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Induction of Genetic Variation in Cowpea (*Vigna unguiculata* L. Walp.) by Gamma Irradiation

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Abstract: Cowpea IT84S2246D mutants were screened for useful agronomic traits. Dry seeds of cowpea 'IT 84S2246D were exposed to gamma irradiation from cobalt 60 source at 196 and 245 Gy dosages. The non-irradiated parent was used as the control. Identification and selections were carried out at the second generation (M_2). The eight mutants selected from 245 Gy population included plants with light green pods, plants with leaflets having tendrils, early maturing plants with broad leaflets, plants with pigmented pods and plants with pods above canopy. They also included plants with dark green pods, plants with wide angled pods and pigmented plants with hairy pods. The two mutants selected from 196 Gy populations were early maturing and dwarf plants. The selected mutants were found to possess useful agronomic traits capable of conferring on them selection advantage for increased yield, easy harvesting and insect tolerance.

Key words: Induced mutations, cowpea, gamma irradiation, morphological attributes

INTRODUCTION

Cowpea is one of the major sources of plant protein in Nigeria. The advent and subsequent improvement of legumes such as cowpea through induced mutation could make it possible to develop new germplasms. The use of induced mutation had long been recognized as a rapid source of producing genetic variability in crops (Harris, 1979). This is because existing genes can change into different alleles, linkage groups can separate and gene(s) can change positions or be eliminated (IAEA, 1977). Variations have been generated in inherited characters in many crops such as yield, maturity time and nutritional quality (FAO/IAEA, 2004). By inducing mutations in cowpea, it may be possible to identify new genes and thus broaden the spectrum of inheritable changes and expand cowpea germplasm. Plant architecture is recognized as one of the major trait for higher yield in grain legumes. Alterations of plant type characterized by modification of leaves into tendrils have been extensively used in developing new cultivars in pea. However information on morphological mutations in cowpea is very limited. This study thus aims at identifying and selecting mutants with useful morphological attributes and agronomic traits.

MATERIALS AND METHODS

This research was conducted at the Teaching and Research farm of the Faculty of Agriculture, University of Ilorin, Ilorin, Nigeria between August and November 2002. Dry seeds of cowpea IT 84S 2246D were exposed to gamma irradiation at the rate of 24 Gy/min, at the optimum dose of 245 Gy and the lower limit of 196 Gy (Adekola and Awoleye, 2002) from $Cobalt^{60}$ source at the Center for Energy Research and Development, Obafemi Awolowo University, Ile-Ife, Nigeria. The non-irradiated parent IT84S 2246D was used as the control.

The first generation plants (M_1) were established on a land previously ploughed, harrowed and ridged. The experiment was laid out as randomized complete block design. Seeds were sown at 30×30 cm spacing on ridges in a double row planting at the rate of two seeds per hole. All necessary cultural practices such as weeding and spraying at two weeks intervals with 20 Emulsifiable Concentrate (EC) lambda cyhalothrin (Karate) done. At maturity, all the dry pods from all plants in each population were harvested and threshed. Seeds were bulked according to dosage level and were treated with 20 EC Actellic solution and kept in airtight containers. The M_1 seeds were used to raise the second generation during the second planting season of 2003. The experiment was also laid out as a randomized complete block design with blocking based on dosage level. Weeding was done manually and spraying at two weeks intervals using 20 Emulsifiable Concentrate (EC) lambda cyhalothrin. The M_2 generation plants were examined for visible changes from the parent such as changes in plant height, plant architecture, leaf colour, leaf length, leaf texture. Also, changes such as earliness, flower colour, pod texture, pod shape, pod angle, pod colour and seed coat colour, presence of pigment and growth habit were examined.

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RESULTS

The following mutations were identified with different morphological attributes from the parent. Leaf mutations: the parent has narrow hastate leaf shape, green coloured and smooth textured leaflets. Shape of leaflets of mutants ranged from broad hastate of mutant 10 to ovate of mutant 7 (Fig. 1). Leaf textures identified ranged from slightly rough found in mutant 3 (Fig. 2) to rough in mutant 10 (Fig. 3). Colour of leaflets also varied from light green in mutant 3 to dark green in mutant 7 (Fig. 4). Some mutants were also identified with growth habit which differs from that of the parent. The parent has medium size branches while the identified mutants have branches which ranged from short in mutant 5 to very long in mutants 9 and 10. Mutants with long branches were tendril-like. Mutants 3 and 10 have semi erect plant type (Fig. 5) while mutant 9 has a prostrate plant type. These differ from the parent, which has erect plant type. Extra early maturity was exhibited in mutants 1 and 4 as compared with early maturing parent. Dwarf ness was also identified in mutant 5.

