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SCREENING FOR DEVELOPMENT OF HOST PLANT RESISTANCE TO INFESTATION BY APHID (*APHIS CRACCIVORA* KOCH) IN COWPEA (*VIGNA UNGUICULATA* [L] WALP)

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ABSTRACT
A study was carried out at International Institute of Tropical Agriculture (IITA) Kano station during 2009 and 2010 growing season, to screen fifty two (52) cowpea varieties for resistance to aphids (Aphis craccivora) attack. It was found that only seven (7) varieties were highly resistant, nine (9) were highly susceptible and the remaining thirty six (36) varieties were neither resistant nor susceptible (intermediate) to aphids attack. Five (5) varieties were selected from the two extremes for multiple crosses to raise F_1 , backcrosses and F_2 populations in which three (3) varieties including Danila, IT98K-131-2 and IT98K-1092-1 were among highly resistant and two (2) varieties including Aloka L and IT98K-1263 were among the highly susceptible varieties, Nine (9) progenies were obtained for F_1 generation from which only five (5) were found to be resistant to aphids attacks while four (4) were susceptible, Out of the nine (9) backcross populations, six (6) progenies were found to be resistant while the remaining three (3) were susceptible. From the nine (9) F_2 progeny obtained, six (6) were also found to be resistant while three (3) were susceptible. The investigation revealed that crossing susceptible with resistant varieties of cowpea yields progenies that are highly resistant. This is an indication that the gene for resistance is highly heritable.
Keywords: Cowpea, resistance, susceptible, progenies

INTRODUCTION

Cowpea (*Vigna unguiculata* [L] WALP) is an important food legume and a versatile crop cultivated between 35^0 N to 30^0 S of the equator, covering Asia and Africa, southern Europe and some parts of southern America (Bata *et al.,* 1987). However, being a drought tolerant crop with better growth in warm climate, cowpea is most popular in the semi arid region of the tropics, where other food legumes do not perform very well. It has the unique ability to fix nitrogen even in a very poor soil (pH range 4.5-9.0) organic matter <0.2%, which make it compatible as an inter crop with a number of cereals and root crops. Cowpea also has quick growth and rapid ground cover which make it an essential component of sustainable agriculture in drier regions of the tropics, where rainfall is scanty and soils are sandy with little organic matter (Rachie, 1989).

One of the most important factors that constitute a serious set back in the cultivation of cowpea all over the world is insect pests. In Africa, insect pests are often responsible for 100 percent losses of cowpea yields and if not controlled, they limit the yields to less than 300kg/ha (Singh *et al*., 1990). A considerable progress has been made during the past decade in cowpea breeding and a range of varieties have been developed with resistance to several diseases, insect pests and parasitic weeds. Much time has been spent to conduct research on host plant resistance(HPR) to insect pests especially aphids. Aphids are among the pests of cowpea and they damage young cowpea seedlings by sucking sap from the young leaves and stem tissues and some time act as vectors in the transmission of cowpea aphids-borne mosaic virus. (Kitch *et al*., 1999).

Aphids primarily infest seedlings, although large populations also infest the pods, they cause direct damage to the plants by removal of its sap, small population may have little impact on the plant, but large population can cause distortion of leaves, stunting of plant and poor nodulation of the root system. Yield is reduced and in extreme cases the whole plant dies. Methodologies have been developed to screen germplasm and breeding lines, the product of this screening provides the building blocks for the development of resistant varieties to insect pests (Singh *et al.,* 1996). The present study was undertaken to evaluate some selected varieties of cowpea for resistance to aphid's infestation with a view to developing a breeding programme for resistance to attack by the pest.

MATERIALS AND METHOD

Experimental site:
The study was conducted in the screen house of the International Institute of Tropical Agriculture (IITA) Kano station, Nigeria located between latitude 12^003^1N and longitude 8^034^1E and altitude 486.5m. Fifty two (52) varieties of cowpea comprising fifty (50) improved and two (2) local varieties including Danila and Aloka were screened during the study period.

Experimental design

The cowpea varieties screened were planted in wooden trays measuring 54x40x11cm filled with sterilized sandy loam soil up to 8cm using completely randomized design (CRD). The seeds were planted in single rows, comprising six rows per tray spaced 9cm apart, while the distance between stands was 4cm, a row of local variety (Aloka) was planted at the center to serve as a susceptible check row.

Aphid's culture was produce by planting highly susceptible cowpea variety (Aloka) in pots and placed in well ventilated wooden cages. A number of aphids were collected from infested cowpea plants from the field using camel's air brush to reduce mechanical injury to the aphids and placed on the young growing Aloka seedlings and allowed to multiply for two (2) weeks from where 5th instar aphids were collected for subsequent infestation.

Each plant was infested artificially with four 5th instars aphids when the seedlings were 10days old. aphids were transferred using camel's hair brush to reduce mechanical injury to the aphids. The trays were then placed in cages (wooden framed cages covered with saran mesh) and kept in the screen house. Two trays were placed in each cage measuring 140 x81 x66cm. Precautions were observed prior to placing the infested trays into the cages. This involved among others the eradication of all organisms which were likely to feed on the aphids such as spiders.

