International Journal of Plant Science and Ecology
Vol. 7, No. 3, 2021, pp. 78-86
http://www.aiscience.org/journal/ijpse
ISSN: 2381-6996 (Print); ISSN: 2381-7003 (Online)

Inheritance of Aphids (*Aphis craccivora* Koch.) Resistance in Cowpea (*Vigna unguiculata* (L.) Walp)

Ekeruo Godspower Chibuike[1, 3, *], Lucky Omoigui[1, 2, 3], Lateef Lekan Bello[1, 3], Macsamuel Ugbaa[1, 3], Iyorkaa Nater[1, 3]

[1]Department of Plant Breeding and Seed Science, College of Agronomy, Federal University of Agriculture Makurdi, Makurdi, Nigeria
[2]International Institute for Tropical Agriculture (IITA), Kano Station, Kano, Nigeria
[3]Molecular Biology Laboratory, Federal University of Agriculture Makurdi, Makurdi, Nigeria

Abstract

Cowpea cultivation is constrained by a variety of biotic and abiotic stresses among which insect pests constitute a serious setback. A major pest constraining cowpea production in the drier region of the tropics is the cowpea aphids (*Aphis craccivora*). Apart from aphids transmitting viruses while feeding, heavy colonization causes rapid wilting and eventual plant death. Among the several strategies employed for its control (chemical, cultural and biological control measures) on cowpea the use of resistant varieties helps to control the insects' population and thus regarded to be more viable and economical for resource poor farmers. This study was designed to identify cowpea genotypes with good source of genetic resistance and elucidate the inheritance pattern of aphid resistance in cowpea. Sixty cowpea genotypes were screened at the Federal University of Agriculture Makurdi, Benue State, Nigeria for resistance to cowpea Aphids using insect cages that only allows air passage but not the insect. Two cowpea genotypes (TVu-2876 and Aloka Local) contrasting clearly with reactions to the cowpea aphid identified in this study as resistant and susceptible respectively were selected for hybridization. Hybridization was carried out in the screen house of the Molecular Biology Laboratory by hand emasculation. The F_2 population obtained from the cross between TVu-2876 and Aloka Local was used for inheritance studies for aphid resistance under artificial infestation with aphids in insect proof cages. Out of the 227 F_2 plants evaluated, 168 showed resistant to cowpea aphid, while 59 plants were identified as susceptible. The Chi-square (χ^2) analysis for goodness-of-fit revealed a segregation pattern that fits the 3:1 genetic ratio, thus indicating that a single dominant gene confers resistance to cowpea aphids in TVu-2876. In the same order, the backcross segregating population involving the F_1 plants and susceptible parent segregated into 1:1 ratio confirming the single gene inheritance model. This information will be helpful in breeding elite cowpea lines with genetic resistance to aphids in cowpea.

Keywords

Cowpea, Aphids, Resistance, Inheritance, Gene Action, Segregation

Received: July 29, 2021 / Accepted: August 24, 2021 / Published online: August 30, 2021

1. Introduction

Cowpea [*Vigna unguiculata* (L.) Walp] is grown in tropical and subtropical regions of the world, primarily in sub-Saharan Africa an important food legume. The largest areas under cultivation are in the Savannas of West and Central Africa (WECA). Cowpea is grown on about 12, 577, 845 million ha of the world's cultivated land, with annual grain production nearing 7,

* Corresponding author
E-mail address: ekeruo.godspower@uam.edu.ng (E. G. Chibuike), ge5benue@gmail.com (E. G. Chibuike)

407, 924 million tonnes [1]. Nigeria is the largest producer and consumer of the crop and accounts for over 3.4 million tonnes of grain production from an estimated 3.7 million ha [1, 2].

