Heterosis and combining ability analysis for growth, yield and quality attributes in bottle gourd [*Lagenaria siceraria* (Mol.) Standl.]

THESIS

Summary of the thesis

Babasaheb Bhimrao Ambedkar University

(A Central University)

Lucknow

BABASAHEB BHIMRAO AMBEDKAR UNIVERSITY

LUCKNOW

प्रज्ञा शील करुणा

ESTABLISHED 1996

FOR THE AWARD OF THE DEGREE OF

Doctor of Philosophy

In

HORTICULTURE

Supervisor
Prof. R.B. Ram
Professor

Submitted by
Amit Kumar Bhargava
Enrollment No. 1323/16

DEPARTMENT OF APPLIED PLANT SCIENCE (HORTICULTURE)
SCHOOL FOR BIO-SCIENCES AND BIOTECHNOLOGY
BABASAHEB BHIMRAO AMBEDKAR UNIVERSITY
(A CENTRAL UNIVERSITY)
VIDYA VIHAR, RAE BARELI ROAD, LUCKNOW-226025 (U.P.)
INDIA

2022

SUMMARY OF THE THESIS

The present investigation entitled **"Heterosis and combining ability analysis for growth, yield and quality attributes in bottle gourd [*Lagenaria siceraria* (Mol.) Standl.]"** was under taken with the objectives (i) to estimate heterosis over better-parent and standard variety (ii) to study the combining ability, variances and their effects, (iii) to find out gene action involved in the inheritance of various characters, (iv) to findout the heritability in narrow sense and genetic advance in per cent of mean and (v) to examine genetic divergence among the parents and their crosses.

The present study was carried out during *Zaid* seasons of 2017-18 and 2018-19 at Horticulture Research Farm, Department of Applied Plant Science (Horticulture), Babasaheb Bhimrao Ambedkar University, Lucknow (U.P.) India. The experimental materials of the study comprised of 54 treatments of bottle gourd [40 F_1's and 14 parental lines (10 lines *viz*., NDBG-504, NDBG-509, NDBG-517, NDBG-522, NDBG-601, NDBG-603, NDBG-749-2, NDBG-11, NDBG-10, Narendra Rashmi and 4 testers *viz.*, Pusa Naveen, NDBG-624, NDBG-S-5, NDBG-104)]. The 14 parents were involved in a crossing programme to develop a line × tester set (10 lines + 4 testers + 40 F_1's). The experimental materials (40 F_1's and 14 parental lines) were evaluated in Randomized Block Design (RBD) with three replications having each experimental unit of single row with spacing of 3.0m × 0.5m during *Zaid* seasons of 2017-18 and 2018-19, respectively. The observations were recorded on eighteen characters, *viz*., days to first staminate flower anthesis, days to first pistillate flower anthesis, node number to first staminate flower, node number to first pistillate flower, days to first fruit harvest, vine length at last picking stage (m), number of primary branches per plant, fruit length (cm), fruit circumference (cm), fruit weight (kg), number of fruits per plant, fruit yield per plant (kg), total soluble solids (°B), ascorbic acid (mg), reducing sugars (%), non-reducing sugars (%), total sugars (%) and dry matter content in fruit (%). The data were recorded from 40 F_1's and 14 parental lines on eighteen characters were subjected to analysis of variance **(Panse and Sukhatme, 1967)**, nature and magnitude of heterosis **(Fonseca and Patterson, 1968),** combining ability variances and their effects **(Kempthorne, 1957)**, heritability in narrow sense **(Kempthorne and Curnow, 1961)**, genetic advance in per cent of mean **(Johnson *et al*.,1955)**, and genetic divergence analysis **(Mahalanobis, 1936)** observations were also recorded for some qualitative traits as well. The salient results of the study and conclusion drawn from them are summarized below:

1. Analysis of variances for line × tester mating design revealed that variance due to treatments, parents and crosses were highly significant for all the traits in both the years.

Variances due to parents *vs* crosses were highly significant for all the characters except for node number to first pistillate flower in Y_1 and ascorbic acid in Y_2. Variances due to line *vs* testers were highly significant for all the characters except for days to first staminate flower anthesis in Y_1, vine length in Y_2 and fruit circumference and number of fruits per plant in both the years. Partitioning of variances into lines revealed highly significant differences for all the characters. Whereas, variances due to testers were also highly significant for all the characters in both the years.

2. The highest mean performance for fruit yield per plant (kg) along with some of the component traits was exhibited by parents NDBG-S-5 (6.33 and 6.35), Narendra Rashmi (5.77 and 5.68), NDBG-504 (5.47 and 5.81) and Pusa Naveen (5.31 and 5.26) in both the years along with NDBG-749-2 (5.11) in Y_1 and NDBG-624 (5.15) in Y_2. The above mentioned genotypes may be used as donor parents in hybridization programme for developing high yielding varieties of respective groups.

