

Heterosis Breeding in Bottle Gourd (*Lagenaria siceraria* L.)

Vikas Gill¹, D.S. Duhan, Surya Bamal³ and Yugvinder¹

¹Ph.D. Scholar, Department of Vegetable Science, CCS HAU, Hisar, India

²Assistant Scientist, Department of Vegetable Science, CCS HAU, Hisar, India

³M.Sc. Scholar, Department of Horticulture, Amity University, Noida, U.P, India

SUMMARY

This article consists of various aspects covered under the purview of heterotic component in Bottle gourd and its potential in crop improvement programmes as well as varietal developmental programmes. Owing to the existence of wide variability, monoecious nature, conspicuous and convenient flower structure, large number of seeds per fruit, bottle gourd can serve as a potential source for the manifestation of heterosis and its commercial exploitation. Characters like days to first female flower, nodes to first female flower, days to first flowering and fruits per vine could serve as the most propitious traits for selection under heterosis breeding. Among the various mating designs, diallel mating/cross techniques has been most frequently used for bottle gourd.

INTRODUCTION

Bottle gourd is a vigorous, annual, running or climbing vine with large leaves and a lush appearance. The vine is branched and climbs by means of tendrils along the stem. The foliage is covered with soft hairs and has a foul musky odour when crushed. Leaves have a velvety texture because of the fine hairs, especially on the under surface. The bottle gourd flowers are born singly in the axils of the leaves, the males with long peduncle and females with short peduncle. The flowers are attractive white, upto 4 inches in diameter, with spreading petals. It is commonly grown for vegetable but is also well known for its medicinal value to human being. It can be used for making sweets (e.g. sweet meat, petha and burfi), raita, kaporkand pickles and kofta. A decoction made from the leaf is very good medicine for curing jaundice. The pulp is good for overcoming cough, constipation, night blindness and as an antidote against certain poisons. The plant extract is used as a cathartic and the seeds are used in dropsy.

Scientific Classification

- Origin : Obscure (India/ Tropical Africa)
- Family : Cucurbitaceae
- Genus : *Lagenaria*
- Species : *siceraria*
- Scientific name : *Lagenaria siceraria* L.
- Common name : Bottle Gourd, Lauki, Calabash, White flowered gourd
- Chromosome Number : $2n=2x=22$
- Economic Part : Immature Fruit
- Pollination : Highly cross pollinated (60-80%)
- Bottle gourd genus name 'Lagenaria' came from 'lagena' the Latin name for a Florence flask, referring to the fruit shape.

Descriptive Keys of Crop

- Habit → Annual climber. The vines are preferably trained on bowers
- Stem → Slender & angular with hairs (when young)
- Leaves → Simple, cordate, non-lobed or slightly lobed
- Flowers → Monoecious crop with solitary flowers appearing on leaf axils
 - Calyx: 5 sepals united at the base
 - Corolla: 5 petals united with one another (white)
 - Androecium: 3 stamens attached to the calyx tube
 - Gynoecium: Epigynous ovary (inferior), syncarpous & unilocular
- Fruit Type → Peco, tough rind, different shapes like pyriform, long slender

- Seed → Numerous (upto 400-500), flat and brown in color on maturity



Floral Biology

- Anthesis → between 2 – 8 p.m.
- Anther dehiscence → few hours prior to anthesis viz 1- 3 p.m.
- Pollen viability → from the time of anther dehiscence till next morning
- Stigma Receptivity → 36 hours before anthesis to 60 hours after anthesis

Breeding Objectives

- High early & total yield.
- Earliness – First pistillate flower to appear at lower node.
- High female to male ratio of flowers, resulting in high number of fruit per plant.
- Size – generally the preference for medium – sized fruits, 15 – 25 cm long.
- Shape – fruit with uniformly medium thickness are preferred.
- Surface – smooth surface
- Colour – preference varies in different regions- White fruits – Tamil Nadu, Karnataka & Maharashtra. Green/Light green – Haryana, Bihar, Eastern U.P., West Bengal and some other areas.
- Less mature seeds at edible maturity.
- Disease resistance against important diseases like - Powdery mildew, Downey mildew Mosaic Insect resistance against important insect-pests like- Red pumpkin beetle & Fruit fly

Heterosis

Heterosis is a biological phenomenon where F1 obtained by crossing two dissimilar individuals shows increased or decreased vigour/level of performance for certain traits over performance of their parents (over better parent or mid-parental values).

Generally, it is manifested as an increase in vigour, size, growth rate, yield and earliness. In simpler terms – Superiority of F1 over the parents.

Types of Heterosis

Average/Mid Parent heterosis - heterosis where F1 is superior to mid parent value. In other words superior to average of two parents.

Heterobeltiosis - Superiority of F1 over the better parent.

Economic/Standard heterosis - Superiority of the F1 compared to the high yielding commercial variety in a particular crop.

