genotypes Resistant to Flower Bud Thrips

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Abstract

Flower bud thrip is destructive insect pests of cowpea and other legumes and can cause complete yield loss in severe infestation. Utilization of resistance in cowpea breeding is one of the most efficient and environmental friendly methods to control the pest. The objective of this study was to identify cowpea genotypes resistant to flower bud thrips. A total 220 cowpea minicore genotypes were evaluated for flower bud thrips and yield response under field conditions in three locations and three seasons. Analysis of variance was done and means separated using Fishers Protected Least Significant Difference. Correlation of traits was also computed using R statistical software. The results identified genotypes TVU-3804, TVU-7647 and Lori Niebe as resistant to flower bud thrips across locations and seasons. In addition, these genotypes had significant high yield performance across seasons. Significant positive correlation was observed between flower bud thrips damage and yield components, an indication of the negative effect caused by increased populations of thrips. The identified resistant genotypes could be used as parents in cowpea breeding program for development of cowpea genotypes that are well adapted to local environment but susceptible to flower bud thrips.

Key words: Cowpea Improvement, *Megalurothrips sjostedti*, Minicore, *Vigna unguiculata*

Résumé

Le thrips des boutons floraux est un ravageur destructeur du niébé et d'autres légumineuses, pouvant causer une perte de rendement totale en cas d'infestation sévère. L'utilisation de la résistance dans l'amélioration du niébé est l'une des méthodes les plus efficaces et respectueuses de l'environnement pour contrôler ce ravageur. L'objectif de cette étude était d'identifier les génotypes de niébé résistants aux thrips des boutons floraux. Un total de 220 génotypes de minicore de niébé ont été évalués pour leur réponse aux thrips des boutons floraux et leur rendement dans des conditions de champ sur trois sites et pendant trois saisons. Une analyse de variance a été effectuée et les moyennes ont été séparées en utilisant la différence significative la plus faible protégée de Fisher. La corrélation des traits a également été calculée en utilisant le logiciel statistique R. Les résultats ont identifié les génotypes TVU-3804, TVU-7647 et Lori Niebe comme résistants aux thrips des boutons floraux dans tous les sites et saisons. De plus, ces génotypes ont montré une performance de rendement significativement élevée à travers les saisons. Une corrélation positive significative a été observée entre les dommages causés par les thrips des boutons floraux et les composantes du rendement, indiquant l'effet négatif causé par l'augmentation des populations de thrips. Les génotypes résistants identifiés pourraient être utilisés comme parents dans les programmes d'amélioration du niébé pour le développement de génotypes bien adaptés à l'environnement local mais résistants aux thrips des boutons floraux.

Mots-clés : Amélioration du niébé, *Megalurothrips sjostedti,* Minicore, *Vigna unguiculata*

Introduction

Cowpea (*Vigna unguiculata* (L.) Walp) is grown by both small and large-scale farmers in tropical and subtropical regions (Alabi *et al.,* 2010). It is a dual-purpose crop with the green leaves and pods being consumed as vegetable, dry grain as sauce while the haulms are used as fodder. The grain is rich in nutrients, containing 25% proteins and significant amounts of macro and micronutrients, while the leaves and green pods also contain valuable nutrients including Iron (Fe) and Zinc (Zn) (Dakora and Belane, 2019). The crop is drought tolerant and improves soil fertility. It is an important crop that can be targeted in achieving zero hunger, good health, climate action and no poverty, of the United Nations standard development goals. Despite these attributes, cowpea production is faced by a number of constraints among them flower bud thrips (*Megalurothrips sjostedti*). Flower but thrips is a field pest that attacks cowpea crops at flowering stage where they suck the sap thereby causing browning of the stipules, flower distortion and abscission. In severe infestation, the pest can cause between 80-100% yield loss (Karungi *et al.,* 2000).

Efforts have been made to combate the menace by developing genotypes that are resistant to flower bud thrips (Agbahoungba *et al.,* 2017). However, resistance tends to breakdown over time probably due to changes in insect genetics (Maharijaya *et al.,* 2017). As a result, it is necessary to constantly evaluate more genotypes for resistance to thrips which can be used as parents for Cowpea improvement program. The objective of the study was therefore to identify new sources of cowpea resistant to flower bud thrips.

