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# GENETICAL STUDIES FOR SEED YIELD AND YIELD CONTRIBUTING CHARACTERS IN COWPEA (*VIGNA UNGUICULATA* (L.) WALP)

**P. J. Shedge[1]*, D. K. Patil[2], H. V. Kalpande[1], S. P. Mehtre[1], V. K. Gite[1] and A. L. Dhamak[3]**

[1]Department of Genetics and plant breeding, VNMKV, Parbhani-431202, Maharashtra, India

[2]Department of Genetics and plant breeding, Agricultural research Station, Badnapur, Vasantrao Naik marathwada Krushi Vidyapith, Parbhani-431202, Maharashtra, India

[3]Department of Soil Science and Agricultural Chemistry, VNMKV, Parbhani-431202, Maharashtra, India

*Corresponding author Email: pranjalshedge22@gmail.com

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**ABSTRACT**

The experimental material consisted of 80 entries comprising 60 hybrids, five lines and twelve testers along with three check hybrids *viz*., PL3, DC15 and RC101. Significant genotypic differences were observed for characters, both at individual and pooled data from multiple locations indicating presence of diversity among the genotypes. The cross Phule Sonali x SNAGR 12-33 exhibited highest mid parent heterosis, better parent heterosis and standard heterosis over check DC15 in desirable directions for days to 50% flowering. Similarly, the cross GC3 x IC599262 exhibited significantly highest negative average heterosis. Highest heterobeltosis was recorded by Phule Sonali x SNAGR 12-33. The significantly superior standard heterosis over checks, DC 15, PL 3 and RC 101 in desirable direction was noticed in crosses *viz*., PL 4 x IC599262, Phule Sonali x SNAGR 12-33 and PL 4 x IC 599262 for days to maturity. The highest positive significant standard heterosis over all the three checks were recorded by promising crosses *viz*., GC 3 x EC 724805, PL 4 x EC 724805, GC 3 x EC 724382, Phule Sonali x 329764 and Phule Rakhumai x IC 626138 for seed yield per plant

***Keywords* :** Heterosis, cowpea, average heterosis, heterobeltosis, standard heterosis.

## Introduction

The cheapest source of proteins and minerals is cowpea. It is a vital source of protein for India's primarily vegetarian population. Young leaves, immature pods, and peas are all utilized as vegetables in fresh forms. Cowpea is sometimes referred to as "vegetable meat" due to its high protein content and high grain and biological value on a dry weight basis. All throughout India, cowpea is commercially farmed for a number of uses, including as a cover crop, a green manure source, a pulse crop with long, green pods, and cattle feed. Cowpea is appreciated for its high nutritional value as a food source, as fodder in animal feeds, and as a significant, less expensive method of enhancing and strengthening soil fertility through biological nitrogen fixation. Cowpea is just as crucial for human nutrition as it is for delivering the required protein and energy for raising cattle. More so, it is highly valued as forage and a possible fodder crop for the future due to its resilience to varied climatic conditions and its capacity to thrive in a less-fertile soil environment (Alemu *et al.,* 2016). The breeding of cultivars that possess early maturity, desirable grain and vegetable qualities, and resistance to key diseases and pests has notably enhanced both yield and the area under cultivation. The impact of plant breeding on genetic diversity has been a persistent topic of interest in the evolutionary biology of crop plants, as highlighted by Simmonds in 1962. In the genus *Vigna*, the transmission of advantageous features between genotypes with different genetic makeup has been thoroughly investigated (Hazra *et al.,* 2007). The significant breakthrough in yield advances could be made through exploitation of heterosis at commercial level. Thus, to get maximum yield, exploitation of heterosis breeding is gaining importance to find out superior crosses as the productivity in grain legumes depends on the direction and magnitude of heterosis. In addition to this, the magnitude of heterosis also provides a basis for determining genetic diversity and serves as a guide to the choice of desirable parents (Swindell and Poehlman, 1976). Modern cowpea varieties currently demonstrate reduced productivity, lack synchronized flowering and fruiting, insufficient reaction to increased input levels such as fertilizers, irrigation, and tillage, incompatibility with diverse cropping systems, susceptibility to lodging and shattering, lengthy growth periods and limited or absent genetic resistance to major insect pests and diseases like mosaic virus, rust, powdery mildew and bacterial blight. These factors resulted into significant damage and extremely low harvest yields. As the area, production and productivity is much lower indicating that cowpea remained as an orphan crop for breeding purpose throughout the world. But in order to meet self sufficiency of country and to increase its productivity up to desirable limits, setting different breeding goals and providing stable and high yielding varieties of cowpea is another challenge for breeders. Hence the crop is having the potential to get its place in food chain to meet the hunger of growing population. In the view of same the present investigation has been carried out to estimate heterosis for earliness and grain yield in cowpea.

## Material and Methods

### Description of Experimental Area

The experiment was conducted at three different cowpea-growing environments during *Kharif* 2023 which is the main cropping season in Marathwada region of Maharashtra, India. The three selected environments for testing experimental material were Parbhani, Badnapur and Aurangabad. These three locations representing three different agro-ecologies of Maharashtra which are descripted in table 1.

### Experimental Materials and Design

The experimental material was developed at the Agricultural Research Station, Badnapur during *kharif* 2022, by crossing five females with twelve males (Testers)in a Line x Tester mating system. The female lines were released varieties while male testers were collected from NBPGR, New Delhi. The characters of parental lines are presented in table 2. Thus, the experimental material consisted of 80 entries comprising 60 hybrids, five lines and twelve testers along with three check hybrids *viz.*, PL3, DC15 and RC101. The experiment was conducted using randomized block design with two replications each at three different locations and each genotype was assigned randomly. The seeds were planted with two rows, with an inter row spacing of 45 cm and 10 cm between seeds and rows respectively. The length of row was 4.00m$^2$. All agronomical practices were carried out as per recommendations.

### Data Collection and Data Analysis

Data for yield and yield related traits were collected on the basis of five sample plants which were randomly taken from the two central rows and their average were used for analysis. The collected data were analyzed using formulas as given below. For estimation of mid parent heterosis [($F_1$-MP)/MP] x 100, for heterobeltosis [($F_1$-BP)/BP] x 100 and for standard heterosis [($F_1$-check)/check] x 100 formulas were used in which MP = mean value of two parents and BP = Mean value of better parent.

## Result and Discussion

Various degrees of heterosis were assessed in the current study as a percentage increase or decrease in crosses over the mid-parent (average heterosis), better parent (heterobeltiosis), and the standard heterosis over the DC1 15, PL 3 and RC 101 standard checks. Table 4. displays the results of the pooled study across three environments together. The estimation of heterosis in pooled locations revealed that forty-nine, fifty-nine, twenty and no crosses evinced significant heterosis in desirable direction for days to 50% flowering and observed that the cross Phule Sonali x SNAGR 12-33 exhibited highest mid parent heterosis (-28.19%), better parent heterosis (-43.84%) and standard heterosis (-17.39%) over check DC 15 in desirable directions of days to 50% flowering. Similar findings were recorded by Pampaniya *et al.* (2017) in which days to 50% flowering displayed negative standard heterosis of -10.21%. While similar results with present investigation was also harmony Babariya *et al.* (2018) who noticed high magnitude of heterobeltotic effects in desired direction and Joshi *et al.* (2022) recorded negative significant heterobeltosis in six hybrids for days to 50% flowering. Similar results were also obtained by Lovely B. and V. Kumar (2024) and Dinakar *et al.* (2019).