Some mutants were identified with pods, which differs from that of the parent. The parent has smooth textured, straight and pendant pods. However, rough textured pods were identified in mutant 10. Pod shape ranged from slightly curved of mutants 1 and 2 while curved shaped pods were found in mutant 9. Pod position varied from pendant in mutant 1 to slightly upright in mutants 4 and 8 (Fig. 7). Mutant 7 was found with pods carried above the plant canopy while mutant 9 has pods at wide angle.

Pigmentation: The parent has no pigmentation on the leaflets, stem and peduncles. Mutant 1 and six other mutants were found with pigmentation on the leaflets, stem and peduncles (Fig. 6). Flower colour of the parent is cream yellow. However, purple colour flowers were identified in mutants 3, 9 and 10 (Fig. 8). Seed coat colour of the parent is dark brown which differs from light brown of mutant 2 and 10, brown seeds of mutant 7 and reddish brown of mutant 3. Seed coat texture of the parent is rough while smooth textured seeds were identified in mutants 3 and 10.

Fig. 1: The different leaf mutants, showing from left to right Broad hastate (Mutant 10), ovate dark green (Mutant 7), hastate light green (Mutant 3) hastate green (parent)

Fig. 2: Slightly rough textured leaves, light green colour of Mutant 3 as compared with smooth textured green leaves of the parent on the right

Fig. 3: Rough textured light green leaves (broad hastate) Mutant 10 as compared with the parent on the right

Fig. 4: Smooth textured leaves, dark green colour mutant 10 and the green leaves of the parent on the right

Fig. 5: Semi-erect plant growth with profuse branches of mutant 10 shown above as compared with erect plant growth of the parent below

Fig. 6: Pigmented veins plus peduncles of mutant 1 (above) and non pigmented veins/peduncles of parent (below)

Fig. 7: Light green pod of mutant 3 above; dark green pod of mutant 8 below

Fig. 8: Flower colour mutant, showing purple colour of mutant 10 and cream yellow flower of parent

DISCUSSION

Cowpea with broad hastate leaflet shape may have yield advantage over the narrow hastate. This is because light penetration may be deeper into the leaf canopy and this may enhance photosynthetic activities of such plant (IITA, 1989). It may also imply high leaf area index, which may result in higher photosynthetic rate. The rough texture of leaflets may be an escape mechanism from leaf feeding insects. Mutants with dark green leaflets may be more efficient in photosynthetic activities due to increase in chlorophyll pigments. It may also serve as genetic marker for easy identification of cowpea.

As for the growth mutations identified, the mutants with short branches and erect growth habit are mostly determinate in nature. This may confer the advantage of planting at higher density. Such high population tends to result in significant yield improvement. Similar results have been observed by Awoleye (2000) in cowpea. On the other hand, higher branching may favour higher production of pods which may result in higher seed yield. Fawole *et al*. (1985) reported the identification of a cowpea mutant with branched peduncles which is potentially capable of carrying more than usual number of pods. Extra early maturing mutants may be selected for the many advantages it may confer on the plant. These include ability to escape or tolerate insect damage due to short duration of reproductive period. Short duration of flowering has been known to prevent insect population from building up on such plants. Hence, such plants may suffer less yield reduction (Jackai, 1982). Early maturing mutants are also suitable for late planting in areas with short rainfall duration as they show better tolerance to drought. The dwarf mutant that was identified in this study may possess the advantage of lodging resistance due to their short basal branches.

Pod mutations such as rough texture suggest the presence of trichomes. Cowpea plant with trichomes has been found to suffer less damage by *Maruca vitrata* (Veeranna and Hussain, 1997). Pod position may also confer selection advantage on the plant. Mutants with upright pods and pods above plant canopy may be selected for mechanical harvesting. Such findings have been reported by Wien and Summerfield (1980). Furthermore, mutant 9 with pods at wide angle has the potential of suffering less damage from insect. This is because *Maruca* damage has been reported to vary inversely with pod angle. Pods that were held closely at narrow angle were found to be more susceptible to *Maruca* damage than those held widely apart (Oghiakhe *et al*., 1992).

The presence of anthocyanin pigment on stem and peduncles as found in mutant 1 may confer selection advantage on such plant. This is because it may likely exhibit better level of insect tolerance. Woolley (1977) reported similar findings whereby plants that have pigments exhibit better level of tolerance to *Maruca vitrata*. Cowpea pods with dark green coloration have been reported to show less damage to *Maruca* (Ojomo and Cheda, 1975). Also, flower mutation as observed in mutant 10 has been found to make plants more attractive to foraging by insects particularly when they are large in size. Such plants are more susceptible to insect damage when left unprotected (Ntonifor *et al*., 1996). Seed coat colour and texture have important effect on consumer's preference which differs among regions of the world. In Nigeria, rough textured seeds are preferred, probably due to short cooking time.

CONCLUSION

Significant morphological variability was created among mutants using gamma irradiation. The selected mutants show useful agronomic traits capable of conferring on them selection advantage for increased yield and insect resistance. There is therefore, possibility for further cowpea improvement through induced mutation (FAO/IAEA, 2001, 2004).

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