Cowpea is a major nutritious food in the diet in Africa and Asian continents [3]. It is also an important source of nutritious fodder for livestock production in West Africa [2]. Cowpea contains 23-35% protein in its grains, which is about twice the protein content of most cereals [4]. It is a rich source of B-vitamins, containing 62 percent soluble carbohydrates, little amounts of other nutrients [5, 6, 7] and relatively free from anti-nutritive factors [4]. Their amino acid also complements those of cereals [8-10]. Islam *et al.* [11] emphasized that all parts of the cowpea used as food have nutritive values, providing protein and vitamins. Green pods and immature peas are eaten as vegetables while dried grains can be prepared as main dishes or used to make snacks [12, 13]. Because both grain and fodder can be obtained from the same crop, the use of cowpea haulms as fodder is attractive in mixed crop/livestock systems [14]. In addition, cowpea is a dependable commodity that produces valuable income for many small holder farmers and traders in sub-Saharan Africa [15].

Among biotic factors that impact negatively on cowpea production and productivity, insect pests is a serious setback in the cultivation of cowpea all over the world. Cowpea has at least one major insect pest that can cause serious damage and impact yield negatively throughout its life cycle [16]. In Africa, insect pests causes significant losses of cowpea yields, limiting yields to less than 300 kg/ha if not controlled [17]. Some of the most important insect pests are aphids (*Aphids sp*.), pod borers (*Maruca testulalis* Geyer) and thrips [18]. Among the aphid species, *Aphis craccivora* (Koch.) is a major pest to cowpea [18]. Cowpea aphids have been found to be well distributed through the tropics as a result of their quick colony expansion in hot-dry weather and also because of their numerous hosts. They occur on the growing point of the host plants including tips, flowers and developing pods [19] and are regularly attended to by ants.

Aphids (*A. craccivora*) primarily infest seedlings, although large populations also infest flower buds, flowers and pods, and cause direct feeding damage to the plants by sucking its sap [20]. Small population may have little impact on the plant, but large population kills young plant at seedling stage as a result of heavy feeding, cause leaf distortion, stunted plant, delay in initiation of flowers, poor root nodulation and reduced pod formation in plants which survive attack [20]. Aphids also cause harm to the cowpea through secretion of honeydew that encourages growth of sooty moulds and other fungi on leaves, thus reducing photosynthetic potential of the plant [21]. Yield is reduced and in severe cases the plant dies completely [20]. Aphids draws up sap from the young leaves and stem tissues. Thus acting as vectors in the transmission of cowpea aphids-borne mosaic virus [22]. The presence of high amount of flavonoid compound which is mediated by gene has been attributed to aphid resistance in cowpea [23]. This therefore, suggests the possibility of developing cowpea varieties resistant against aphid attack. Breeding cowpea varieties with genetic resistance to aphids can be fast tracked with the use of molecular markers. Molecular markers linked to gene for aphid resistance can be effectively deployed for efficient tracking of resistance in breeding populations. However, limited study has reported molecular markers linked to cowpea aphid resistance in Nigeria.

Several control methods have been reported for the control of *A. craccivora*. These include; chemical control, cultural control, and biological control. These management practices for the control of aphids are usually not very effective because of the pests' exceptionally very short life cycle and extremely high reproductive capacity. As a result, when chemical control strategy is employed, large quantities of insecticides are used. Chemicals application is expensive, causing environmental degradation and ultimately destroying non-targeted beneficial insects such as predators, parasitoids, and pollinators. Moreover, use of chemicals has led to high levels of resistance to insecticides in several aphid species, and this further complicates chemical control of aphids [24].

Among control strategies, the use of host plant resistance through the use of varieties possessing resistance gene(s) appears to be economically viable for the resource-poor small holder farmers. Among the benefits of host plant resistance (HPR) is the environmentally friendly approach in controlling aphids, thus promotes production of healthy products that are free of pesticide residues. It has to be considered as an essential component of an integrated crop management system to control aphid pests [25].

Cultivar resistant to aphids have been researched by other workers [26], but there is also the need to understand the genetic basis of resistance [24]. Moreover, there has been report of breakdown of resistance in some genotypes previously reported with aphid resistance gene [27] and identifying new sources of genetic resistance will provide an opportunity to pyramid resistance genes in improved varieties for broad based and durable resistance. This research was therefore undertaken to identify sources of genetic resistance to aphids and elucidate inheritance pattern of aphid resistance in cowpea.

