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By

Nwosu D. J.
Aladele S.
Adeosun J. O.
Nwadike C.
Awa E. N.

Research Article

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***[1]Nwosu D. J., [2]Aladele S., [3]Adeosun J. O., [4]Nwadike C and [5]Awa E. N.**

[1]Plant Genetic Resources Unit, National Centre for Genetic Resources and Biotechnology (NACGRAB), Moor Plantation, Ibadan-Nigeria.
[2]Plant Genetic Resources Unit, National Centre for Genetic Resources and Biotechnology (NACGRAB), Moor Plantation, Ibadan-Nigeria.
[3]School of Agriculture, Abubakar Tatari Ali Polytechnic, Bauchi-Nigeria.
[4]Forestry Research Institute of Nigeria, Federal college of Forestry, Jos P.M.B 2019. Jos-Plateau State. Nigeria.
[5]Faculty of Plant Science and Biotechnology, University of Port Harcourt, Port Harcourt, Rivers State-Nigeria.

Emails and Phones: [2] sundayaladele@yahoomail.com: +234038074937, [3]adeosun_oluwole@yahoo.com +2348036123415, [4]chrisnwadike@ymail.com : +234035369835, [5]lizzy_uchyl83@yahoo.com: +2348034148672

*Corresponding Author's Email:[1]olaraich75@yahoomail.com: phone: +234069739901

Abstract

A hybridization programme that potentially exploits the variability existing in the wild African germplasm of *V. unguiculata* and cultivated cowpea was performed. Four cultivated cowpea (Achi shuru, Ife Brown, Kanannado and Zebra bean) were crossed to their wild relative subsp. *unguiculata* var. *spontanea* to ascertain their cross compatibility, reproductive potential and possible heterosis in the F_1 generations. Results show that the cultivated varieties hybridized relatively well with their wild relative with pod set of 40.8% to 46.7%. F_1 hybrid plants also showed high heterosis in plant height and number of leaves and produced viable seeds. These results are indications of a good reproductive potential of the hybrids suggesting that the wild relative could be used in hybridization programmes for improvement of cultivated populations.

Keywords: Cowpea, F_1 hybrids, Cross-compatibility, *Spontanea*, Wild.

Introduction

Cowpea (*Vigna unguiculata* L. Walp), is one of the most important pulse crops native to central Africa, it belongs to family Fabaceae. Cowpea is called vegetable meat due to high amount of protein in grain with better biological value on dry weight basis. On dry weight basis, Cowpea grain contains 23.4 per cent Protein, 1.8 per cent Fat and 60.3 per cent Carbohydrates and it is a rich source of Calcium and Iron (Gupta, 1988). Cowpea plays a critical role in the lives of millions of people in Africa and other parts of the developing world, where it is a major source of dietary protein that nutritionally complements staple low-protein cereal and tuber crops, and is a valuable and dependable commodity that produces income for farmers and traders (Singh, 2002; Langyintuo *et al*., 2003). Cowpea is a valuable component of farming systems in many areas because of its ability to restore soil fertility for succeeding cereal crops grown in rotation with it (Carsky, *et al*., 2002; Tarawali, *et al*., 2002; Sanginga *et al*., 2003).

Cowpea is native to West Africa and wild and weedy forms exist in many parts of the region (Faris, 1965; Rawal, 1975, Ng and Marechal, 1985). Wild relatives of crop species are often sources of genes for disease and insect resistance, increased yield, improved product quality, earliness and wide adaptation (Leppik, 1970, Stalker, 1989). Wild forms and closely related species of cowpea, therefore, have great potential as an additional source of useful germplasm for cowpea improvement (Baudoin and Marechal, 1985; Padulosi and Ng, 1990).

In addition to their use in breeding, crop wild relatives are also used in their wild state. A number of wild cowpea species (*Vigna* spp.) in Africa contribute directly to food security through consumption of their tubers, fruits and seeds (www.biodiveersityinternational.org). Crop Wild Relatives (CWR), are important for maintaining genetic diversity and preventing loss of germplasms due to genetic vulnerability. The crossing programme presented here, exploits the variability existing in the wild African germplasm of *V. unguiculata* and cultivated cowpea.