The estimation of heterosis in pooled locations revealed that the cross GC 3 x IC 599262 exhibited significanty highest negative average heterosis (23.24%) while (-38.03%) highest heterobeltosis were recorded by Phule Sonali x SNAGR 12-33. The significantly superior standard heterosis over checks, DC 15, PL 3 and RC 101 in desirable direction were noticed in crosses *viz.*, PL 4 x IC 599262 (-6.63%), Phule Sonali x SNAGR 12-33 (-2.83%) and PL 4 x IC 599262 (-10.29%) respectively for days to maturity.

The similar findings were in accordance with Karpe (2002) who reported that the character days to maturity showed lower levels of heterosis. Pal *et al.* (2020) reported NDCP-13, Red seeded, Kala Zamala, cowpea local, Ramnagar kala and Pusa komal showed both the better parent and mid parent values in desirable direction and perform as promising parents for early maturity. similarly, the significant and desirable negative heterosis for days to maturity in all three bases of heterosis estimation were evinced by Patil and Gosavi (2007) and Joshi *et al.* (2022).

The data for pooled locations revealed that, among the sixty crosses, thirty-one, fifty, one, four and single cross exhibited significant negative heterosis over mid parent, better parent, standard checks *viz*., DC 15, PL 3 and RC 101 respectively for plant height. The cross combination of Phule Vithai x IC 326997 exhibited highest negative significant standard heterosis (-20.44%, -31.98% and -13.46%) over all standard checks for Plant height. According to Sarath P. S. and Reshma T. (2015) thirteen hybrids showed significant negative heterobeltosis for plant height and twelve hybrids showed significant negative heterosis while Pampaniya *et al.* (2017) showed highest economic heterosis 41.55% for plant height.

The pooled analysis for number of branches per plant revealed the cross, PL 4 × EC 101958 manifested highest and significant average heterosis (124.39%). Highest significant heterobeltiosis (105.56%) by cross Phule Sonali × EC 101958 and standard heterosis by cross GC 3 × IC 68786 (60.61%, 100% and 89.29%) for number of branches per plant over checks *viz*., DC 15, PL 3 and RC 101 in desired direction. Babariya *et al.* (2018) observed highest magnitude of standard heterosis for number of branches per plant.

The cross Phule Sonali × IC 628138 (92.41%) followed by Phule Rakhumai × IC 626138 (19.68%) and Phule Sonali × EC 101958 (86.50%) exhibited highest significant average heterosis for number of pods per plant in pooled location. The cross Phule Sonali × EC 101958 (83.28%) followed by Phule Sonali × SNAGR 12-33 (51.54%) and Phule Rakhumai × IC 599262 (49.00%) exhibited highest significant heterobeltosis for number of pods per plant in pooled location. While, the crosses showing significant standard heterosis over checks *viz*., DC 15 by Phule Sonali × EC 101958 (18.88%) , PL 3 by Phule Sonali × EC 101958 (31.42%) followed by Phule Rakhumai × IC 599262 (11.08%) and RC 101 by Phule Sonali× EC 101958 (22.54%) in pooled locations for the same character. Similar results of the current investigation confirm the heterotic expression for number of pods per plant at individual as well as pooled locations denoting the same reports as Kajale *et al.* (2013), El-Ameen *et al.* (2014), Pethe *et al.* (2014) and Get *et al.* (2021).

The estimation of heterosis in pooled data of three locations revealed that the crosses such as PL 4 × IC326997 (59.62%) and PL 4 × EC 738277 (33.67%) exhibited highest positively significant mid parent heterosis while PL 4 × IC326997 (49.23%) and PL 4 x EC 724805 (27.07%) highest positive and significant heterobeltosis for pod length. Whereas, the crosses Phule Sonali x IC 622602 (75.01%, 63.83% and 100.22%) followed by Phule Vithai x IC 622602 (64.68% 54.16% and 88.40%) and Phule Sonali x IC 626138 (64.09%, 53.61% and 87.73%) evinced highest maximum standard heterosis over checks *viz*., DC 15, PL 3, RC 101 respectively in positive direction for pod length. Similar findings were also reported by Kajale *et al.* (2013), El-Ameen *et al.* (2014) and Pethe *et al.* (2017) for positive and significant heterosis over mid, better and standard parent for pod length in cowpea.

The estimation of pooled heterosis for number of seeds per pod evinced that significantly positive heterosis in twenty-four, twelve, zero, ninteen and thirty-three crosses were observed for average heterosis, heterobeltosis and two standard heterosis over checks *viz*., DC 15, PL 3 and RC 101 respectively. The cross GC 3 x IC 626138 (35.45% and 46.49%) registered highest standard heterosis over checks PL 3 and RC 101. The highly significant mid parent heterosis and better parent heterosis was reported in cross Phule Sonali x IC 326997 (44.63% and 33.94%) and PL 4 × EC 738277 (27.56% and 25.15%) in pooled locations. However, four crosses over the better parent and five crosses over the standard check showed considerable and positive heterosis, according to Sarath P.S. and Reshma T. (2015). Similarly, for the number of seeds per pod, Gupta *et al.* (2020) and Babariya *et al.* (2018) observed considerable and positive heterosis.

The cross GC 3 x EC724382 (91.32%) recorded highest significantly mid parent heterosis and the cross Phule Vithai x EC724805 (83.35%) recorded highest better parent heterosis over mean heterotic value of three locations for 100 seed weight. Further, the top three crosses *viz*., PL 4 x IC202931 (162.11%, 138.14%, 158.00%) followed by GC 3 x EC724382 (145.33%, 122.90%, 141.49%) and PL 4 x EC724805 (132.86%, 111.56%, 129.31%) registered maximum pooled standard heterosis over checks *viz*., DC 15, PL 3 and RC 101 respectively.

Similar highest positive heterosis 38% for 100 seed weight reported by Patil and shete (1987) while substantial positive heterosis for test Weight (20.00%)

was noted by Bhushana *et al.* (2000). Patel (2000) found 48.20% heterotic effect of 100 seed weight. Patil *et al.* (2005) also reported twelve hybrids showing positive standard heterosis. Shirisha *et al.* (2022) reported wide range of relative heterosis from 13.92% to 100.96%, heterobeltosis from -26.20% to 77.92% and standard heterosis from 0.55% to 61.43% and 9.17% to 45.83%. Further, simillar results were also shown by Babariya *et al.* (2018), Get *et al.* (2021) and Pethe *et al.* (2017).