Materials and Methods

Experimental sites and genotypes. A total of 220 cowpea genotypes, a subset of 368 accessions from the minicore collection (the University of California, Riverside (UCR) Minicore) (Muñoz-Amatriaín *et al.,* 2021) were used in this study. The genotypes were evaluated under field conditions in Uganda in three locations, Makerere University Agricultural Research Institute Kabanyolo (MUARIK) in Wakiso district, Ngetta Zonal Agricultural Research and Development Institute (NgettaZARDI) in Lira district (Lira district) and National Semi-Arid Resource Research Institute (NaSARRI) in Serere district (Eastern Uganda) which are known to be hotspot for flower bud thrips. The weather conditions for the three sites are shown in Table 1.

Table 1. Geographical location weather and soil conditions of the trial sites

Location	Longitude	Latitude	Altitude (masl)	AAT (°C)	AAR (mm)	Soil type
MUARIK	32°37'E	0°28'N	1200	21.50	1150	Sandy, clay loam
Ngetta	32°56'E	2°17'N	1180	25.05	1305	Sandy, Loam
Serere	33°54'E	1°49'N	1126	24.00	1250	Sandy, loam

AAT=average annual temperature. AAR= average annual rainfall. masl-meters above sea level. Source: (Sserumaga *et al.,* 2015)

Data collection and analysis. Data was collected on flower bud thrips damage severity on a scale of 1-9 at 50, 65 and 80 days after planting (DAP). Scores were defined as: 1-3 = resistant, 4-6 = moderately resistant and 7-9 = susceptible (Jackai and Singh, 1988). Rating was based on a combination of varying intensities of thrips induced browning of the stipules and flower buds, non-elongation of peduncles, and flower bud abscission. At maturity, the number of pods per plant (NPDPP), number of seeds per pod (NSDPP), seed/grain yield per plot (SYPP) and 100 seed weight (100SWT) were determined. Flower thrips damage scores at 50, 65, and 80 days after planting were used to compute the area under pest progress curve as shown,

$$AUPPC = ((S1 + S2)|2)t + ((S2 + S3)|2)t$$

Where S = the flower thrips damage score, t = interval (days) between two consecutive scores.

The data were used to perform the analysis of variance using R statistical software (Table 2) . The equation below is the model for the analysis of variance for locations and seasons.

$$y_{ijlm} = \mu + g_i + l_j + b_{m(l)} + gl_{ij} + \varepsilon_{ijlm}$$

Where: y_{ijlm} is the observed value for the i^{th} genotype from j^{th} location/season, in the m^{th} block nested within the l^{th} replication; μ is the overall mean effect, g_i is the i^{th} genotype effect, l_j is the j^{th} location/season effect, $b_{m(l)}$ is the effect of m^{th} block nested within the l^{th} replication, gl_{ij} is the interaction effect of i^{th} genotype and j^{th} location/season, ε_{ijlm} is the experimental error.

The means for each trait were separated using Fishers Protected Least Significant Difference (LSD) at 5%. To assess the degree of association between traits, Pearson's correlation analysis was performed using the R package.

Results and Discussion

Response of cowpea genotypes to flower bud thrips. Significant (P<0.001) differences were observed among cowpea genotypes for their response to flower bud thrips at 50, 65, 80 DAP and AUPPC (Table 2). The substantial variation in the severity of the damage scores observed in this study was a clear indication of the existence of new sources of cowpea resistance to flower bud thrips in the minicore population. Genotypes that were resistant to flower thrips damage scores were TVU-3804, Ecute, and TVU-7647 (Figure 1).

In similar studies, Agbahoungba *et al.* (2017) identified three out of 70 genotypes to be resistant to flower thrips in Uganda. This indicates that most of the genotypes do not have resistant genes, hence the need for consistently evaluating wider gene pools. Genotype Sanzi found to be resistant in previous study (Omo-ikerodah *et al.,* 2009) and used in the current study, was found to be moderately resistant to flower bud thrips, signifying possible presence of flower thrips biotypes which may have overcome the resistance.