Screening and identification of infested varieties

Fifteen days after infestation the plants were screened to identify infested and non infested varieties using a scale of 1-5 (Singh *et al.,* 1996). Where 1 and 2, were looking healthy and considered to be resistant, 3 were moderately healthy and considered intermediate, while 4 and 5, are the ones that are highly infested and considered to be susceptible to aphids.

This screening was carried out between March and April, 2009 and was repeated three times in succession from which the varieties from two extremes (i.e. highly resistant and highly susceptible) were selected for subsequent hybridization experiment (Table 2). The selection was done based on similarities and ancestral origin among the varieties. The varieties selected were believed to have the same parental origin which was an added advantage for successful crosses.

Breeding and development of new varieties

The selected resistant and susceptible varieties were then planted in pots and allowed to grow up to flowering stage in the screen house, each variety was planted in three (3) pots and each pot was left with three (3) growing seedling after thinning, one resistant variety was crossed with one susceptible variety and the F_1 seeds were collected and kept in a labeled envelope. Seeds obtained from the crosses (F_1 seeds) were planted along with parental varieties and crosses were made between them to obtain backcross seeds while F_2 seeds were obtained by allowing F_1 to self pollinate. The F_1, backcross and F_2 populations were raised in the screen house and evaluated for resistance to aphids infestation using the procedure described earlier. The plants were rated accordingly.

RESULTS AND DISCUSSION

The screening of fifty two (52) varieties of cowpea (*V. unguiculata*) for resistance to aphid (*A. craccivora*) infestation revealed that seven (7) varieties were highly resistant (Table 1). There were no symptoms of damage and very few aphids were seen on the seedlings. According to Hill and Walter (1982) resistance to pest attack is characterized by a lower pest population density or fewer damage symptoms on the resistant plants.

The highly susceptible varieties on the extreme were found to be nine (9) in number (Table 1). The seedlings of these varieties were found to be highly infested by the aphids, almost covering the whole plants, including the stems, buds and leaves. The aphids preferred to infest these varieties probably due to their succulence nature and easy penetration when sucking the non-toxic substances in the plant juice (sap) or the plant juice has taste which is preferable to the aphids.

The moderately susceptible varieties offered very little resistance to the aphid's infestation. Possibly they acquired some of the qualities which enabled them to offer such little resistance e.g. starting to develop toxic substances in the juice. Similarly, the moderately resistant varieties might have lost some of the qualities for resistance, hence they cannot offer complete resistance to the aphids attack. (Kumar, 1999)

In this study five cowpea varieties were selected for multiple crosses comprising three varieties were highly resistant, and two varieties that were highly susceptible to aphids attack. Basically hybridization has always been bi-parental, but bi-parental crosses are too restrictive to permit rapid improvement of selfing species like cowpea especially in crop resistance and this can be overcomes by the use of multiple crosses which involve many parents to be crossed in successive generation (Smithson *et a.,*/ 1980).

F_1 generation Cross

Cowpea is generally easier to cross than any other legumes (IITA, 2005); this is because cowpea flowers are large and easy to manipulate. With a few floral nodes per receme, this helps to lower the rate of abortion in cowpea and 8-12 seeds are usually produced per each cross. The findings of this study agree with the above statement in which 6-14 seeds were produced per each cross with exception of crosses involving IT98K-1263 when used as female stock.

Rachie (1989) reported that when some varieties of cowpea are used as female stock during breeding the crosses are 100% unsuccessful. Bukar and N'tari (2000) has traced the parental progeny of IT98K-1263 and found it to be among such varieties.

Response of F_1 progenies to aphids infestation indicated that resistant progenies were produced when Aloka local (highly susceptible variety) was used in both forward and reciprocal crosses except when crossed with IT98K-1092-1, where susceptibility to aphids remains. Danila local (highly resistant) showed a promising response of being highly resistant in F_1 progenies when crossed with both two highly susceptible varieties in both forward and reciprocal crosses as showed in Table 3.

Crosses between IT98K-131-2 and Aloka showed a mixed response in F_1 progeny, in which progenies of the forward crosses were found to be highly resistant, while the reciprocal crosses were highly susceptible to aphids infestation. This may be due to certain hybridization problem where the resistance factor was not properly transferred to the progeny. IT98K-1263 (highly susceptible) when crossed with Danila and IT98K-131-2 (both resistant varieties) were found to be resistant in the forward crosses except with IT98K-1092-1 where susceptibility persist, as reciprocal crosses were not successful. Crosses between IT98K-1092-1 (highly susceptible) are both two susceptible varieties (i.e. Aloka and IT98K-1263) showed no positive response as the resulting F_1 progenies were susceptible to aphids infestation.

