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Anbukarasi V
Department of Vegetable Science
Horticultural College and Research Institute
Tamil Nadu Agricultural University
Coimbatore
Tamil Nadu
India

Dhandapani M
Tamil Nadu Rice Research Institute
Tamil Nadu Agricultural University
Aduthurai
Tamil Nadu
India

Prabhu M
Department of Vegetable Science
Horticultural College and Research Institute
Tamil Nadu Agricultural University
Coimbatore
Tamil Nadu
India

Pugalendhi L
Department of Vegetable Science
Horticultural College and Research Institute
Tamil Nadu Agricultural University
Coimbatore
Tamil Nadu
India

Corresponding Author
Prabhu M
muthusamyprabhu@gmail.com

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Genetic Improvement of Cucurbitaceous Vegetables through Speed Breeding Approaches

Cucurbits largely consist of economically and nutritionally important vegetables and their genetic improvement can be enhanced and intensified by speed breeding approaches *viz.*, shortening life cycles by precocious floral induction and anther culture based double haploid techniques.

INTRODUCTION

Cucurbitaceous consist of larger number of fruit vegetables which are richer in digestible fibre, mineral nutrients and anti-oxidants which are widely cultivated throughout the world. In India, major cucurbitaceous vegetables are bitter gourd, bottle gourd, ridge gourd, and ivy gourd. All these gourds are nutritionally very important owing to their therapeutic values *viz.*, obesity, gastro intestinal disorders and micro nutrient deficiencies. They were domesticated from wild habitats as wines growing on the grounds and trailing on the trees and shrubs which were bitter and selected as staking vegetables. They are one of the most primitive crops being domesticated by humankind for consumption. They are essentially cross pollinated due to the monoecious nature of floral organs. Despite of cross pollination, they have merely low levels of inbreeding depression. Nutritionally very important vegetable component for the balanced diet, cucurbits are widely cultivated globally irrespective of the climatic and soil factors. India is one of the largest producer and consumer of most of the cucurbits.

AREA, PRODUCTION AND PRODUCTIVITY OF MAJOR CUCURBITS

The area, production and productivity of major cucurbits are furnished below (NHB, 2020)

Crop	Area (000 ha)	Production (000 MT)	Productivity (MT/ ha)
Musk melon	59	1330	22.54
Water melon	110	2787	25.34
Bittergourd	101	1214	12.02
Cucumber	104	1603	15.41
Parwal/ Pointed gourd	56	760	13.57
Pumpkin/ Kaddu	99	2117	21.38

Among the different cucurbits, water melon ranks first in area and production. The productivity is high in pumpkin.

BREEDING OBJECTIVES OF CUCURBITS

1. Climate smart hybrids suitable to all seasons.
2. Hybrids with enhanced nutrients contents and protective compounds.
3. Dwarf and self-staking types for protected cultivation conditions.
4. Tolerance to biotic and abiotic stresses.

SCOPE OF SPEED BREEDING APPROACHES IN CUCURBITS IMPROVEMENT

Being monoecious nature, cucurbits evolved essentially as open pollinated species accumulating wider gene pool consisting of many useful traits. Cucurbits were one of the breeder's friendly crop species, in which heterotic vigour has been successfully utilized for the development of high yielding hybrids both from public and private sectors. Rural households maintain their own seed stocks for backyard gardening and crops like bottle gourd, bitter gourd, snake gourds are being grown. They are open pollinated local types grown mainly for consumption. Due to high demand among consumers, cucurbits cultivation at commercial level is increasing viz., squashes, melons, gourds are highly remunerative crop ventures being undertaken up at states like Karnataka Tamil Nadu and Andhra Pradesh in larger scale.

Development of hybrids, open pollinated populations like composites and synthetics, inbred developed through combination breeding for biotic and abiotic stress tolerance are mainly concentrated in cucurbits breeding. Being a cross pollinated crop, it takes almost 7-9 generations for obtaining homozygous lines through inbreeding. Inbreds are essential for hybrids development and development of inbreds is a continuous and time consuming process.