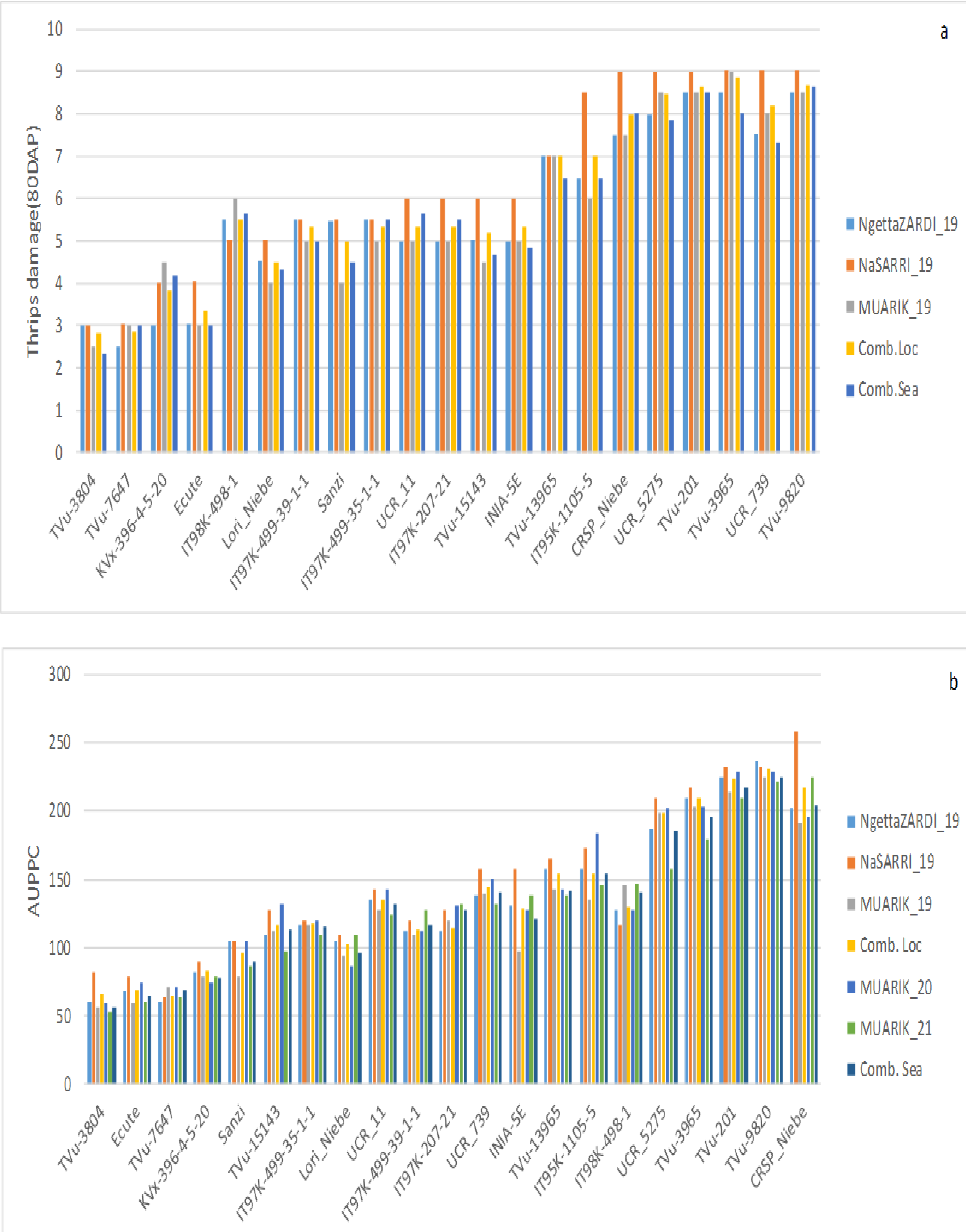

Figure 1. Distribution of flower thrips damage at 80 DAP and area under pest progress curve (AUPPC) of selected cowpea genotypes screened for resistance to flower thrips. Comb.Loc= Combined locations, Comb.Sea= Combined seasons. Comb.Loc = Combined locations, Comb.Sea = Combined seasons, DAP = days after planting

Significant (P<0.001) differences were observed among cowpea genotypes for yield component traits across locations and seasons (Table 2). The significant variation observed for the number of pods per plant, 100 seed weight and yield indicated that cowpea genotypes reacted differently under various environmental conditions under thrips infestation. Genotypes TVU-3804, Sanzi, Lori Niebe and TVU-7647 (Figure 2) were least affected by flower bud thrips hence recorded higher pod formation and yield and could be considered resistant to flower bud thrips.