Formula's to compute various types of heterosis

$$\left(\frac{F1 - MP}{MP}\right) \times 100 = \text{Heterosis over mid parent (relative heterosis)}$$

$$\left(\frac{F1 - BP}{BP}\right) \times 100 = \text{Heterosis over better parent (heterobeltiosis)}$$

$$\left(\frac{F1 - STV}{STV}\right) \times 100 = \text{Heterosis over check (standard heterosis)}$$

Where,

F1 = Mean value of hybrid

MP = Mean value of parents

BP = Mean value of better parent

STV = Mean value of standard variety

Heterosis in Vegetable Crops

- Heterosis breeding is the predominant breeding method in improvement of cross pollinated vegetable crops. Hybrids are superior with respect to productivity, earliness, uniformity, quality and adaptability.
- Exploitation of hybrid vigour in bottle gourd is possible by inter varietal crossing.
- Owing to the existence of wide variability, monoecious nature, conspicuous and convenient flower structure, large number of seeds per fruit, bottle gourd can serve as a potential source for the manifestation of heterosis and its commercial exploitation.

Heterosis Breeding in Bottle gourd:

- Heterosis in bottle-gourd was first reported by Dr. Indra Dutta Tyagi.
- Heterosis breeding depends mainly on choice of superior parents for hybridization and the knowledge of combining ability and gene actions.
- Also, screening of the parents and crosses before their use in any breeding programme is to be emphasized.
- Among the various mating designs, diallel mating/cross techniques has been most frequently used.

Important characters/traits to be emphasized for heterosis breeding in bottle gourd**Days to first female flower**

- | | | |
|--------------------------|---|-------------------|
| Nature of gene action | - | Additive |
| Mean degree of dominance | - | Partial dominance |

Nodes to first female flower

- | | | |
|--------------------------|---|----------------|
| Nature of gene action | - | Non - Additive |
| Mean degree of dominance | - | Over dominance |

Days to first picking

- | | | |
|--------------------------|---|----------------|
| Nature of gene action | - | Non - Additive |
| Mean degree of dominance | - | Over dominance |

Fruit length

- | | | |
|--------------------------|---|-------------------|
| Nature of gene action | - | Additive |
| Mean degree of dominance | - | Partial dominance |

Fruit per vine

Nature of gene action	-	Non - Additive
Mean degree of dominance	-	Over dominance

Fruit diameter

Nature of gene action	-	Additive
Mean degree of dominance	-	Partial dominance

Vine length

Nature of gene action	-	Non - Additive
Mean degree of dominance	-	Over dominance

** For maturity traits, negative heterosis is usually desirable, because this will cause the hybrids to produce first fruits earlier as compared to parents, thereby increasing their productivity per day per unit area.

Seed Production

Pinching of male flowers in female plant is commercially practiced for hybrid seed production.

Isolation distance:

Foundation Seed – 1000 m

Certified Seed – 500 m

Pollen Control– no as such requirement as it is naturally cross pollinated crop (Monoecy).

Achievements

Pusa Meghdoot : developed at IARI

Pusa summer prolific long (PSPL) × Selection 2 → Pusa Meghdoot

Hybrid (F1) showed 50% heterosis over PSPL (BP) in terms of yield. Long and slender shaped fruits with attractive green colour. Suitable for both seasons (summer & rainy).



Pusa Meghdoot →



Pusa Manjari →

Pusa Manjari : developed at IARI

Pusa summer prolific round (PSPR) × Selection 11 → Pusa Manjari

Hybrid (F1) showed 48% heterosis over PSPL (BP) in terms of yield. Round shaped fruits with thick and smooth surface. Suitable for both seasons (summer & rainy).

CONCLUSION

After a certain stage improvement in available genetic variability comes to a stagnation phase, there arises the need to create novel variability. And through heterosis breeding we can create new variability apart from already available genetics stocks, as it involves crossing of dissimilar parents.

REFERENCES

- Doloi, N., Patel, J.N., Acharya, R.R. (2018). Heterosis studies in bottle gourd (*Lagenaria siceraria* (Mol) Standl.). *A Scitechnol Journal*, **31**(1).
- Gautam, D.K., Yadav, G.C., Kumar, P., Kumar, V. and Singh, M. (2019). Estimation of heterosis for growth, yield and quality traits in bottle gourd (*Lagenaria siceraria* (Mol.) Standl.). *International Journal of Current Microbiology and Applied Sciences*, **6**(8):789-802.
- Ghuge, M.B., Syamal, M.M. and Karcho, S. (2016). Heterosis in bottle gourd [*Lagenaria siceraria* (Mol.) Standl.]. *Indian Journal of Agricultural Research*, **50** (5) 2016 : 466-470.
- Jayanth S, Lal, M., Duhan, D.S. and Vidya, R. (2018). Estimation of heterosis and combining ability for earliness and vegetative traits in bottle gourd [*Lagenaria siceraria* (Molina.) Standl.]. *International Journal of Chemical Studies*, **7**(1): 20-25.
- Mishra, S., Pandey, S., Kumar, N., Pandey, V.P., and Singh, T. (2019). Studies on the extent of heterosis for the quantitative characters in kharif season bottle gourd [*Lagenaria siceraria* (Molina) standl.]. *Journal of Pharmacognosy and Phytochemistry*, **8**(1): 29-38.
- Thakur, P. (2017). Heterosis and combining ability for yield attributing traits in bottle gourd (*Lagenaria siceraria* (Mol.) Standl.). Ph. D. (Horti.) Thesis, Indira Gandhi Vishwavidyalaya, Raipur, 2017.<http://krishikosh.egranth.ac.in>.