From the manifestation of heterosis in pooled locations, it was observed that, among the sixty crosses evaluated, forty-eight, forty thirty, ten, twenty-four and twenty-five crosses evinced highly significant positive average heterosis, heterobeltosis, standard heterosis over checks *viz*., DC 15, PL 3 and RC 101for seed yield per plant. The significant highest mid parent heterosis in positive direction were manifested by the crosses *viz*., Phule Rakhumai x IC 626138 (174.61%), GC 3 × EC724382 (148.94%), GC 3 x EC 738277 (137.98%), Phule Vithai x IC 622602 (132.08%) and GC 3 x EC 724805 (130.82%), whereas significant positive better parent heterosis were appeared in crosses *viz*., Phule Rakhumai x IC 626138 (166.21%), GC 3 × EC724382 (129.47%), GC 3 x EC 724805 (118.10%), Phule Vithai x IC 622602 (113.17%) and Phule Vithai x IC 626138 (111.60%).

Top most crosses showing highest significant positive standard heterosis over standard over checks *viz*., DC 15, PL 3 and RC 101 under the present study were observed in crosses like GC 3 x EC 724805 (35.54%, 85.95% and 90.48%) followed PL 4 x EC 724805 (29.99%, 78.34% and 82.67%) and GC 3 × EC724382 (26.89%, 74.09% and 78.32%).

Simillar results were coincides with Katariya *et al.* (2015) who revealed that the crosses GC 4 x Waghai local and W3-2 x W5 was found with highest standard heterosis 12.45% and 10.38% respectively for seed yield per plant as well as positive standard heterosis for pods per plant i.e., 5.82 and 4.85% according to Pampanita *et al.* (2017), the crosses GC-4 x CPD-11 and Anand Cowpea - 1 x Pusa Phalguni showed the highest economic heterosis, with values of 41.55% for plant height and 33.40% for seed yield per plant Get *et al.* (2021) observed that out of top five crosses, only one cross RC-19 x RC-101 exhibited desirable heterosis / heterobeltosis for pods per plant, pod length and 100 seed weight. Similar findings were also reported by Shirisha *et al.* (2022) who reveled in their study that most of the hybrids exhibited significant heterosis for different traits along with grain yield over better parent or standard checks.

The estimation of standard heterosis in pooled locations evinced that cross Phule Rakhumai x IC 329764 (1.53%, 8.16% and 9.23%) followed by GC 3 × EC 101958 (8.76%, 5.47% and 6.51%) and Phule Rakhumai x IC 68786 (7.79%, 4.53% and 5.57%) exhibited significantly more standard heterosis over checks *viz*., DC 15, PL 3 and RC 101 respectively for protein content. Patel *et al.* (2009) noted a positive heterosis over superior parent in cross GC9710 x CAZC 21 for protein content. Simillarly Patel *et al.* (2014) and Babariya *et al.* (2018) also observed significant heterotic effects for protein content.

**Table 1:** Description of the test environments.

| Sr. No. | Details | Locations (Environments) | | |
|---|---|---|---|---|
| | | Parbhani ($L_1$) | Badnapur ($L_2$) | Aurangabad ($L_3$) |
| 1 | Latitude | 19.25° N | 19.86° N | 18.72° N |
| 2 | Longitude | 75.76° E | 75.70° E | 76.38° E |
| 3 | Altitude | 478.77 m | 586.65 m | 637 m |
| 4 | Date of sowing | 27/06/2022 | 01/07/2022 | 03/07/2022 |
| Location details: | | | | |
| $L_1$: Experimental farm, Safflower Research Station, VNMKV, Parbhani. Dist. Parbhani | | | | |
| $L_2$: Experimental farm, Agricultural Research Station, Badnapur. Dist. Jalana | | | | |
| $L_3$: Experimental farm, National Agricultural Research Project, Aurangabad. Dist. Aurangabad | | | | |

**Table 2 :** Mean and stability parameters for seed yield per plant in cowpea.

| Sr. No | Parents | Source | Characteristics of parents |
|---|---|---|---|
| Females | | | |
| 1. | PL 4 | ARS, Badnapur | Early |
| 2. | Phule Vithai | MPKV, Rahuri | High yielding, indeterminate, dark purple flowers |
| 3. | GC 3 | ARS, Badnapur | Light brown seed color |
| 4. | Phule Rakhumai | MPKV, Rahuri | High yielding, indeterminate. |
| 5. | Phule Sonali | MPKV, Rahuri | High yielding. |

| | | | |
|---|---|---|---|
| Males | | | |
| 1. | EC 101958 | Collection from NBPGR, New Delhi | White colored flowers |
| 2. | IC 68786 | | High yield and good number of pods |
| 3. | IC 329764 | | Dark purple colored flowers |
| 4. | IC 599262 | | High yielder |
| 5. | SNAGR 12-33 | | Long pod |
| 6. | IC 326997 | | High 100 seed weight |
| 7. | IC 202931 | | High yielder |
| 8. | EC 724805 | | High pod length |
| 9. | EC 738277 | | Long pod |
| 10. | IC 622602 | | Long pod |
| 11. | IC 626138 | | Yellow colored flowers |
| 12. | EC 724382 | | High yielder |
| Checks | | | |
| 1. | PL 3 | ARS, Badnapur | 50-55 cm tall, bush type, brown colored seeds |
| 2. | DC 15 | ARS, Badnapur | Wide adaptability |
| 3. | RC 101 | ARS, Badnapur | Early maturing |

**Table 3 :** Top ranking pooled heterotic crosses and their per se performance for seed yield and related traits in cowpea, *Kharif* 2023.

| Sr. No. | Name of cross | Seed yield / Plant (g) | Heterosis for yield over BPH and best check | | Significant heterosis in desired direction for other characters over check | |
|---|---|---|---|---|---|---|
| | | | BPH | DC 15 | PL 3 | RC 101 |
| 1. | GC 3 x EC 724805 | 31.33 | 118.10** | 35.54 ** | NOB, NOSP, HSW | DM,NOB,PL, NOSP, HSW |
| 2. | PL 4 x EC 724805 | 30.05 | 109.16 ** | 29.99 ** | PL, NOSP, HSW | DM, PL, NOSP, HSW |
| 3. | GC 3 x EC 724382 | 29.33 | 129.47 ** | 26.89 ** | NOB, HSW | NOB, HSW |
| 4. | Phule Sonali x IC 329764 | 27.87 | 83.53 ** | 20.55 ** | NOB, NOSP, HSW | DM, NOB, PL, NOSP, HSW |
| 5. | Phule Rakhumai x IC 626138 | 26.13 | 166.21 ** | 13.05 ** | PL, NOSP, HSW | PL, NOSP, HSW |

*Significant at 5% level, **Significant at 1% level

Whereas,

DF = Days to 50% flowering NOSP = Number of seeds per plant
DM = Days to maturity PL = Pod length
PH = Plant height (cm) HSW = Hundred seed weight
NOB = Number of branches

**Table 4 :** Per cent mid parent heterosis (MPH), better parent heterosis (BPH) and standard heterosis over DC 15 ($SH_1$), PL 3 ($SH_2$) and RC 101 ($SH_3$) estimated over locations for different quantitative traits in cowpea, *Kharif* 2023.