Backcrosses

Backcross is a form of recurrent hybridization by which a superior character is added to a desirable variety (IITA, 1994). The advantage of backcrosses is that high level of homozygosity can be obtained in a very short time. Table 4 shows that out of nine (9) successful backcrosses between resistant and susceptible varieties, six (6) were found to be highly resistant, while the remaining three (3) were susceptible. Backcrosses procedure can easily be carried out if the character intends to transfer are simply inherited and were dominant (Singh 1998). Response of backcrossed progenies to aphids infestation (Table 4) shows that all F_1 progenies whether resistant or susceptible when backcrossed with resistant parents became highly resistant to aphids, except the F_1 progeny of IT98K-1263 x IT98K-1092-1 when backcrossed with IT98K-1092-1 which maintained its susceptibility. But when the F_1 progenies were backcrossed with the two susceptible parents, the resulting progenies showed a mixed responses; some became resistant as in the case of (Danila x Aloka) x Aloka, while some were susceptible as in the case of (IT98K-131-2 x Aloka) x Aloka, and (IT98K-1092-1 x Aloka) x Aloka. This may be due to high level of susceptibility to aphid's infestation by the susceptible parents. The present finding is in conformity with that of Rachie (1989).

Selfing for F_2 generation

The F_2 is the first opportunity for selection and identification of either homozygous or heterozygous character especially the character responsible for resistance or susceptibility to a particular pests or diseases because it is controlled by a single gene (IITA, 2005). The number of seeds obtained during F_2 generation crosses is higher than those in the other crosses as crosses are natural and self controlled. For their response to aphids infestation, it tallies with that of their F_1 parental progenies, were all progenies produced when aloka was used in both forward and reciprocal crosses were found to be resistant to aphids attacks, except when aloka was crossed with IT98K-1092-1(Table 5). This shows that a breeding programme could be developed between Aloka variety (susceptible) and two resistant varieties (Danila and IT98K-131-2) to produce highly resistant progenies in F_1, backcrosses and F_2 populations.

Table 1: Rating for Aphids Infestation among Cowpea Varieties Screened

Rating category	Number of varieties
I	7
II	10
III	8
IV	19
V	9
TOTAL	52

Table 2: Selected Varieties for Crosses

Highly Resistant	Highly susceptible
DAN' ILA	ALOKA LOCAL
IT98K– 131 – 2	IT98K – 1263
IT98K–1092– 1	

Table 3: Response of F_1 Progenies to Aphids Infestation

CROSSES (F_1progeny)	INFERENCE
Danila x Aloka	RESISTANT
Aloka x Danila	RESISTANT
IT98K-131-2 x Aloka	RESISTANT
Aloka x IT98K-131-2	SUSCEPTIBLE
IT98K-1092-1 x Aloka	SUSCEPTIBLE
Aloka x IT98K-1092-1	INTERMEDIATE
IT98K-1263 x Danila	RESISTANT
IT98K-1263 x IT98K-131-2	RESISTANT
IT98K-1263 x IT98K-1092-1	SUSCEPTIBLE

Table 4: Response of Backcross Progenies to Aphids Infestation

BACKCROSS PROGENIES	INFERENCE
(Danila x Aloka)x Aloka	RESISTANT
(Danila x Aloka) x Danila	RESISTANT
(IT98K-131-2 x Aloka)x Aloka	SUSCEPTIBLE
(IT98K-131-2 x Aloka) x IT98K-131-2	RESISTANT
(IT98K-1092-1 x Aloka)x Aloka	SUSCEPTIBLE
(IT98K-1092-1 x Aloka)xIT98K-1092-1	RESISTANT
(IT98K-1263 x Danila) x Danila	RESISTANT
(IT98K-1263xIT98K-131-2)xIT98K-131-2	RESISTANT
(IT98K-1263xIT98K-1092-1)xIT98K-1092-1	SUSCEPTABLE

Table 5: Response of F_2 Progenies to Aphids Infestation

CROSSES	INFERENCE
Danila x Aloka	RESISTANT
Aloka x Danila	RESISTANT
IT98K-131-2 x Aloka	RESISTANT
Aloka x IT98K-131-2	RESISTANT
IT98K-1092-1 x Aloka	INTERMEDIATE
Aloka x IT98K-1092-1	SUSCEPTIBLE
IT98K-1263 x Danila	RESISTANT
IT98K-1263 x IT98K-131-2	RESISTANT
IT98K-1263 x IT98K-1092-1	SUSCEPTIBLE

CONCLUSION

This study revealed that out of fifty two (52) varieties of cowpea screened against aphids infestation only seven (7) were found to be highly resistant, while twenty eight (28) were susceptible and the remaining seventeen (17) were neither resistant nor susceptible (intermediate). This shows that a breeding programme could be developed by using Aloka variety (susceptible) and two resistant varieties (i.e. Danila and IT98K-131-2) to produce highly resistant progenies in both F_1, backcrosses and F_2. From the present study, it can be concluded that when susceptible varieties are crossed with resistant ones the resulting progeny will certainly become resistant to aphids infestation indicating that the susceptible variety have consequently acquired the gene for resistance against aphids attacks and that the gene for resistant is highly heritable.

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