Furthermore, seasons and locations had significant (P<0.001) effects on flower thrip infestation at 50, 65, 80 DAP, AUPPC and yield component traits including for NSDPP and 100SWT except for NPDPP and SYPP where non-significance were observed in the locations (Table 2). The interactions between genotypes × seasons and between genotypes × locations were highly significant (p<0.001) for all the traits under study. The significant genotype × location interaction was an indication that the environmental conditions of the sites where the experiments were carried out effected the cowpea genotypes differently. Similarly, the significant genotype × season interaction implied that seasonal variations in a single site influenced the response of cowpea to flower bud thrips as well as yield. These results were in agreement with those of Agbahoungba *et al.* (2017) who observed significant genotype × location interaction while evaluating a different set of cowpea genotypes for resistance to flower bud thrips in Uganda.

A significant positive correlation was observed between the flower thrips parameters (Figure 3). The area under pest progress curve had a positive correlation with thrips damage scores at 50 DAP (r=0.93), 65 DAP (0.94) and 80 DAP (0.97). At 80 DAP, there was a positive correlation with thrips damage at 50 DAP (0.85) and 65 DAP (0.87), while damage at 50 DAP positively correlated with damage at 65 DAP (0.97) (Figure 3). The yield was significantly negatively correlated with flower bud thrips damage at 50 DAP (r = -0.45), 65 DAP (r = -0.51), 80 DAP (r = -0.68) and with the area under pest progress curve (r = -0.64). Similarly, for the yield parameters; number of pods per plant, number of seeds per pod and 100 seed weight, were significantly negatively correlated with thrips damage parameters; damage at 50, 65, 80 DAP and Area under pest progress curve (Figure 3). Among flower thrips resistant traits, the correlation was positive and significant, an indication that either of the parameters (50, 65, 80 DAP or AUPPC) could be considered in decision making. The flower bud thrips damage scores had significant negative correlations with the number of pods per plant and seed yield signifying that as the thrips population increased, the number of pods per plant and seed yield reduced hence reducing production and lowering the grain quality.

Conclusion

The phenotypic data indicated a significant variation among genotypes for resistance response to flower bud thrips and genotypes TVU-3804, TVU-7647, Sanzi and Lori Niebe were the most resistant. These genotypes should be incorporated into breeding program as parents, for improvement of cowpea resistance to flower bud thrips.

Table 2. Mean squares for the flower bud thrips damage and yield traits in cowpea genotypes across locations and seasons.

SoV	df	50DAP	65DAP	80DAP	AUPPC	NPDPP	NSDPP	SYPP (g)	100SWT (g)
					Locations				
Rep	1	18.20	0	0	945.00	92.00	64.50	8097.00	24.70
Rep:Block	18	1.83	1.32	1.37	804.22	40.44	13.97	1190.89	8.49
Genotype (G)	219	4.60***	4.90***	5.30***	3608.6***	194.60***	26.80***	14506.50***	67.20***
Location (L)	2	278.70***	212.30***	255.60***	210194.00***	1.50^{ns}	24.40*	355.00^{ns}	185.30***
G× L	438	1.90***	2.20***	278.00***	1476.7***	78.00***	14.50***	5722.40***	19.30***
Residuals	641	1.00	0.90	1.00	530.7	46.60	6.90	1410.50	10.80
Mean		4.10	4.60	6.20	146.8	13.50	9.10	71.40	14.20
CV (%)		24.80	21.00	16.10	15.69	28.70	29.10	32.60	23.10
					Seasons				
Rep	1	11.84	0.30	0.30	1458.00	39.00	0.10	24907.00	62.40
Rep:Block	18	1.48	2.17	1.36	1025.83	101.78	49.66	16778.39	26.06
Genotype(G)	219	2.90***	3.90***	4.90***	2788.90***	141.90***	19.80***	84696.90***	54.00***
Season (S)	2	168.70***	201.00***	495.20***	219438.50***	2091.00***	3782.70***	131659.00***	845.60***
G× S	438	1.70***	2.00***	2.90***	1321.40***	99.00***	14.20***	82983.20***	36.80***
Residuals	641	0.90	0.80	0.90	411.90	41.60	8.20	7404.70	18.90
Mean		3.40	4.30	5.70	133.50	14.40	9.40	197.20	14.90
CV (%)		27.80	21.10	16.20	15.20	24.70	30.60	32.70	29.10