2. Materials and Methods

2.1. Germplasm Collection

Cowpea genotypes were obtained from the International

Institute of Tropical Agriculture (IITA) research stations through the Molecular Biology Laboratory of the Federal University of Agriculture Makurdi (FUAM). A total of 60 cowpea genotypes (some which have known aphid history), including 4 improved FUAM lines, were used for the research.

Table 1. List of Cowpea Germplasm used for the study to Screen for Aphid Resistance.

S/No	Germplasm	Reaction to Aphids	Source	Genetic Study (if any)
1	TVu 347	Not Available	IITA	Not Available
2	TVu 984	Not Available	IITA	Not Available
3	IT99K-216-24-2	Not Available	IITA	Not Available
4	IT84S-2246-4	Resistant	IITA	Not Available
5	TVu1016-1	Not Available	IITA	Not Available
6	IT82D-812	Resistant	Thailand	Breeding
7	TVu 2876	Resistant	Thailand	Breeding
8	IT87S-1394	Resistant	Thailand	Breeding
9	TVu 1029	Not Available	IITA	Not Available
10	IT90K-76	Resistant	IITA	Screening
11	IT90K-277-2	Resistant	Thailand	Breeding
12	TVu 1453	Resistant	IITA	Screening
13	IT82E-16	Resistant	IITA	Screening
14	BOSADP	Not Available	Local	Not Available
15	IT97K-499-35	Resistant	IITA	Screening
16	TVX-3236	Susceptible	IITA	Screening
17	IT98K-131-2	Resistant	IITA	Screening
18	IT98K-1092-1	Resistant	IITA	Screening
19	IAR-48	Susceptible	IAR	Screening
20	TVu 4539	Not Available	IITA	Not Available
21	TVu 4540	Not Available	IITA	Not Available
22	TVu 6699	Not Available	IITA	Not Available
23	Ifebrown	Not Available	OAU	Not Available
24	TVu 57	Not Available	IITA	Not Available
25	TVu 134	Not Available	IITA	Not Available
26	TVu 157	Not Available	IITA	Not Available
27	TVu 231-2	Not Available	IITA	Not Available
28	IT82E-18	Not Available	IITA	Not Available
29	IT98K-1263	Not Available	IITA	Not Available
30	TVu 1000	Not Available	IITA	Not Available
31	TVu 16514	Not Available	IITA	Not Available
32	Golam white	Resistant	Land race	Screening
33	UAM 1046-6-1	Not Available	UAM	Not Available
34	UAM 1051-1	Not Available	UAM	Not Available
35	UAM 1055-6	Not Available	UAM	Not Available
36	UAM 1046-6-2	Not Available	UAM	Not Available
37	UAM 1056-2	Not Available	UAM	Not Available
38	IT98K-573-1-1	Resistant	IITA	Screening
39	IT98K-573-2-1	Resistant	IITA	Screening
40	IT89KD-391	Not Available	IITA	Screening
41	Aloka local	Susceptible	IITA	Screening
42	Kanannado	Susceptible	Land race	Screening
43	Danila	Resistant	IITA	Screening
44	TVu 1092	Not Available		Not Available
45	TVNu 1158	Resistant	IITA	Screening
46	TVu 109-1	Not Available	IITA	Screening
47	IT93K-503-1	Not Available	IITA	Not Available
48	SARC-1-57-2	Resistant	Ghana	Screening
49	IT90K-59	Resistant	Thailand	Breeding
50	Sierraleone 1	Not Available		Not Available
51	Sierraleone 2	Not Available		Not Available
52	Kano local	Not Available		Not Available
53	TVu 3000	Resistant	IITA	Screening
54	TVu 36	Resistant	IITA	Screening
55	TVu 62	Resistant	IITA	Screening
56	TVu 408	Resistant	IITA	Screening
57	TVu 410	Resistant	IITA	Screening
58	TVu 801	Resistant	IITA	Screening
59	TVu 2896	Resistant	IITA	Screening
60	Tvu 2027	Not Available		Not Available

2.2. Experimental Site

The experiment was conducted at the College of Agronomy Teaching and Research Farm of the Federal University of Agriculture Makurdi, located between latitude 7.41^0 and 7.39^0N; longitude 8.28^0 and 8.25^0E, and 97m above sea level.

