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DEVELOPMENT OF THE HOT PEPPER INDUSTRY IN THE ENGLISH-SPEAKING SUB-REGION OF THE CARIBBEAN – GENETIC IMPROVEMENT

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ABSTRACT: Hot peppers (*Capsicum chinense* Jacq.) are popular in the Caribbean among growers, consumers, agro-processors. CARDI has been conserving and developing the Regional Capsicum germplasm. The Institute selected the first commercial cultivars such as the West Indies Red and CARDI Green which are being planted in many countries. Over the recent past the Moruga Red has been purified, stabilised and commercialised in Trinidad and Tobago. Other selections derived from the Regional gene pool such as the Scotch Bonnet, Tiger Teeth, Red Congo and Cayenne were also purified and stabilised. The Scotch Bonnet was improved through a backcross programme implemented in Jamaica. The cross between Scotch Bonnet x Bird Pepper resulted in two selections, Joyce and Phyllis, with yellow berries. As the hot pepper industry grew in CARICOM, CARDI led the way in also developing a sustainable commercial seed production system linking Barbados, Antigua and Belize. The positive impact made by both genetic improvement and the steady supply of high quality seed on the overall growth of the hot pepper industry, was briefly described. Emphases should be placed on breeding for resistances and the expression of hybrid vigour in future work.

Introduction

The main pillar supporting the Caribbean hot pepper industry is its germplasm of the *Capsicum chinense* Jacq. species which originated in the Neotropics of the New World. This diverse species boasts biotypes of the highest pungency and the strongest unique aromas far surpassing the others, for instance the *Capsicum annuum* L.

From as early as 1980 CARDI recognised that the demand for Caribbean hot peppers was rapidly increasing particularly on the export market where they were all lumped under the trade name of 'Scotch Bonnet' (Adams 1997). No description of this cultivar was found in the literature at that time. However, a yellow fruited pepper with bonnet shaped berries was grown in Jamaica where it was called 'Scotch Bonnet.' Other populations of hot pepper landraces with certain percentages of their berries bonnet shaped and red coloured were re-introduced into production for the export market for hot red peppers although mixtures of green and yellow berries were also traded. A closer look at the other landraces disclosed many national favourites but they had the following traits in common:

1. They were not characterised

2. The berries were not sufficiently uniform for the export market and
3. Quality seed was not available. Farmers recouped seeds from the standing crop resulting in a steady accumulation of viral disease particles and increased inter-crossing between biotypes which led to crop and berry quality decline.

The solution, therefore, presented itself as the need for larger and more uniformly shaped berries and a sustained supply of quality seed from genetically pure cultivars.

Materials and Methods

The main short and medium term problems, described above, were to be solved through genetic and agronomic improvement inter alia. The existing landraces were to be primarily purified and stabilised, thereafter quality seed produced and supplied to growers regularly. Agronomic improvement was to be done simultaneously. The first characters to be genetically improved through simple recurrent mass selection, after ensuring selfing, were as follows:

- High pungency in berry
- Uniform berry size and shape
- Uniform deep dark-red colour of mesocarp
- High general adaptability of populations
- Uniform plant height and canopy width
- Uniform flowering and ripening of plants and
- High productivity of per plant

1) The selection procedure was applied to plants grown out of seeds obtained in 1989 from Jamaica, Trinidad, Barbados and the East Caribbean. "Red Scotch Bonnet" seeds were re-introduced from the UK. Red berries were kept separately from the yellows. The plantings and selections were carried out in Antigua at Betty's Hope and Green Castle from 1990 to 1996.
2) Basic seed was supplied to the seed production units in Belize and Barbados. The cultivars were characterised for some characters using a short list of the IPGRI Descriptors (1995).

This first effort was followed by:

1) CARDI – Barbados — Adams – Collecting missions and establishment of the Regional Hot Pepper Genebank (seed room and fields)
2) Evaluation, purification, stabilisation and breeders' seed production of commercial landraces of the region – Barbados
3) Crossing of Scotch Bonnet x Bird Pepper followed by selection among the segregants (F2-9) in Barbados
4) CARDI – Barbados – Roberts, C. – breeding for resistance to viral diseases
5) Genebank maintenance and continuous supply of breeders' seed to the commercial seed multiplication units in CARDI Antigua and CARDI Belize

6) Breeding for viral disease resistances with Scotch Bonnet in Jamaica McGlashan -(2007)
7) Purification and stabilisation of eight Trinidad and Tobago landraces, Adams (2003)
8) Agronomic improvement – high plant population densities (Adams, 2010-2012) – Trinidad
9) UWI – Cave Hill, St. Augustine and Mona campuses– biotechnology, pure lines and hybridization

The major national collaborators are the Sugarcane Feed Centre (SFC), National Agricultural Marketing Development Corporation (NAMDEVCO), the Ministry of Food Production, and the Tobago House of Assembly (THA) – support the inputs and infrastructure.

International Collaborations

Asian Vegetable Research and Development Center (AVRDC), Biodiversity International (BI), the Global Crop Diversity Trust (GCDT), and the Pepper Breeding Institute of the University of New Mexico.