Inbreds are being tested for general and specific combining abilities by making cross combinations with specific mating designs. Hybrids development followed by evaluation for the release takes place at 5-7 years for the release of hybrids in cucurbits.

By following speed breeding approaches inbreds can be developed shortly by reducing the life cycle through floral induction and reduction of inbreeding cycles through anther cultures in cucurbits.

FLORAL INDUCTION UNDER CONTROLLED CONDITIONS AND GERMINATION OF IMMATURE EMBRYOS FOR RAPID GENERATION ADVANCEMENT

Under controlled conditions, flower induction can be initiated with 20 days old seedlings by regulating light, temperature followed by spraying of combination of phosphorous along with micro nutrients and GA_3 for induction of female and male flowers in most of the cucurbit

species. Usually cucurbits initiate flowering on 45 days old plants. Fruit maturity takes place between 80-90 days. Flower induction on 20-25 days old seedlings followed by hand pollination will form fertilized embryos. So, fertilized immature embryos can be excised and inoculated onto MS medium supplemented with combination of cytokinins for direct shoot regeneration and excised shoots will be transferred to rooting medium for root induction.

Rooted plantlets again transferred to controlled conditions for flower induction followed by pollination cycles. Six to seven inbreeding generations is practically possible to attain homozyogosity to develop inbreds. Hence, totally 400 - 440 days will be sufficient for attaining complete homozygosity from an open pollinated cucurbit crops like cucumber gourds and melons. After six generations inbreds can be evaluated for agronomic traits and screened for biotic and abiotic stresses tolerance. Usually it takes 3.5- 4 years of complete inbreeding cycles of cucurbits to attain homozygosity for the development of inbreds.

ANTHER CULTURE TECHNIQUES FOR RAPID GENERATION OF HOMOZYGOUS LINES

Bigger size anthers and amenable of having grown under protected conditions free of external and endogenous pathogens, make anther culture based doubled haploid induction is an easy processes in cucurbits improvement. Healthy plants should be sprayed with systemic and broad spectrum fungicides during flower initiation to prevent fungal and bacterial contaminations. Before opening of flowers, buds should be excised and cold temperatures treatment for 12 hours should be given (4^0C). Surface sterilisation of buds should be done with effective sterilisation agents followed by excising of anthers and inoculation onto somatic embryo induction medium. Anthers with abundant tetrad stage, Pollen mother cells should be selected for inoculation and induction of somatic embryos in MS medium supplemented with 2,4-D and combinations of various cytokinins.

After somatic embryos formation, they will be transferred to regeneration medium for plantlets development. Plantlets with roots will be transferred to basal medium for root proliferation and transferred to green house for acclimation process. Natural double haploidy will be evaluated with cytological and fruit setting. After attaining maturity, seeds will be extracted and the inbred lines will be evaluated for traits of interest to be included in breeding programs. One year it is possible to obtain complete homozygous lines for evaluation through anther culture techniques.

FUTURE PROSPECTS

Clonal propagation of fixed heterotic lines for production under protected conditions is another possibility for exploiting hybrid vigour in short period of time by avoiding crossing and extraction of seeds for selling to the farmers. Elite heterotic lines can be clonally multiplied through plant regeneration techniques and plantlets will be supplied. The advantages will be of maternal influence of balanced nutrition during regeneration and combined with heterotic vigour which will result in higher productivity per unit area in protracted cultivation (eg.) melons, cucumber and squashes.

CONCLUSION

Cucurbits owing to their open pollinated nature, low inbreeding depression and larger sized floral organs make them breeder's friendly crop for genetic improvement. Speed breeding approaches will be successfully utilized for rapid development of inbreds with various novel traits for hybrids / populations development on commercial scales cultivation in open as well as under protected cultivation methods for higher productivity. Self-staking

types and dwarf types can be cultivated in kitchen and terrace gardening under urban farming for nutritional security and supply.

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