2.3. Aphid Culture

Cowpea aphids used for infestation were obtained from farmer's cowpea field in Makurdi. The aphids were cultured and maintained on TVx 3236 – a susceptible variety in an insect proof cage.

2.4. Procedure for Phenotypic Screening of Cowpea Germplasm

Phenotypic screening was conducted in the screen house using wooden trays (57.5cm X 37.5cm X 14.5cm) placed in insect-proof cages made with fine mesh, to allow passage of air but prevents insect from moving out. A Completely Randomized Design (CRD) with two replications was used for the study. Seeds of all 60 (sixty) cowpea genotype were sown in wooden trays filled with top soil. Two (2) wooden trays were properly arranged into each insect proof cage, and each tray contained 5 rows (one row per genotype); of which each row consisted of seven (7) plants of the same genotype. Irrigation of plants was carried out as at when necessary. Five apterous adult aphids at 4^{th} instar stage were released on each plant at 10 days after sowing using a soft camel's hair brush to reduce mechanical injury on the insect as described by [27].

2.5. Data Collection

Cowpea genotype screening for aphid resistance were visually observed to score genotypes as resistant/susceptible using a scale of 1-5 modified from [27] (Table 4). Visual damage rating was used to score for Population pressure at 3, 6, 9 and 12 days after infestation. Total plant damage score was taken at 15 days after infestation.

The number of dead plants was recorded at 7, 9, 11, 13 days after infestation and at the end of the experiment (15 days after infestation). Dead plants were also considered to be susceptible. Plants with first trifoliate leaves developing were considered alive and classified as resistant.

Table 2. Aphid scoring scale for insect colony and Visual Plant Damage Rating.

Score	Description	Reactions
1	Few individual aphids (<20 aphids); no symptom of attack.	Resistant
2	Few small individual colonies (21-50 aphids); plant showing little symptom (seedling slightly stunted).	Moderately Resistant
3	Several small colonies (51-100 aphids); Plant showing symptoms of attack (seedling slightly stunted with slight yellowing of older leaves); No seedling damage.	Moderately Resistant
4	Large individual colonies (101-500 aphids); Plant showing weak stem, leaves and seedling damage (seedling moderately stunted with yellowing of older leaves and curling of young leaves).	Moderately Susceptible
5	Large continuous colonies (>500 aphids). Severely stunted seedling with severely curled and yellow leaves, stem and leaves covered with soothy mould or dead seedling.	Highly Susceptible

Source [27]

Healthy/non-infested plants were considered resistant and given a scored '1'. Moderately healthy plants were considered intermediate and scored '2' and '3'. Infested plant were considered susceptible with a score of '4', and plants with a score of '5' was considered highly susceptible to aphids (highly infested). Plant Resistance was evaluated by measuring differences in aphid population, number of dead plants and visual damages on the genotypes according to [27, 28].

2.6. Data Analysis

Data was subjected to analysis of variance (ANOVA) using the Statistical Analysis System (SAS) version 9.4 to determine the significant differences among cowpea genotypes for reaction to aphids infestation. The Least significant difference (LSD) test at 1 and 5% probability was used to separate treatment means. The result of phenotypic screening for resistance to cowpea aphids was used to identify aphid resistant cowpea genotypes.

2.7. Development of Segregating Population

The result of screening cowpea genotypes for resistance/susceptibility to aphids infestation identified two genetically diverse parents that showed clear contrast for aphid resistance and susceptibility, and thus were selected for crossing to generate populations for inheritance studies. Resistant variety (TVu-2876) was crossed with the susceptible variety (Aloka local) while TVNu-1158 (Resistant variety) was crossed with Keffi Local (Susceptible variety) by hand emasculation as described by [29] in order to raise F_1 seeds. Some of the F_1 seeds were advanced to F_2 by selfing, while some were used in a backcross breeding procedure to raise BC_1F_1 population.