*** = significant at 0.001 probability levels, ^{ns} = non-significant, SoV= Source of variation, df = degrees of freedom, DAP = days after planting, AUPPC = Area under pest progress curve, NPDPP = number of pods per plant, NSDPP = number of seeds per pod, SYPP = seed yield per plot, 100SWT = 100 seed weight, Re p= Replications, G = Genotypes, L= Locations, S = Seasons, CV= coefficient of variation.

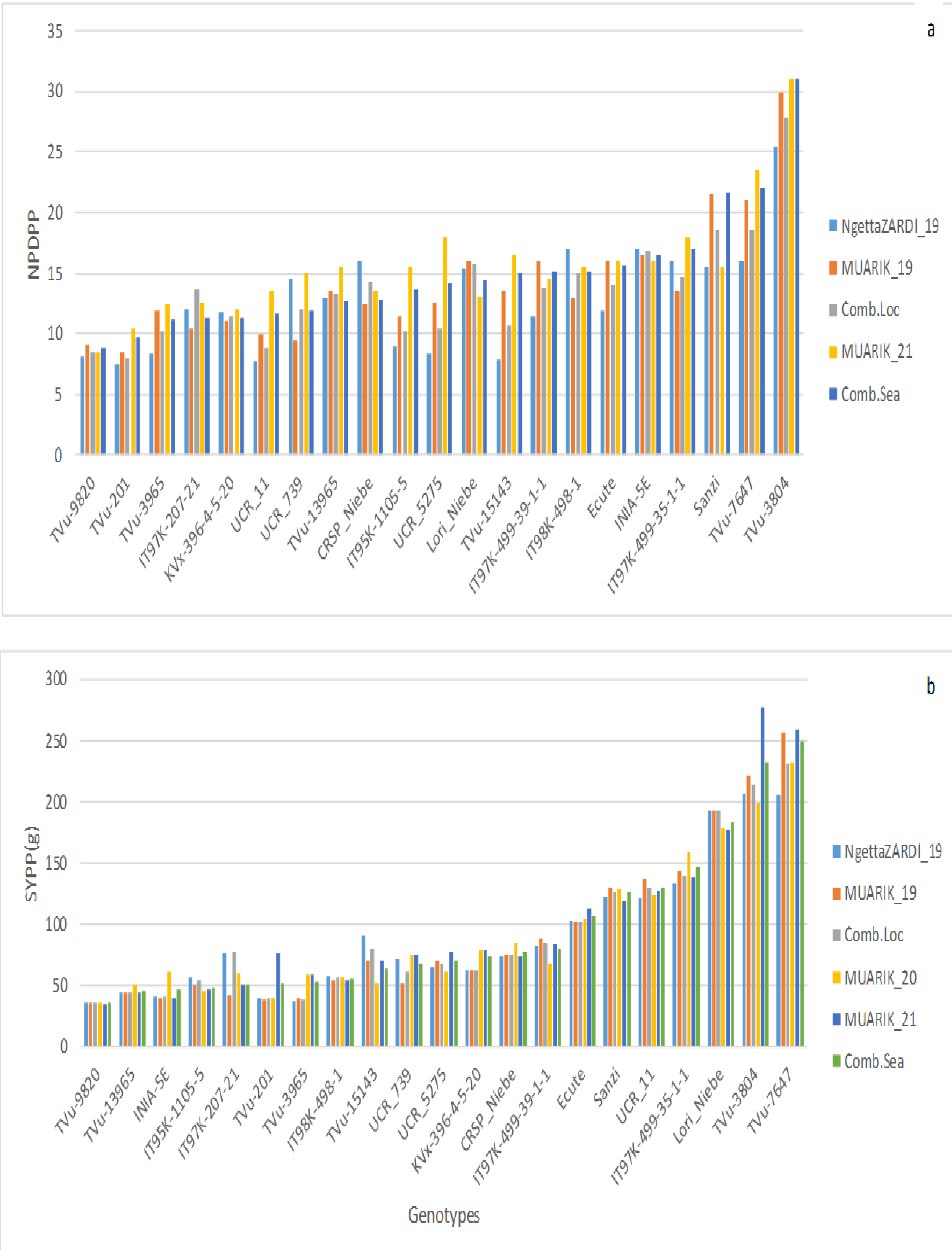

Figure 2. Distribution of the number of pods per plant (NPDPP) and seed/grain yield per plot (SYPP) of selected cowpea genotypes screened for resistance to flower thrips.