The first crossings between crop wild relatives and cultivars to obtain disease resistant varieties dates back to the 1890's, (www.biodiveersityinternational.org) with pest and disease resistance currently remaining the highest priority for breeders and CWR being used primarily for this purpose. Several reports (Ng and Marechal, 1985; Baudoin and Marechal, 1985; Ng, 1990; Fatokun and Singh, 2001) have shown that wild and the weedy subspecies of *Vigna* hybridize easily with the cultivated forms and produce viable hybrids. However, Rawal et al. (1976) reported unsuccessful attempts to use wild forms of cowpea as female parents in crosses. F_1 hybrids are also known to have a degree of vigour over the parent genotypes. But according to (Rawal *et al.*, 1976), the wild form could only be used as the male parent and attempts to use it as the female parent was unsuccessful. Pasquet, (1999) reported that the wild cowpea *Vigna unguiculata* subsp. *unguiculata* var. *spontanea* is likely progenitor of cultivated cowpea. In order to utilise wild relatives of cowpea effectively for cultivar improvement, their cross compatibility and reproductive potential need to be ascertained. The objectives of this study, therefore, were to determine the cross compatibility between cultivated cowpea and wild, var. *spontanea*; to ascertain the reproductive potential and heterosis of the F_1 hybrids from these crosses.

Materials and Method

Six cowpea lines, consisting of four cultivated and two wild varieties, were used in the study. The cultivated varieties are Achi shuru, Kanannado (both are cultivated widely in the Savannah region of Nigeria), Ife Brown and Zebra bean (are cultivated in the western rainforest region of Nigeria). All the female parents are cultivated varieties of *Vigna unguiculata* subsps *unguiculata var. unguiculata.* The wild accession (var. spontanea) used in this study (NG/SA/DEC/10/004) was in the collection of National Centre for Genetic Resources and Biotechnology Gene bank originally collected from Kogi state in north central Nigeria.

The experiments were conducted between September, 2011 and March, 2012 in the Screen house at National Centre for Genetic Resources and Biotechnology, Moor Plantation, Ibadan (7° 22′N and 3° 50′E). The first Experiment involved hand crossing the four cultivated cowpea varieties and the wild variety (var. spontanea). This exercise was carried out between October and November 2011 using methods described by Myers (1991). The wild variety was used as pollen parent. Pods containing F1 seeds were harvested at maturity. Recorded data of number of flowers emasculated, pollinated and number of mature pods set were compared using percentages. Parents and F1 seeds were sown in the second experiment at the NCGRAB Mesh House. Seeds each of the five parents and their four F1 genotypes were sown in poly pots measuring 35cm in height and 18cm across. Two seeds were sown per pot and this was replicated five times in a completely randomized design. Seeds of the wild variety were mechanically scarified before sowing. The pots were watered regularly and weeds were hand removed. Data on mean plant height, number of leaves per plant, mean number of flowers and number of pods plant-1 were recorded, compiled and subjected to Analysis of variance (ANOVA) using Minitab 15. Post-hoc multiple comparisons were by Least Significant Difference (LSD). Pod set was also compared using percentages..

Results

The four cultivated cowpea varieties crossed well with the wild relative by classical breeding, producing 170 mature pods out of total 367 flowers emasculated representing 46.3% of total emasculated flowers (Table 1). Among the crosses with the wild *Vigna*, Achi shuru x wild *Vigna* produced the highest percentage pod seed (52.0%) while the least (40.0) was Zebra bean x wild *Vigna* cross. Table 2 shows significant differences ($P<0.05$) in number of flowers per plant and number of pods per plant. The wild *Vigna* had significantly ($P<0.05$) higher number of flowers (92) and pod sets per plant (34) while the female parents had significantly ($P>0.05$) least number of flowers per plant. The number of pod set per plant in the crosses (30-35) was not significantly ($P>0.05$) varied to the wild parent (34). However, the F1 crosses had higher percentage pod set when compared to the wild *Vigna* and cultivated parents (Table 2).

All F1 plants showed significantly ($P<0.05$) taller plants then their parents (Table 3). Number of leaves per plant was significantly ($P<0.05$) different among the genotypes with Kanannado x wild *Vigna* (38) having the highest and Ife brown (18) having the least. The means for number of flowers per plant, number of pods per plant and percentage pod set for all the F1 plants were higher than the mean for the female parents (Table 3).

Table 1. Number of flowers hybridized, pod set and percentage of pods set in crosses of cultivated and wild *Vigna*.

Cross	Number of flowers pollinated	Number of pods set	Percentage of pod set (%)
Achi shuru x wild *Vigna*	102	53	52.0
Ife brown x wild *Vigna*	100	48	48.0
Kanannado x wild *Vigna*	85	37	43.5
Zebra bean x wild *Vigna*	80	32	40.0
Total	367	170	46.32 (Mean)

Table 2. Number of flowers per plant, number of pods per plant and percentage of mature pods produced per plant in parents and F_1s in crosses of cultivated and wild *Vigna* varieties.