Poor seed germination was observed in TVNu-1158 which nictitated the use of 'TVu-2876 x Aloka local' cross combination for this study.

2.8. Screening of F_1 and F_2 Populations

The parents, F_1 and F_2 segregating populations were screened for aphid resistance following the same procedure described above to elucidate the nature of aphid resistance in cowpea.

Segregation data collected from Phenotyping for aphid resistance in the parents, F_1 and F_2 was subjected to chi-square (χ^2) analysis at 5% level of probability to test for goodness-of-fit to known genetic ratio. Chi-square (χ^2) was calculated by the following formula;

$$x^2 = \sum \frac{(O_i - E_i)^2}{E_i}$$

Where; O_i = Observed frequencies and

E_i = Expected frequencies

This information was useful in elucidating gene action and mode of inheritance of aphid resistance gene in cowpea.

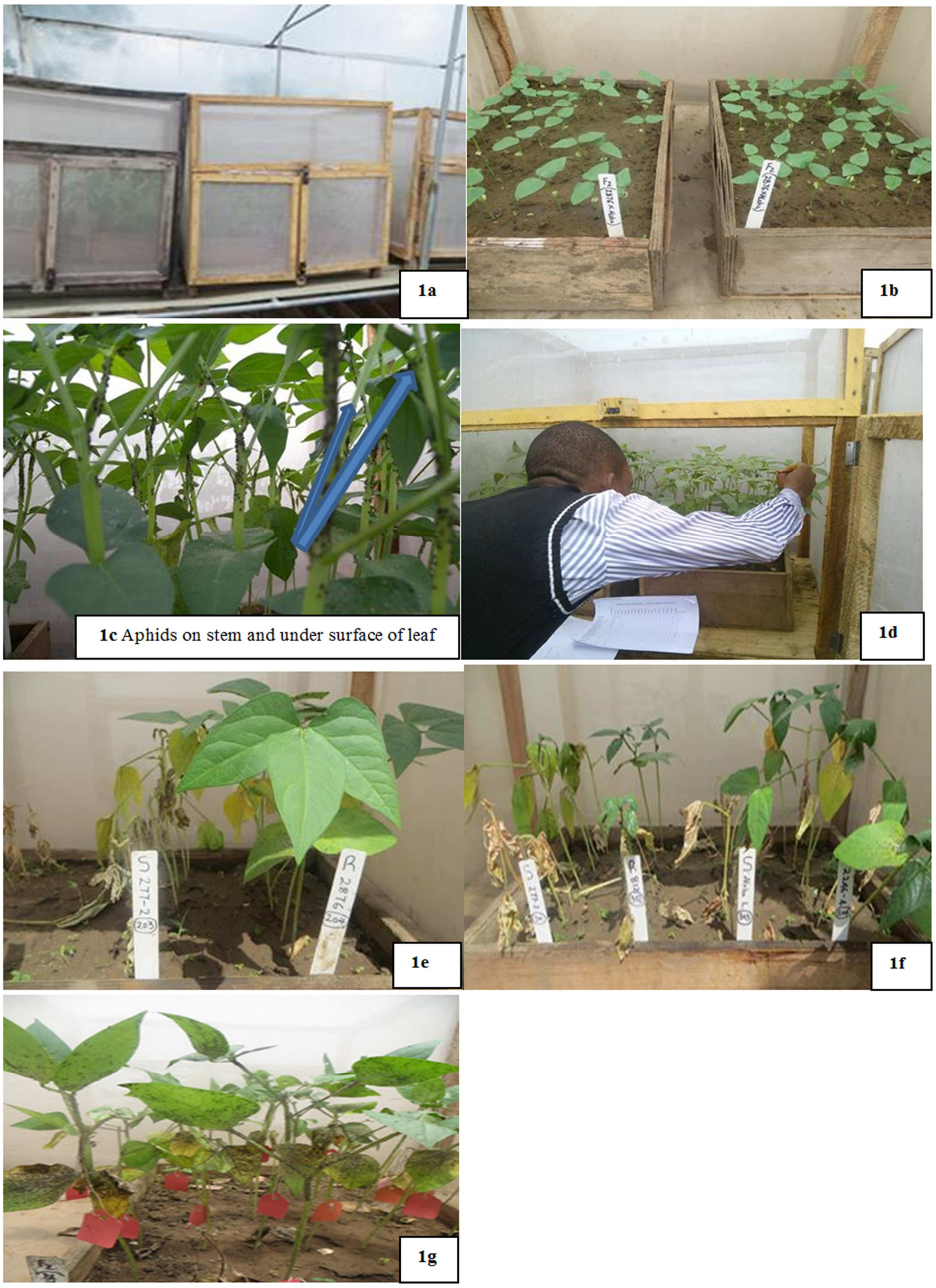

Figure 1. Insect proof cages and various stages of screening procedure.

a: aphid screen house..
b: cowpea plant sown in boxes place in insect-proof cages.
c: aphid build-up on stem and leaf of cowpea plant after infestation.
d: data collection on infested plants.
e and f: differential reaction of resistant and susceptible genotypes to aphid infestation.
g: F_2 (Aloka local X Tvu-2876) lines resistant to cowpea aphids

3. Results

3.1. Phenotypic Screening

Young and adult cowpea aphids were found to feed on the cowpea plant by sucking plant sap and causing serious damage to the overall plant vigour. Noticeable among the plant damage caused by the insect included, distortion of leaf and stunting of plant. Chlorosis of primary leaves and the appearance of sooty moulds were the resultant effect of honey dew secretion produced by the insect. Aphid population build-up at cowpea seedling stage was observed in many of the genotypes evaluated for resistance to the cowpea aphids.