| Sr. No. | Crosses | Days to 50% flowering | | | | | Days to Maturity | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | MPH | BPH | $SH_1$ | $SH_2$ | $SH_3$ | MPH | BPH | $SH_1$ | $SH_2$ | $SH_3$ |
| **1.** | PL 4 x EC 101958 | -3.65 ** | -19.94 ** | 0.36 | 17.87 ** | 23.11 ** | -1.72 * | -18.79 ** | 9.18 ** | 10.03 ** | 4.90 ** |
| **2.** | PL 4 x IC 68786 | -6.62 ** | -19.37 ** | -7.97 ** | 8.09 ** | 12.89 ** | -15.14 ** | -31.23 ** | -2.81 * | -2.06 | -6.62 ** |
| **3.** | PL 4 x IC 329764 | -1.47 | -15.14 ** | -2.54 | 14.47 ** | 19.56 ** | -3.01 ** | -19.42 ** | 6.89 ** | 7.71 ** | 2.70 * |
| **4.** | PL 4 x IC 599262 | -18.04 ** | -31.58 ** | -15.22 ** | -0.43 | 4.00 * | -21.29 ** | -37.54 ** | -6.63 ** | -5.91 ** | -10.29 ** |
| **5.** | PL 4 x SNAGR 12-33 | -0.79 | -22.41 ** | 14.13 ** | 34.04 ** | 40.00 ** | -5.87 ** | -26.39 ** | 14.54 ** | 15.42 ** | 10.05 ** |
| **6.** | PL 4 x IC 326997 | -0.74 | -14.06 ** | -2.54 | 14.47 ** | 19.56 ** | 1.39 | -15.64 ** | 11.48 ** | 12.34 ** | 7.11 ** |
| **7.** | PL 4 x IC 202931 | -12.04 ** | -30.46 ** | -0.72 | 16.60 ** | 21.78 ** | -6.64 ** | -23.02 ** | 4.08 ** | 4.88 ** | 0 |
| **8.** | PL 4 x EC 724805 | -10.00 ** | -21.86 ** | -11.96 ** | 3.40 * | 8.00 ** | -5.76 ** | -19.80 ** | 0.26 | 1.03 | -3.68 ** |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **9.** | PL 4 x EC 738277 | -11.40 ** | -23.49 ** | -12.68 ** | 2.55 | 7.11 ** | -2.14 * | -17.14 ** | 4.85 ** | 5.66 ** | 0.74 |
| **10.** | PL 4 x IC 622602 | -9.42 ** | -27.13 ** | -0.72 | 16.60 ** | 21.78 ** | -10.79 ** | -27.75 ** | 2.30 * | 3.08 ** | -1.72 |
| **11.** | PL 4 x IC 626138 | 3.34 * | -6.07 ** | -4.71 ** | 11.91 ** | 16.89 ** | -9.09 ** | -24.76 ** | 0.77 | 1.54 | -3.19 ** |
| **12.** | PL 4 x EC 724382 | -6.98 ** | -26.93 ** | 6.16 ** | 24.68 ** | 30.22 ** | -2.89 ** | -21.40 ** | 11.48 ** | 12.34 ** | 7.11 ** |
| **13.** | Phule Vithai x EC 101958 | -13.33 ** | -21.10 ** | -1.09 | 16.17 ** | 21.33 ** | -16.15 ** | -25.62 ** | 0.00 | 0.77 | -3.92 ** |
| **14.** | Phule Vithai x IC 68786 | -12.52 ** | -16.83 ** | -5.07 ** | 11.49 ** | 16.44 ** | -17.88 ** | -28.70 ** | 0.77 | 1.54 | -3.19 ** |
| **15.** | Phule Vithai x IC 329764 | -18.14 ** | -22.40 ** | -10.87 ** | 4.68 ** | 9.33 ** | -10.99 ** | -20.58 ** | 5.36 ** | 6.17 ** | 1.23 |
| **16.** | Phule Vithai x IC 599262 | -17.25 ** | -24.27 ** | -6.16 ** | 10.21 ** | 15.11 ** | -22.74 ** | -34.47 ** | -2.04 | -1.29 | -5.88 ** |
| **17.** | Phule Vithai x SNAGR 12-33 | -20.29 ** | -32.27 ** | -0.36 | 17.02 ** | 22.22 ** | -17.88 ** | -31.48 ** | 6.63 ** | 7.46 ** | 2.45 * |
| **18.** | Phule Vithai x IC 326997 | -7.20 ** | -11.50 ** | 0.36 | 17.87 ** | 23.11 ** | -2.38 ** | -12.74 ** | 15.31 ** | 16.20 ** | 10.78 ** |
| **19.** | Phule Vithai x IC 202931 | -13.27 ** | -25.38 ** | 6.52 ** | 25.11 ** | 30.67 ** | -2.99 ** | -14.15 ** | 16.07 ** | 16.97 ** | 11.52 ** |
| **20.** | Phule Vithai x EC 724805 | -7.56 ** | -11.58 ** | -0.36 | 17.02 ** | 22.22 ** | -2.90 ** | -11.02 ** | 11.22 ** | 12.08 ** | 6.86 ** |
| **21.** | Phule Vithai x EC 738277 | -1.17 | -6.03 ** | 7.25 ** | 25.96 ** | 31.56 ** | -1.33 | -10.08 ** | 13.78 ** | 14.65 ** | 9.31 ** |
| **22.** | Phule Vithai x IC 622602 | -20.61 ** | -30.32 ** | -5.07 ** | 11.49 ** | 16.44 ** | -12.98 ** | -24.50 ** | 6.89 ** | 7.71 ** | 2.70 * |
| **23.** | Phule Vithai x IC 626138 | -6.38 ** | -7.04 ** | -4.35 ** | 12.34 ** | 17.33 ** | -15.54 ** | -24.95 ** | 0.51 | 1.29 | -3.43 ** |
| **24.** | Phule Vithai x EC 724382 | -19.42 ** | -31.17 ** | 0 | 17.45 ** | 22.67 ** | -15.77 ** | -26.98 ** | 3.57 ** | 4.37 ** | -0.49 |
| **25.** | GC 3 x EC 101958 | -11.95 ** | -19.08 ** | 1.45 | 19.15 ** | 24.44 ** | -14.03 ** | -19.17 ** | 8.67 ** | 9.51 ** | 4.41 ** |
| **26.** | GC 3 x IC 68786 | -4.46 ** | -8.25 ** | 4.71 ** | 22.98 ** | 28.44 ** | -9.82 ** | -17.15 ** | 17.09 ** | 17.99 ** | 12.50 ** |
| **27.** | GC 3 x IC 329764 | -11.37 ** | -15.14 ** | -2.54 | 14.47 ** | 19.56 ** | -13.82 ** | -18.46 ** | 8.16 ** | 9.00 ** | 3.92 ** |
| **28.** | GC 3 x IC 599262 | -12.03 ** | -18.71 ** | 0.72 | 18.30 ** | 23.56 ** | -23.24 ** | -31.23 ** | 2.81 * | 3.60 ** | -1.23 |
| **29.** | GC 3 x SNAGR 12-33 | -12.07 ** | -24.63 ** | 10.87 ** | 30.21 ** | 36.00 ** | -19.18 ** | -28.85 ** | 10.71 ** | 11.57 ** | 6.37 ** |
| | **Crosses** | **Days to 50% flowering** | | | | | **Days to Maturity** | | | | |
| | | **MPH** | **BPH** | **$SH_1$** | **$SH_2$** | **$SH_3$** | **MPH** | **BPH** | **$SH_1$** | **$SH_2$** | **$SH_3$** |