Results and Discussion

The two first selections from the regional heterogeneous landraces differed in fruit colour, yellow and red berries. A limited number of characters were described to allow identification by the stakeholders in the hot pepper industry.

Key Indicators of the Species

Like the Scotch Bonnet heterogeneous landrace, these two selections also belonged to *Capsicum chinense* Jacq. as evidenced by the taxonomic indicators of greenish white corolla, marked annular constriction ring at the calyx/peduncle juncture, Pickersgill (1989), and a mean of three berries per node or branch axil.

Cultivar Descriptors

The first selection, a typical West Indies Red hot pepper plant exhibits the following characters:

Plant habit

Stout, low compact shrub with a flattish crown, 60-80 cm high and 70-110 cm wide.
There are 2-4 secondary branches arising out of a primary. Several water shoots/suckers close to the base of the main stem may be produced especially by lodged plants, giving the shrub an uneven growth look.

Flowers and Flowering

Two to six flowers are produced in each branch/branch or branch/leaf axil or at each stem node. Flowering is year round appearing in flushes about 2-3 weeks apart. Flowers are pendant; petals number five or six and are greenish white. The anthers number five or six and the stamens are light blue to purple in colour.

Fruits

The fruits are botanically berries and light green in colour when immature. Ripening berries attain a deep orange red which turns to crimson. Some dark green glossy berries ripen to a deep darker red colour. The fruits of West Indies Yellow remain a golden yellow colour upon maturity. The berries are pendant and persistent at maturity.

Fruit Shape

There is still considerable variability and berries are generally of the lantern type i.e. with the broadest part close to the peduncle and tapering towards the blossom end.

The berry may be blunt or with a sharply pointed distal end. In cross section the berry wall may vary from slightly to deeply corrugated. In the longitudinal section the berry wall may be smooth to somewhat folded. Rarely is there a complete double fold all the way round the equator of the berry as in the true Scotch Bonnet.

Fruit size

Berry sizes, similar to other qualitative characters such as plant height, vary with the growing conditions, developmental stages and age of the plants. The following sizes were recorded in the Caribbean:

- Mean weight of berry 9 - 15 g
- Mean length of berry 30-60 mm
- Diameter of berry 25-50 mm
- Number of berries in a kg 77-88 (35-40 in a pound)

Pungency and aroma of berries

These cultivars have been classified as the superhot group due to the high pungency in their berries when compared to those of *C. annuum* cultivars with very lower pungencies. The West Indies Red berries are >100,000 SHU whilst the *C. annuum* cultivars vary from 20,000 - 80,000 SHU.
The total organoleptic qualities of West Indies Red are not found elsewhere in the world and can be said to be uniquely Caribbean.

Yields and Harvests

Berry yield depends on many environmental and managerial factors. In Antigua, Trinidad and Tobago and Barbados, several crops produced averages of 15,000 to 25,000 kg/ha (13,365 to 22,275 lb/ac) marketable berries. Yields generally increased from the first to the sixth picking, at 2-3 weeks intervals, reached a plateau from the 6th - 8th picking after which came a decline in productivity and berry sizes. The yields can be stabilised up to the 12th picking if management is maintained at a high level with regular and adequate irrigation, fertilisation and efficient spraying to keep down pests and diseases (especially viral diseases, Phythophthora root rots, white flies, aphids, fruit worms, mites and thrips).

The efforts to breed highly adaptable and marketable varieties resulted in a number of selections in the advanced segregating generations of the cross between Scotch Bonnet x Bird Pepper. This interspecific cross produced two selections (Joyce and Phyllis) with yellow berries. They are being evaluated around the region.

The Scotch Bonnet in Jamaica was improved firstly through the selection of a 4-lobed berry type which was subsequently converted into a variety with resistance to TEV and PVY viral diseases. This was achieved through a series of backcrosses successfully incorporating the resistant genes. McGlashan (personal communication, 2007).

The University of the West Indies, St. Augustine Campus has put together a germplasm collection of *C. chinense*, carried out molecular and morphological characterisation of the accessions and defined the phylogenetic relationships of the Caribbean germplasm to the Central America and Amazonian (Umaharan et al. 2007). This work is the precursor to the selection of pure lines and the evaluation of hybrid combinations between these lines.

The overall economic result of significant importance to the hot pepper industry is the production of quality seed extracted from the improved landraces. The further degeneration of the landraces has been halted partly through the sustained production and distribution of quality seed of West Indies Red, Yellow Scotch Bonnet, CARDI Green, Moruga Red and Scorpion to farmers.

At the same time the Regional Germplasm Collection is maintained along with breeder's seed of the five landraces mentioned above.

Conclusions

The next step in genetic improvement is the crossing in different parental combinations and their evaluation to determine the value of the new hybrids. These are expected to be of a higher productivity both in quantity and quality of berries and processed products owing to the expression of heterosis in certain characters. The selection of the parental pure lines and the analyses of the resulting F1 and segregating progenies are to determine the combinations that will exhibit heterosis in the production of capsaicin,

in berry productivity and tolerances to pests and diseases. Also male sterile lines must be created and utilised to reduce the cost of hybrid seed production.

Finally, the new pure lines and the resulting hybrids should be protected under the Plant Breeders' Rights of the UPOV Convention.

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