The result of the analysis of variance (Table 3) shows that significant differences (P≤0.05) among cowpea genotypes was observed for population pressure scored at twelve (12) days after infestation (DAI), plant damage, number of dead plants at 13 DAI and for number of dead plants at end of experiment. However, differences in population pressure at 3 DAI, population pressure at 6 DAI, population pressure at 9 DAI, number of dead plants at 7 DAI, number of dead plants at 11 DAI was not significant as genotypic differences did not account for any differential response to cowpea aphid infestation for these parameters.

Although, the rate of aphid multiplication in the evaluated genotypes at the early stage after infestation (within 3 to 9 days after infestation) did not differ significantly, the response of genotypes to aphid infestation as indicated by significant difference in aphid population pressure at 12DAI suggests an increase in reproduction rate (Fecundity) on susceptible varieties. Increase fecundity was observed to be highest on Keffi Local with a recorded mean population pressure score of 5 and lowest on TVNu-1158 with a mean score of 2 as shown in table 4.

Phenotypic screening of cowpea genotypes revealed that the genotypes evaluated differed significantly in the number of dead plants recorded at end of experiment (Table 4). The highest mean number of dead plants (5) was recorded for Keffi local which differed in response to aphid infestation from resistant genotypes (TVu-2876, IT84S-2246-4, TVNu-1158 and IT82D-812) with a mean number of dead plants of one (1) plant at the end of experiment.

Table 3. Mean Squares from Analysis of Variance for cowpea reaction to aphids.