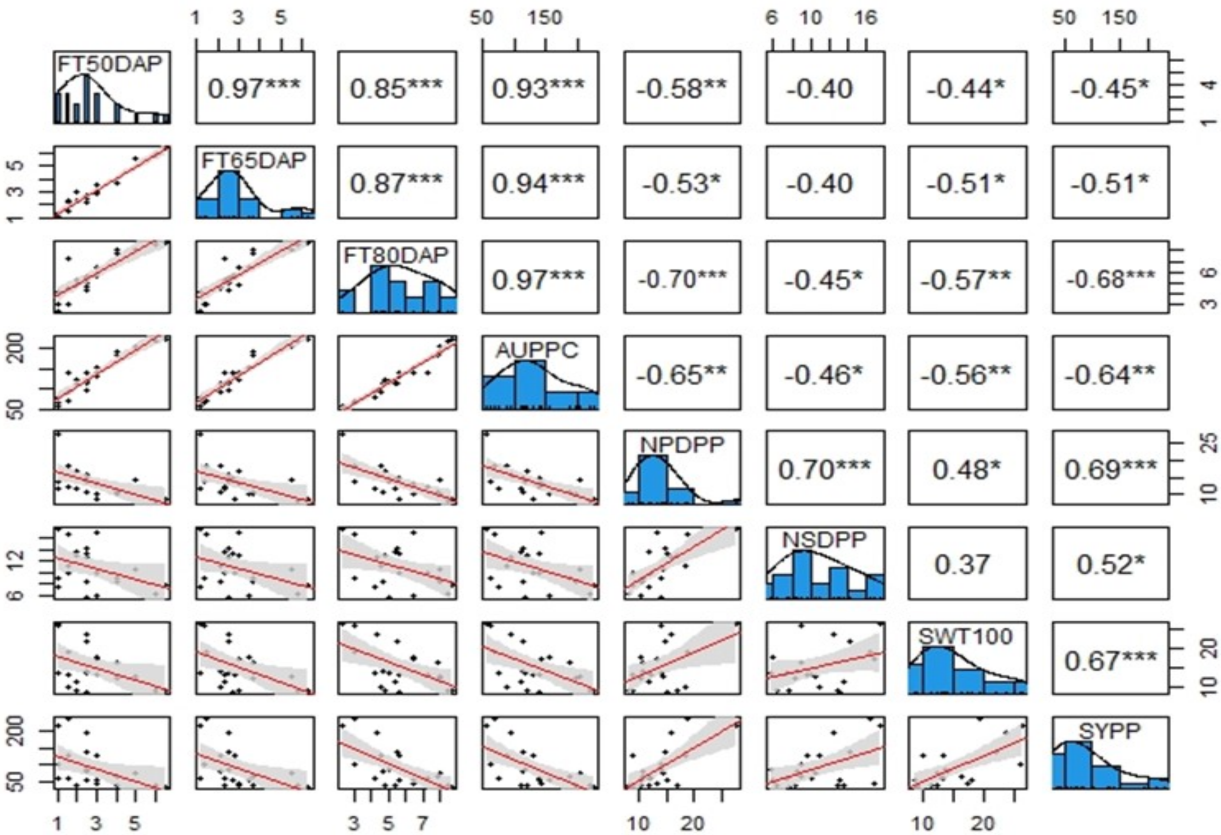

Figure 3. Correlation coefficients (r) for cowpea genotypes screened for flower bud thrips in field. FT = flower bud thrips, DAP = Days after planting, AUPPC = Area under pest progress curve, NPDPP = number of pods per plant, NSDPP = number of seeds per pod, SWT100 = 100 seed weight, SYPP = seed/grain yield per plot.

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