| **30.** | GC 3 x IC 326997 | -5.80 ** | -9.27 ** | 2.90 * | 20.85 ** | 26.22 ** | -6.72 ** | -11.58 ** | 16.84 ** | 17.74 ** | 12.25 ** |
| **31.** | GC 3 x IC 202931 | -17.54 ** | -28.43 ** | 2.17 | 20.00 ** | 25.33 ** | -12.07 ** | -17.55 ** | 11.48 ** | 12.34 ** | 7.11 ** |
| **32.** | GC 3 x EC 724805 | -14.48 ** | -17.36 ** | -6.88 ** | 9.36 ** | 14.22 ** | -16.77 ** | -18.98 ** | 1.28 | 2.06 | -2.70 * |
| **33.** | GC 3 x EC 738277 | -10.08 ** | -13.65 ** | -1.45 | 15.74 ** | 20.89 ** | -14.38 ** | -17.14 ** | 4.85 ** | 5.66 ** | 0.74 |
| **34.** | GC 3 x IC 622602 | -3.60 ** | -14.63 ** | 16.30 ** | 36.60 ** | 42.67 ** | -10.70 ** | -18.02 ** | 16.07 ** | 16.97 ** | 11.52 ** |
| **35.** | GC 3 x IC 626138 | 19.30 ** | 17.24 ** | 23.19 ** | 44.68 ** | 51.11 ** | -2.33 ** | -8.00 ** | 23.21 ** | 24.16 ** | 18.38 ** |
| **36.** | GC 3 x EC 724382 | -6.22 ** | -19.20 ** | 17.39 ** | 37.87 ** | 44.00 ** | -7.25 ** | -14.93 ** | 20.66 ** | 21.59 ** | 15.93 ** |
| **37.** | Phule Rakhumai x EC 101958 | -0.78 | -8.09 ** | 15.22 ** | 35.32 ** | 41.33 ** | -5.34 ** | -14.23 ** | 15.31 ** | 16.20 ** | 10.78 ** |
| **38.** | Phule Rakhumai x IC 68786 | -1.97 | -5.08 ** | 8.33 ** | 27.23 ** | 32.89 ** | -9.37 ** | -19.68 ** | 13.52 ** | 14.40 ** | 9.07 ** |
| **39.** | Phule Rakhumai x IC 329764 | -3.59 ** | -6.94 ** | 6.88 ** | 25.53 ** | 31.11 ** | 3.38 ** | -5.77 ** | 25.00 ** | 25.96 ** | 20.10 ** |
| **40.** | Phule Rakhumai x IC 599262 | -10.83 ** | -16.96 ** | 2.90 * | 20.85 ** | 26.22 ** | -13.41 ** | -25.09 ** | 11.99 ** | 12.85 ** | 7.60 ** |
| **41.** | Phule Rakhumai x SNAGR 12-33 | -14.41 ** | -26.11 ** | 8.70 ** | 27.66 ** | 33.33 ** | -13.29 ** | -26.23 ** | 14.80 ** | 15.68 ** | 10.29 ** |
| **42.** | Phule Rakhumai x IC 326997 | -14.8 | -17.25 ** | -6.16 ** | 10.21 ** | 15.11 ** | -15.22 ** | -22.59 ** | 2.30 * | 3.08 ** | -1.72 |
| **43.** | Phule Rakhumai x IC 202931 | -6.82 ** | -18.53 ** | 16.30 ** | 36.60 ** | 42.67 ** | 0.42 | -9.25 ** | 22.70 ** | 23.65 ** | 17.89 ** |
| **44.** | Phule Rakhumai x EC 724805 | -13.86 ** | -16.08 ** | -5.43 ** | 11.06 ** | 16.00 ** | -9.59 ** | -15.31 ** | 5.87 ** | 6.68 ** | 1.72 |
| **45.** | Phule Rakhumai x EC 738277 | -15.74 ** | -18.41 ** | -6.88 ** | 9.36 ** | 14.22 ** | -5.19 ** | -11.69 ** | 11.73 ** | 12.60 ** | 7.35 ** |
| **46.** | Phule Rakhumai x IC 622602 | -12.97 ** | -22.34 ** | 5.80 ** | 24.26 ** | 29.78 ** | -5.19 ** | -16.04 ** | 18.88 ** | 19.79 ** | 14.22 ** |
| **47.** | Phule Rakhumai x IC 626138 | -9.22 ** | -11.53 ** | -5.43 ** | 11.06 ** | 16.00 ** | -5.98 ** | -14.67 ** | 14.29 ** | 15.17 ** | 9.80 ** |
| **48.** | Phule Rakhumai x EC 724382 | -13.79 ** | -25.19 ** | 8.70 ** | 27.66 ** | 33.33 ** | -8.94 ** | -19.42 ** | 14.29 ** | 15.17 ** | 9.80 ** |
| **49.** | Phule Sonali x EC 101958 | -7.13 ** | -22.83 ** | -3.26 * | 13.62 ** | 18.67 ** | 1.45 | -13.85 ** | 15.82 ** | 16.71 ** | 11.27 ** |
| **50.** | Phule Sonali x IC 68786 | -6.99 ** | -19.68 ** | -8.33 ** | 7.66 ** | 12.44 ** | -9.11 ** | -24.37 ** | 6.89 ** | 7.71 ** | 2.70 * |
| **51.** | Phule Sonali x IC 329764 | -4.03 ** | -17.35 ** | -5.07 ** | 11.49 ** | 16.44 ** | -13.06 ** | -25.77 ** | -1.53 | -0.77 | -5.39 ** |
| **52.** | Phule Sonali x IC 599262 | -9.28 ** | -24.27 ** | -6.16 ** | 10.21 ** | 15.11 ** | -16.77 ** | -32.25 ** | 1.28 | 2.06 | -2.70 * |
| **53.** | Phule Sonali x SNAGR 12-33 | -28.19 ** | -43.84 ** | -17.39 ** | -2.98 | 1.33 | -22.70 ** | -38.03 ** | -3.57 ** | -2.83 * | -7.35 ** |
| **54.** | Phule Sonali x IC 326997 | -4.80 ** | -17.57 ** | -6.52 ** | 9.79 ** | 14.67 ** | -5.87 ** | -19.50 ** | 6.38 ** | 7.20 ** | 2.21 * |
| **55.** | Phule Sonali x IC 202931 | -9.15 ** | -28.17 ** | 2.54 | 20.43 ** | 25.78 ** | -6.46 ** | -20.75 ** | 7.14 ** | 7.97 ** | 2.94 ** |
| **56.** | Phule Sonali x EC 724805 | 8.15 ** | -6.11 ** | 5.80 ** | 24.26 ** | 29.78 ** | -2.10 * | -14.29 ** | 7.14 ** | 7.97 ** | 2.94 ** |
| **57.** | Phule Sonali x EC 738277 | -2.57 * | -15.87 ** | -3.99 ** | 12.77 ** | 17.78 ** | -6.48 ** | -18.55 ** | 3.06 ** | 3.86 ** | -0.98 |
| **58.** | Phule Sonali x IC 622602 | -7.11 ** | -25.27 ** | 1.81 | 19.57 ** | 24.89 ** | -7.69 ** | -23.24 ** | 8.67 ** | 9.51 ** | 4.41 ** |
| **59.** | Phule Sonali x IC 626138 | 4.52 ** | -5.00 ** | -3.62 * | 13.19 ** | 18.22 ** | -6.61 ** | -20.57 ** | 6.38 ** | 7.20 ** | 2.21 * |
| **60.** | Phule Sonali x EC 724382 | -16.83 ** | -34.66 ** | -5.07 ** | 11.49 ** | 16.44 ** | -8.44 ** | -23.92 ** | 7.91 ** | 8.74 ** | 3.68 ** |