SOV	df	PP3DAI	PP6DAI	PP9DAI	PP12DAI	PTDMG	NDP7DAI	NDP9DAI	NDP11DAI	NDP13DAI	NDPTMN
Variety (V)	59	0.201ns	0.479ns	0.667ns	0.961**	1.314**	0.010ns	0.011ns	0.143ns	2.167*	5.124**
Year (Y)	1	39.609**	38.400**	33.004**	0.017ns	0.759ns	0.017ns	0.026ns	0.759*	26.334**	109.350**
V*Y	59	0.226ns	0.411ns	0.417ns	0.394ns	0.314ns	0.010ns	0.011ns	0.143ns	1.540ns	2.589ns
Error	120	0.174	0.504	0.433	0.475	0.468	0.010	0.011	0.132	1.314	2.927

* = Significant at P ≤ 0.05. ** = Highly significant at P ≤ 0.05. ns = Not significant at P ≤ 0.05. PP3DAI = Population pressure three days after planting. PP6DAI = Population pressure six days after planting. PP9DAI = Population pressure nine days after planting. PP12DAI = Population pressure twelve days after planting. PTDMG = Plant damage. NDP7DAI = Number of dead plants seven days after infestation. NDP9DAI = Number of dead plants nine days after infestation. NDP11DAI = Number of dead plants eleven days after infestation. NDP13DAI = Number of dead plants thirteen days after infestation. NDPTMN = Number of dead plants at termination (15 days after infestation).

Table 4. Mean performance of Selected Genotypes for Resistance and Susceptibility to Aphids.

Variety	Population Pressure 12Days After Infestation	Number of Dead plants	Percentage survival (%)	Mean plant damage	Reaction to Cowpea aphids
TVNu 1158	2	1	88	1	Resistant
IT82D-812	3	1	87	3	Resistant
TVu 2876	3	1	91	2	Resistant
IT84S-2246-4	4	1	91	4	Tolerant
Aloka local	4	2	65	4	Susceptible
TVu 4539	4	3	51	5	Susceptible
IT90K-277-2	4	2	70	5	Susceptible
Keffi local	5	5	21	5	Susceptible
Mean	4	1.081		4.098	

Among the sixty (60) cowpea genotypes evaluated, 2 (two) genotypes TVu-2876 and TVNu-1158, expressed high resistance to cowpea aphid by showing less damage with plant damage score of 2 and 1 respectively. Hence, these varieties can be considered as moderately resistant to the cowpea aphids. IT82D-812 and IT84S-2246-4 recorded mean plant damage scores of and 3 and 4 respectively. Keffi Local variety recorded the greatest plant damage caused by the activity of cowpea aphid, with a damage score of 5.0. Hence the variety is considered to be highly susceptible to cowpea aphid (Table 4).

Parental genotypes were identified in this study as resistant and susceptible to cowpea aphid, based on the result of screening (Table 4).

3.2. Segregation of F_2 (Aloka Local X TVu-2876) Population

Table 5 shows the segregation of F_2 plants derived from the cross between Aloka Local and TVu-2876. With respect to cowpea aphid resistance, the number of resistant individuals was 168 while 59 individuals were identified as susceptible. The χ^2analysis for goodness-of-fit shows that the inheritance pattern closely fits the 3:1 genetic ratio. This therefore indicates that resistance to cowpea aphids in TVu-2876 is governed by a single dominant gene.

Table 5. Chi-square (χ^2) Analysis of Segregation in the F_2 Generation of Single Cross between Aloka Local and Tvu-2876.

Cross	N	R	S	Genetic Ratio	Calculated χ^2 value	Critical χ^2 value (P<0.05)
TVu-2876	12	12	0			
Aloka Local	12	0	12			
F_1	20	20	0	1:0		
F_2	227	168	59	3:1	0.09	3.841

N = Total number of plants screened. R = Number of resistant Plants after screening. S = Number of susceptible plants after screening.