3. The most desirable parents were Pusa Naveen, NDBG-S-5, NDBG-504, NDBG-10 in both the years along with NDBG-601 in Y_1 and NDBG-10 and NDBG-624 in Y_2 for first staminate flower anthesis; NDBG-601, NDBG-S-5 and NDBG-509 in both the years along with Narendra Rashmi and NDBG-603 in Y_1 and NDBG-624 and Pusa Naveen in Y_2 for days to first pistillate flower anthesis; Pusa Naveen, NDBG-11, NDBG-10, and NDBG-104 in both the years along with Narendra Rashmi in Y_1 and NDBG-104 in Y_2 for node number to first staminate flower; Pusa Naveen, NDBG-517, NDBG-104, NDBG-11 and NDBG-624 in both the years for node number to first pistillate flower; NDBG-517, NDBG-603, NDBG-S-5 and NDBG-509 in both the years along with NDBG-504 in Y_1 and NDBG-601 in Y_2 for days to first fruit harvest; NDBG-624, NDBG-603, NDBG-517, NDBG-11 and Narendra Rashmi in both the years for vine length; NDBG-624, NDBG-S-5, Narendra Rashmi and Pusa Naveen in both the years along with NDBG-749-2 in Y_1 and NDBG-603 in Y_2 for number of primary branches per plant; NDBG-624, NDBG-517, NDBG-522 and NDBG-603 in both the years along with NDBG-104 in Y_1 and NDBG-11 in Y_2 for fruit length; NDBG-509, NDBG-603, NDBG-522 and NDBG-517 in both the years along with NDBG-749-2 in Y_1 and NDBG-S-5 in Y_2 for fruit circumference; NDBG-624, NDBG-749-2, NDBG-603, NDBG-S-5 and NDBG-517 in both the years for fruit weight; Narendra Rashmi, NDBG-504, Pusa Naveen, NDBG-509 and NDBG-S-5 in both the years for number of fruits per plant; NDBG-624, NDBG-509, Pusa Naveen, NDBG-504 and NDBG-517 in both the years for total soluble solids; NDBG-S-5, NDBG-

10, NDBG-522, NDBG-517 and NDBG-11 in both the years for ascorbic acid; Narendra Rashmi, NDBG-509, NDBG-749-2, Pusa Naveen and NDBG-624 in both the years for reducing sugars; NDBG-104, NDBG-10, NDBG-S-5, NDBG-11 and NDBG-517 in both the years and NDBG-603 in Y_2 for non-reducing sugars; NDBG-509 and Narendra Rashmi, NDBG-749-2, NDBG-11 in both the years along with Pusa Naveen in Y_1 and NDBG-624 in Y_2 for total sugars and NDBG-104, Narendra Rashmi, NDBG-509, NDBG-11 and Pusa Naveen in both the years for dry matter content in fruit. These lines have merit as promising parents for hybridization programme for bringing over all improvement in plant architecture in a component breeding approach ultimately leading to high yielding bottle gourd genotypes even if they have moderate or low fruit yield per plant.

4. A wide range of variation in the estimates of heterobeltiosis and standard heterosis in positive and negative direction were observed for all the traits studied. In case of fruit yield per plant, heterobeltiosis ranged from -32.77 to 71.42% and standard heterosis from -42.15 to 89.32% in Y_1 and heterobeltiosis ranged from-27.42 to 79.16% and standard heterosis from-33.69 to 96.90% in Y_2.
5. Out of 40 crosses, nineteen F_1's showed significant and positive heterosis over better parent and standard parent in Y_1 and twenty F_1's showed significant and positive heterosis over better parent and twenty one F_1's showed significant and positive standard heterosis in Y_2. The best five F_1's common over seasons for heterobeltiosis were NDBG-517 × Pusa Naveen, NDBG-749-2 × BG-S-5, NDBG-10 × Pusa Naveen, Narendra Rashmi × Pusa Naveen and NDBG-517 × NDBG-S-5. The best five F_1's common over both the seasons for standard heterosis were NDBG-749-2 × NDBG-S-5, NDBG-517 × Pusa Naveen, NDBG-517 × NDBG-S-5, NDBG-10 × Pusa Naveen and NDBG-11 × NDBG-S-5.
6. Analysis of variances for combining ability revealed that the partitioning of variances due to lines × testers showed highly significant differences for all the eighteen characters in both the years. Variances due to lines were significant for fruit length, fruit circumference, days to first staminate flower anthesis and dry matter content in fruit in both the years and for days to first fruit harvest in only Y_2. The variances due to testers were also highly significant for days to first staminate flower anthesis, days to first pistillate flower anthesis, node number to first staminate flower, fruit weight, number of fruits per plant, fruit yield per plant and dry matter content in fruit in both years and for total sugars in only Y_1 and days to first fruit harvest in only Y_2.

7. Lines NDBG-749-2, NDBG-10, Narendra Rashmi and NDBG-517 and testers NDBG-S-5 and Pusa Naveen in both the years showed desirable and significant gca effects for fruit yield per plant and several other important traits and emerge as valuable parents for hybridization programme for obtaining high yielding hybrid/varieties.