**Table 4. Continue….**

| Sr. No. | Crosses | Plant height | | | | | Number of branches per plant | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | MPH | BPH | $SH_1$ | $SH_2$ | $SH_3$ | MPH | BPH | $SH_1$ | $SH_2$ | $SH_3$ |
| **1.** | PL 4 x EC 101958 | 50.84** | -2.58 | 92.52** | 64.60** | 109.39** | 121.60** | 114.73** | 59.20** | 62.94** | 61.05** |
| **2.** | PL 4 x IC 68786 | -25.72** | -53.36** | 5.1 | -10.14 | 14.31* | 2.5 | -17.59** | -5.75 | -3.53 | -4.65 |
| **3.** | PL 4 x IC 329764 | -16.01** | -47.23** | 18.55** | 1.36 | 28.94** | 38.17** | 11.73** | 25.86** | 28.82** | 27.33** |
| **4.** | PL 4 x IC 599262 | 0.71 | -31.10** | 7.82 | -7.81 | 17.27** | 4.87 | -27.10** | 29.89** | 32.94** | 31.40** |
| **5.** | PL 4 x SNAGR 12-33 | 57.45** | -4.31* | 155.89** | 118.78** | 178.32** | 70.72** | 37.00** | 57.47** | 61.18** | 59.30** |
| **6.** | PL 4 x IC 326997 | -0.18 | -28.95** | -3.32 | -17.34** | 5.15 | 25.08** | 3.23 | 10.34* | 12.94** | 11.63* |
| **7.** | PL 4 x IC 202931 | 61.20** | -1.35 | 153.94** | 117.11** | 176.20** | 71.75** | 56.08** | 32.76** | 35.88** | 34.30** |
| **8.** | PL 4 x EC 724805 | 52.29** | 1.54 | 75.48** | 50.03** | 90.86** | 5.54 | -12.90** | -6.9 | -4.71 | -5.81 |
| **9.** | PL 4 x EC 738277 | 33.93** | -16.40** | 93.91** | 65.79** | 110.90** | 56.39** | 43.45** | 19.54** | 22.35** | 20.93** |
| **10.** | PL 4 x IC 622602 | 1.96 | -37.20** | 56.10** | 33.46** | 69.78** | 55.19** | 54.55** | 7.47 | 10.00* | 8.72 |
| **11.** | PL 4 x IC 626138 | 8.13* | -31.77** | 50.08** | 28.31** | 63.23** | 40.62** | 33.33** | 3.45 | 5.88 | 4.65 |
| **12.** | PL 4 x EC 724382 | 36.35** | -13.28** | 83.78** | 57.12** | 99.88** | 94.95** | 73.08** | 55.17** | 58.82** | 56.98** |
| **13.** | Phule Vithai x EC 101958 | -15.80** | -29.31** | 39.70** | 19.44** | 51.94** | 115.87** | 110.85** | 56.32** | 60.00** | 58.14** |
| **14.** | Phule Vithai x IC 68786 | -19.20** | -35.54** | 45.25** | 24.19** | 57.98** | 60.87** | 30.15** | 48.85** | 52.35** | 50.58** |
| **15.** | Phule Vithai x IC 329764 | 1.11 | -19.24** | 81.43** | 55.12** | 97.33** | 63.64** | 33.16** | 50.00** | 53.53** | 51.74** |
| **16.** | Phule Vithai x IC 599262 | -23.21** | -28.67** | 11.62* | -4.57 | 21.40** | -15.01** | -40.65** | 5.75 | 8.24 | 6.98 |
| **17.** | Phule Vithai x SNAGR 12-33 | -30.39** | -47.73** | 39.79** | 19.51** | 52.04** | 56.66** | 26.50** | 45.40** | 48.82** | 47.09** |
| **18.** | Phule Vithai x IC 326997 | -41.13** | -41.53** | -20.44** | -31.98** | -13.46* | 22.33** | 1.61 | 8.62 | 11.18* | 9.88* |
| **19.** | Phule Vithai x IC 202931 | -21.43** | -40.23** | 53.87** | 31.55** | 67.35** | 38.01** | 26.35** | 7.47 | 10.00* | 8.72 |
| **20.** | Phule Vithai x EC 724805 | -13.41** | -23.08** | 32.93** | 13.65** | 44.58** | -4.85 | -20.97** | -15.52** | -13.53** | -14.53** |
| **21.** | Phule Vithai x EC 738277 | -35.82** | -49.34** | 17.50** | 0.46 | 27.80** | 49.25** | 37.93** | 14.94** | 17.65** | 16.28** |
| **22.** | Phule Vithai x IC 622602 | -12.44** | -32.58** | 67.57** | 43.27** | 82.26** | 57.20** | 55.28** | 9.77* | 12.35* | 11.05* |
| **23.** | Phule Vithai x IC 626138 | -18.03** | -34.01** | 45.15** | 24.10** | 57.87** | 37.21** | 31.11** | 1.72 | 4.12 | 2.91 |
| **24.** | Phule Vithai x EC 724382 | -16.77** | -32.03** | 44.06** | 23.16** | 56.68** | 70.61** | 52.56** | 36.78** | 40.00** | 38.37** |
| **25.** | GC 3 x EC 101958 | -9.28** | -12.17** | 73.56** | 48.39** | 88.77** | 78.63** | 75.94** | 34.48** | 37.65** | 36.05** |
| **26.** | GC 3 x IC 68786 | -14.26** | -21.93** | 75.93** | 50.41** | 91.34** | 86.75** | 55.78** | 78.16** | 82.35** | 80.23** |
| **27.** | GC 3 x IC 329764 | -25.32** | -31.91** | 52.97** | 30.79** | 66.38** | 41.64** | 18.88** | 33.91** | 37.06** | 35.47** |
| **28.** | GC 3 x IC 599262 | -11.14** | -18.00** | 51.73** | 29.72** | 65.02** | -13.32** | -38.06** | 10.34* | 12.94** | 11.63* |
| **29.** | GC 3 x SNAGR 12-33 | -9.87** | -23.75** | 103.89** | 74.32** | 121.76** | -18.92** | -32.50** | -22.41** | -20.59** | -21.51** |
| | **Crosses** | **Plant height** | | | | | **Number of branches per plant** | | | | |
| | | **MPH** | **BPH** | **$SH_1$** | **$SH_2$** | **$SH_3$** | **MPH** | **BPH** | **$SH_1$** | **$SH_2$** | **$SH_3$** |