4. Discussion

The process of breeding for resistance to insect pests involves understanding and manipulating two genetic systems (one for host and the other for the pest) not independently, but with regard to the interaction between the two systems. To ensure that plant resistance is genetically controlled, infestation was carried out at the early seedling stage of plant development. Five apterous adult aphids at 4^{th} instar stage were released on each plant at 10 days after planting. This study presents a different time of infestation from the works of [30]. In his study on the inheritance of aphid resistant gene in IT82E-16 variety, infestation was carried out at four (4) weeks after planting. Infestation at cowpea seedling stage is advantageous in identifying genetically controlled resistance and not as a result of resistance due to plant structure. Also, because cowpea aphids are present on cowpea fields at the early stage of plant growth, it is important to screen cowpea for aphid resistance at the seedling growth stage. Resistance and susceptibility to cowpea aphid in cowpea was determined by the population pressure (aphid colony), the number of dead plants and the level of plant damage caused by the activities of cowpea aphid. The success of evaluating plant materials against insect pest using insect-proof cages made with fine mesh as described by [27, 31] was also demonstrated in this study as resistant and susceptible genotypes were clearly distinguished.

The result of screening reveals novel genetic sources of resistant gene to cowpea aphids as genotype showed significant differences in population pressure at 12 DAI, number of dead plants at end of experiment and the total plant damage score. Increased population pressure, high plant damage, and greater number of dead plants resulting from the feeding and reproductive activities of cowpea aphids were evident reactions of susceptible genotypes. The ability of these parameters to clearly differentiate between resistant and susceptible genotypes shows their possibility for use in identifying significant differences in cowpea reactions to aphids.

Aphid population pressure score of two (2), three (3) and three (3) was observed for cowpea aphid resistant varieties TVNu-1158, TVu-2876 and IT82D-812 respectively. Worthy of note is the fact that aphid build up was observed for all genotypes as population pressure at 3days, 6days and 9 days after infestation showed no significant difference. This suggests that plant resistance if present, are unable to prevent reproduction at the very early seedling stage of plant growth. This report is confirmed by the study of Aliyu and Ishiyaku [32] who reported aphid infestation on all eight (8) varieties evaluated for resistance to aphids. However, population pressure at 12 DAI was observed to be significant different. This variation may be attributed to the ability of the plant to incite the production of plant chemicals in response to aphid attack. This phenomenon is generally referred to as hypersensitive reaction.

Evidence of susceptibility characterized by stunted growth, increased secretion of honey dew, was prevalent on IT90K-277-2, TVu-4539, Aloka local and Keffi local. Thus resulting in an early yellowing of older leaves and complete plant damage.

Varieties resistant to cowpea aphids identified by this study showed high percentage survival ranging from 80% – 91% and lower mean plant damage score of 1, 2 and 3 in TVu-1158, TVu-2876, and IT82D-812 respectively. These varieties identified as resistant to the cowpea aphids can be used as potential sources of aphid resistant genes in breeding to improve locally adapted cultivars susceptible to the cowpea aphids.

Chi-square (χ^2) analysis of the segregation of F_2 individuals bred from a single cross of Aloka Local and TVu-2876 varieties showed that the inheritance pattern fits the 3:1 genetic ratio as no significant difference exist between the observed and the expected frequencies. This clearly indicates that the resistance to cowpea aphid present in TVu-2876 is monogenically inherited as a dominant gene. A similar finding of a single dominant gene was reported for the resistance to cowpea aphid present in IT82E-16 [26]. A single dominant gene was also found to control resistance to the sorghum aphid [33]. The resistance observed in all F_1 progenies evaluated for resistance to *Aphid craccivora* further confirms the pattern of inheritance and gene action of resistance gene present in the aphid resistant cowpea genotype TVu-2876. Earlier studies [34, 35] also reported resistance to *aphis craccivora* to be controlled by a single dominant gene and further proposed a symbol called the *Rac1* gene. In a similar study, [36] proposed a single dominant gene *Rac2* to also control resistance to aphids, and suggested no linkage between *Rac1*and *Rac2*.

5. Conclusion

Cowpea genotypes screened for resistance/susceptibility to *Aphis craccivora* showed differential reactions. The new sources of cowpea aphid resistance identified in this study have provided the opportunity for introgression of aphid resistance gene into adapted cowpea cultivars. This will be useful in the control of the pest through the use of host plant resistance. The resistance observed in cowpea genotype TVu-2876 was found to be controlled by a single dominant gene, thus suggesting that the introgression of this gene is possible though backcross breeding method.

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