8. Lines NDBG-749-2 was found good general combiners for fruit yield per plant, days to first staminate flower anthesis, node number to first staminate flower, node number to first pistillate flower, number of primary branches per plant, fruit circumference, fruit weight, number of fruits per plant, ascorbic acid, non-reducing sugars and total sugars in both the years.

9. Thirteen crosses *viz*., NDBG-504 × NDBG-104, NDBG-509 × NDBG-104, NDBG-517 × Pusa Naveen, NDBG-517 × NDBG-S-5, NDBG-522 × NDBG-624, NDBG-601 × Pusa Naveen, NDBG-601 × NDBG-104, NDBG-603 × NDBG-624, NDBG-749-2 × NDBG-S-5, NDBG-749-2 × NDBG-104, NDBG-11 × NDBG-S-5, NDBG-10 × Pusa Naveen and Narendra Rashmi × Pusa Naveen showed significant and positive sca effects for fruit yield per plant as well as some other yield components over both the years.

10. The relative contribution of lines × testers component were higher than the lines and testers for all the characters in both the years, except fruit length and fruit circumference in Y_1 and days to first staminate flower anthesis, fruit length and fruit circumference in Y_2.

11. Combining ability analysis elucidated higher magnitude of variances due to sca (σ^2s) than variance due to gca (σ^2g) indicating preponderance of non-additive gene action for all the characters. The values of dominance genetic variances (σ^2D) were larger than additive genetic variance (σ^2A) and average degree of dominance were more than unity (>1) for all the characters under study except for days to first staminate flower anthesis, number of fruits per plant, fruit yield per plant and dry matter content in fruit in both the years and days to first pistillate flower anthesis in Y_2 which indicated existence of over dominance and controlled by a preponderance of non-additive gene effects suggesting thereby scope of development of F_1's as well as the recombinants within the segregating populations. Days to first staminate flower anthesis, number of fruits per plant, fruit yield per plant and dry matter content in fruit which had less than one value of average degree of dominance suggested existence of partial dominance.

12. The predictability ratio was lesser than (<1) for all the characters under study in both the years.

13. High estimate of heritability in narrow-sense was recorded for days to first staminate flower anthesis followed by dry matter content in fruit, fruit yield per plant, number of fruits per plant, fruit circumference, fruit weight, days to first pistillate flower anthesis, total sugars, ascorbic acid, total soluble solids, node number to first staminate flower, reducing sugars and fruit length in both years and for days to first fruit harvest in only Y_2.
14. Moderate estimate of heritability in narrow sense was observed for node number to first pistillate flower followed by number of primary branches per plant, days to first fruit harvest, vine length at last picking stage and non-reducing sugars in both the years which indicated that these traits are likely to provide reasonable selection response.
15. High estimate of genetic advance in per cent of mean (>20%) was observed for number of fruits per plant, fruit yield per plant and dry matter content in fruit in both the years.
16. Moderate estimate of genetic advance in per cent of mean was observed for fruit weight followed by number of primary branches per plant, vine length at last picking stage, total soluble solids and node number to first staminate flower in both the years and non-reducing sugars in only Y_2.
17. Clustering pattern of the genotypes of heterogeneous origin, indicating no parallelism between genetic and geographical diversity. All the parents and F_1's were grouped into eight clusters with different genotypes in both seasons which suggested that there were ample diversity within the experimental material.
18. Reducing sugar (Y_1) and total soluble solids (Y_2) contributed maximum towards total divergence, while minimum contribution was reflected by days to first pistillate flower anthesis and total sugars in both the years along with fruit weight in Y_1 and node number to first staminate flower, node number to first pistillate flower and vine length at last picking stage in Y_2.

Based on the above findings it may be concluded that crosses NDBG-749-2 × NDBG-S-5, NDBG-517 × Pusa Naveen, NDBG-517 × NDBG-S-5, NDBG-10 × Pusa Naveen and NDBG-11 × NDBG-S-5 which showed top heterosis over seasons, parents (better and standard) and also possessed attractive fruit shape as per market demand may be exploited as commercial hybrid in future. Parents NDBG-749-2, NDBG-10, Narendra Rashmi, NDBG-517, NDBG-S-5 and Pusa Naveen may be used in future crossing programme. Preponderance of dominant gene action along with over dominance in parents for most of the traits suggested that heterosis breeding approach might be more rewarding than selection in bottle gourd.

High heritability in narrow sense along with high genetic advance indicated that selection for number of fruits per plant, fruit yield per plant and dry matter content in fruit may give high response for yield improvement. Divergence analysis indicated that diverse crosses involving parents with different clusters reflects the chances of getting transgrassive segregates either by making three way crosses and or double crosses between the numbers of diverse clusters.

Thus, there is an ample scope for development of desirable F_1/segregates as per consumers choice to meet out the ever increasing demand of bottle gourd in future.