| **30.** | GC 3 x IC 326997 | 15.45** | 0.18 | 85.35** | 58.47** | 101.60** | 16.61** | 0 | 6.9 | 9.41 | 8.14 |
| **31.** | GC 3 x IC 202931 | -0.87 | -14.81** | 119.29** | 87.49** | 138.51** | 58.72** | 50.68** | 28.16** | 31.18** | 29.65** |
| **32.** | GC 3 x EC 724805 | -18.21** | -20.91** | 46.34** | 25.12** | 59.16** | 28.53** | 10.22* | 17.82** | 20.59** | 19.19** |
| **33.** | GC 3 x EC 738277 | -4.38* | -14.05** | 99.36** | 70.44** | 116.83** | 43.88** | 37.93** | 14.94** | 17.65** | 16.28** |
| **34.** | GC 3 x IC 622602 | -9.46** | -21.03** | 96.28** | 67.81** | 113.48** | 69.96** | 61.65** | 23.56** | 26.47** | 25.00** |
| **35.** | GC 3 x IC 626138 | -2.09 | -9.87** | 98.25** | 69.49** | 115.62** | 66.42** | 65.19** | 28.16** | 31.18** | 29.65** |
| **36.** | GC 3 x EC 724382 | -3.16 | -9.31** | 92.21** | 64.33** | 109.05** | 37.02** | 26.92** | 13.79** | 16.47** | 15.12** |
| **37.** | Phule Rakhumai x EC 101958 | 0.96 | -7.40** | 82.98** | 56.44** | 99.01** | 24.83** | 10.06* | 6.9 | 9.41 | 8.14 |
| **38.** | Phule Rakhumai x IC 68786 | -4.52* | -17.33** | 86.28** | 59.26** | 102.61** | 3.26 | -4.52 | 9.2 | 11.76* | 10.47* |
| **39.** | Phule Rakhumai x IC 329764 | -3.28 | -16.15** | 88.37** | 61.05** | 104.88** | 6.3 | -1.02 | 11.49* | 14.12** | 12.79** |
| **40.** | Phule Rakhumai x IC 599262 | 30.35** | 27.03** | 109.44** | 79.06** | 127.80** | -16.49** | -35.48** | 14.94** | 17.65** | 16.28** |
| **41.** | Phule Rakhumai x SNAGR 12-33 | 10.13** | -10.99** | 138.03** | 103.51** | 158.90** | 35.50** | 25.00** | 43.68** | 47.06** | 45.35** |
| **42.** | Phule Rakhumai x IC 326997 | 24.64** | 13.75** | 87.55** | 60.35** | 103.99** | -10.42** | -14.52** | -8.62 | -6.47 | -7.56 |
| **43.** | Phule Rakhumai x IC 202931 | 25.78** | 3.17 | 165.59** | 127.07** | 188.87** | -25.55** | -30.18** | -32.18** | -30.59** | -31.40** |
| **44.** | Phule Rakhumai x EC 724805 | -7.31** | -9.44** | 56.51** | 33.81** | 70.23** | 14.93** | 9.68* | 17.24** | 20.00** | 18.60** |
| **45.** | Phule Rakhumai x EC 738277 | -4.87* | -18.63** | 88.73** | 61.36** | 105.28** | 9.55* | 1.78 | -1.15 | 1.18 | 0 |
| **46.** | Phule Rakhumai x IC 622602 | 43.21** | 19.10** | 196.02** | 153.09** | 221.97** | 35.64** | 15.98** | 12.64** | 15.29** | 13.95** |
| **47.** | Phule Rakhumai x IC 626138 | 13.45** | -0.76 | 118.28** | 86.62** | 137.41** | 21.05** | 8.88 | 5.75 | 8.24 | 6.98 |
| **48.** | Phule Rakhumai x EC 724382 | -2.95 | -13.72** | 82.85** | 56.33** | 98.88** | 14.46** | 10.06* | 6.9 | 9.41 | 8.14 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **49.** | Phule Sonali x EC 101958 | -5.82* | -27.20** | 43.86** | 23.00** | 56.47** | 86.09** | 65.89** | 22.99** | 25.88** | 24.42** |
| **50.** | Phule Sonali x IC 68786 | -45.77** | -59.90** | -9.64 | -22.74** | -1.72 | 41.33** | 6.53 | 21.84** | 24.71** | 23.26** |
| **51.** | Phule Sonali x IC 329764 | -31.76** | -49.49** | 13.47** | -2.98 | 23.42** | 27.95** | -3.06 | 9.2 | 11.76* | 10.47* |
| **52.** | Phule Sonali x IC 599262 | -14.42** | -27.71** | 13.13* | -3.28 | 23.04** | -12.41** | -41.94** | 3.45 | 5.88 | 4.65 |
| **53.** | Phule Sonali x SNAGR 12-33 | -30.45** | -51.19** | 30.52** | 11.59** | 41.96** | 50.83** | 13.50** | 30.46** | 33.53** | 31.98** |
| **54.** | Phule Sonali x IC 326997 | -25.15** | -32.90** | -8.69 | -21.93** | -0.69 | 42.16** | 9.68* | 17.24** | 20.00** | 18.60** |
| **55.** | Phule Sonali x IC 202931 | 12.01** | -20.52** | 104.61** | 74.93** | 122.54** | 56.63** | 31.76** | 12.07* | 14.71** | 13.37** |
| **56.** | Phule Sonali x EC 724805 | -2.26 | -20.61** | 37.19** | 17.29** | 49.21** | 42.86** | 10.22* | 17.82** | 20.59** | 19.19** |
| **57.** | Phule Sonali x EC 738277 | 14.39** | -16.20** | 94.37** | 66.18** | 111.41** | 43.90** | 22.07** | 1.72 | 4.12 | 2.91 |
| **58.** | Phule Sonali x IC 622602 | 13.67** | -18.49** | 102.59** | 73.21** | 120.35** | 55.66** | 43.33** | -1.15 | 1.18 | 0 |
| **59.** | Phule Sonali x IC 626138 | 40.69** | 4.85* | 130.62** | 97.17** | 150.83** | 55.08** | 35.56** | 5.17 | 7.65 | 6.4 |
| **60.** | Phule Sonali x EC 724382 | -6.19* | -29.21** | 50.02** | 28.26** | 63.16** | 43.97** | 18.59** | 6.32 | 8.82 | 7.56 |