Genotype	Mean number of flowers per plant	Mean number of pods per plant	Percentage mature pods (%)
Parents			
Achi shuru	30[c]	16[b]	53.3
Ife brown	26[c]	16[b]	63.9
Kanannade	29[c]	15[b]	50.5
Zebra	20[c]	10[b]	45.0
wild *Vigna*	92[a]	34[a]	37.0
Mean	26.3	14.3	53.1
F_1 crosses			
Achi shuru x wild *Vigna*	45[b]	35[a]	77.7
Ife brown x wild *Vigna*	43[b]	30[a]	69.8
Kanannado x wild *Vigna*	41[b]	32[a]	78.0
Zebra bean x wild *Vigna*	45[b]	30[a]	66.7
Mean	43.5	36.3	73.1
S.E.±(0.05)	2.76	1.66	

Means followed by the same letter(s) in the same column are not significantly different at 5% level of probability.

Table 3. Mean plant height and number of leaves per plant of parents and F_1s of crosses between cultivated and wild *Vigna* varieties.

Genotype	Plant height (cm)	Number of leaves per plant
Parents		
Achi shuru	95.7^{ab}	23^{bc}
Ife brown	43.3^{d}	18^{c}
Kanannade	39.9^{d}	26^{bc}
Zebra	82.2^{b}	19^{c}
Wild *Vigna*	70.6^{c}	21^{bc}
Mean	66.3	21.4
F_1 crosses		
Achi shuru x wild *Vigna*	114.4^{a}	32^{ab}
Ife brown x wild *Vigna*	107.7^{a}	29^{b}
Kanannado x wild *Vigna*	113.3^{a}	38^{a}
Zebra bean x wild *Vigna*	103.1^{a}	32^{ab}
Mean	109.6	32.8
S.E.±(0.05)	6.01	1.94

Means followed by the same letter(s) in the same column are not significantly different at 5% level of probability.

Discussion

Result of mean percentage pod set resulting from hand crossing (46.32%) (Table 1) compares fairly well with mean percentage pod set of 49.9% achieved by natural selfing among the parent genotypes (Table 2). The F_1 crosses mean percentage pod set of 73.1% is higher than that of the parents (Table 2), and shows high heterosis for pod set in the crosses and thus cross-compatibility between the cultivated cowpea and their wild relative *var. spontanea*. This may suggest viability of commercial cowpea production by hand crossing. Pod set percentage of F_1 crosses comparable to that of their parents have been reported by several authors (Ng, 1990; Fatokun and Singh, 2001; Mohammed *et al*., 2010).

Viability of the F1 seeds of all the crosses indicates good reproductive potential. Ng, (1990) reported that wild and weedy subspecies of cowpea hybridize well with the cultivated forms and produce viable hybrids. Number of flowers produced was significantly ($P<0.05$) higher in the F1 crosses as compared to the parents except for the wild genotype (Table 2). The wild though produced significantly higher flowers than all the other genotypes; the pod set was not significantly different from those of the F1 crosses. This results show that many flowers of the wild were wasted as opposed to those of the F1s. Mohammed et al. (2010) in a similar work with *var pubiscens* attributed the higher number of flower in the wild type over the cultivated parents type to partial dominance gene control for this trait. The F_1 genotypes had a significantly higher number of pod set than all the maternal parents. This may be an indication that the high yielding capability of the wild cowpea is dominant and may have been inherited by the F_1 crosses. Similarly, the F_1 crosses had higher percentage mature pods per plant than their parents (Table 2). This again indicates good reproductive potential (Fatokun and Singh, 2001) in a similar work reported that the F_1 were vigorous but partially sterile. However the F_1 genotypes in this study have both vigour and high reproductive potential. This explains the fewer abortions observed among the F_1 plants.

Furthermore, plant height and number of leaves per plant were significantly higher in F_1 crosses as compared to the parents (Table 3). This result again confirms the reproductive vigour and heterosis of the F_1 crosses of cultivated cowpea and their wild relative var. *spontanea* over the parents. This agrees with the work of (Bhor *et al*., 1997). High heterosis in number of leaves per plant may indicate more photosynthetic activities resulting to higher productivity.

Conclusion

The results show that cultivated varieties of cowpea are cross-compatible with their wild relative var. *spontanea* and their F_1 produce viable seeds with high reproductive potential as well as good hybrid vigour. It is suggested therefore, that the gene pool of this wild cowpea variety may be of great importance in cowpea improvement programme. The genetics and inheritance of other characters will be evaluated as the F_2, are advanced in the field.

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