## Table 4. Continue….

| Sr. No. | Crosses | Number of pods per plant | | | | | Pod length | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | MPH | BPH | $SH_1$ | $SH_2$ | $SH_3$ | MPH | BPH | $SH_1$ | $SH_2$ | $SH_3$ |
| **1.** | PL 4 x EC 101958 | -5.67 | -10.74* | -42.10** | -36.00** | -40.32** | 3.51 | 1.69 | -2.07 | -8.33* | 12.03** |
| **2.** | PL 4 x IC 68786 | -7.72 | -7.99 | -46.72** | -41.11** | -45.08** | 1.98 | 1.97 | -1.78 | -8.05* | 12.37** |
| **3.** | PL 4 x IC 329764 | 37.30** | 22.06** | -29.33** | -21.87** | -27.15** | 17.50** | 16.67** | 13.98** | 6.7 | 30.39** |
| **4.** | PL 4 x IC 599262 | -4.98 | -15.81** | -51.25** | -46.11** | -49.75** | 5.11 | 2.47 | -1.32 | -7.62* | 12.89** |
| **5.** | PL 4 x SNAGR 12-33 | 61.03** | 35.44** | -21.58** | -13.31** | -19.17** | 2.18 | 2.02 | -1.75 | -8.03* | 12.40** |
| **6.** | PL 4 x IC 326997 | 22.48** | -7.99 | -46.72** | -41.11** | -45.08** | 59.62** | 49.23** | 43.72** | 34.54** | 64.41** |
| **7.** | PL 4 x IC 202931 | -30.14** | -41.76** | -66.28** | -62.73** | -65.24** | 20.89** | 18.25** | 19.08** | 11.48** | 36.23** |
| **8.** | PL 4 x EC 724805 | 25.53** | -1.83 | -43.16** | -37.17** | -41.41** | 28.82** | 27.07** | 25.79** | 17.75** | 43.90** |
| **9.** | PL 4 x EC 738277 | 59.83** | 24.46** | -27.94** | -20.34** | -25.72** | 33.67** | 20.69** | 44.26** | 35.04** | 65.03** |
| **10.** | PL 4 x IC 622602 | 10.8 | -15.14** | -50.87** | -45.69** | -49.35** | -10.17** | -34.80** | 39.06** | 30.18** | 59.08** |
| **11.** | PL 4 x IC 626138 | 34.07** | 1.5 | -41.23** | -35.04** | -39.42** | 1.77 | -17.93** | 28.99** | 20.75** | 47.56** |
| **12.** | PL 4 x EC 724382 | 46.73** | 21.46** | -29.67** | -22.26** | -27.51** | 14.66** | 8.80* | 4.78 | -1.92 | 19.87** |
| **13.** | Phule Vithai x EC 101958 | 34.45** | 27.43** | -17.34** | -8.63* | -14.80** | -1.26 | -8.44* | -0.45 | -6.81 | 13.89** |
| **14.** | Phule Vithai x IC 68786 | -6.71 | -7.13 | -46.05** | -40.36** | -44.39** | 10.09** | 3.81 | 12.87** | 5.66 | 29.13** |
| **15.** | Phule Vithai x IC 329764 | -4.73 | -15.42** | -50.87** | -45.69** | -49.35** | 7.79* | 2.32 | 11.25** | 4.14 | 27.27** |
| **16.** | Phule Vithai x IC 599262 | 28.96** | 14.10** | -33.72** | -26.73** | -31.68** | 19.25** | 9.78** | 19.36** | 11.74** | 36.55** |
| **17.** | Phule Vithai x SNAGR 12-33 | 57.95** | 32.67** | -22.93** | -14.80** | -20.56** | 3.9 | -2.19 | 6.35 | -0.44 | 21.67** |
| **18.** | Phule Vithai x IC 326997 | 65.08** | 23.88** | -28.03** | -20.45** | -25.82** | 18.42** | 4.83 | 13.98** | 6.7 | 30.39** |
| **19.** | Phule Vithai x IC 202931 | 2.59 | -14.59** | -50.39** | -45.15** | -48.86** | 4.06 | 0.22 | 8.96* | 2 | 24.66** |
| **20.** | Phule Vithai x EC 724805 | -12.95* | -32.01** | -60.50** | -56.34** | -59.29** | 13.21** | 8.14* | 17.58** | 10.07** | 34.51** |
| **21.** | Phule Vithai x EC 738277 | -14.71* | -33.67** | -61.46** | -57.40** | -60.28** | 19.00** | 13.62** | 35.81** | 27.14** | 55.37** |
| **22.** | Phule Vithai x IC 622602 | 85.35** | 41.79** | -17.63** | -8.95* | -15.09** | 2.28 | -22.79** | 64.68** | 54.16** | 88.40** |
| **23.** | Phule Vithai x IC 626138 | 83.33** | 38.64** | -19.46** | -10.97** | -16.98** | 17.76** | -0.39 | 56.56** | 46.56** | 79.11** |
| **24.** | Phule Vithai x EC 724382 | 20.76** | -0.17 | -42.00** | -35.89** | -40.22** | 15.46** | 3.64 | 12.68** | 5.48 | 28.91** |
| **25.** | GC 3 x EC 101958 | -15.94** | -20.04** | -42.53** | -36.47** | -40.76** | 6.38 | 4.31 | 0.85 | -5.59 | 15.37** |
| **26.** | GC 3 x IC 68786 | 24.60** | 12.20** | -19.36** | -10.86** | -16.88** | 14.13** | 13.92** | 10.14* | 3.11 | 26.00** |
| **27.** | GC 3 x IC 329764 | 19.31** | -2.95 | -30.25** | -22.90** | -28.10** | 20.03** | 19.41** | 16.66** | 9.21* | 33.46** |
| **28.** | GC 3 x IC 599262 | -9.59* | -26.68** | -47.30** | -41.75** | -45.68** | 13.18** | 10.12* | 6.47 | -0.33 | 21.80** |
| **29.** | GC 3 x SNAGR 12-33 | 71.80** | 33.11** | -4.34 | 5.75 | -1.39 | 17.04** | 16.62** | 12.75** | 5.55 | 28.99** |
| | Crosses | Number of pods per plant | | | | | Pod length | | | | |
| | | MPH | BPH | $SH_1$ | $SH_2$ | $SH_3$ | MPH | BPH | $SH_1$ | $SH_2$ | $SH_3$ |
| **30.** | GC 3 x IC 326997 | 62.21** | 13.94** | -18.11** | -9.48** | -15.59** | 17.12** | 9.30* | 5.67 | -1.08 | 20.89** |
| **31.** | GC 3 x IC 202931 | 60.75** | 23.58** | -11.18** | -1.82 | -8.45** | 26.02** | 23.50** | 24.38** | 16.43** | 42.29** |
| **32.** | GC 3 x EC 724805 | 75.12** | 27.35** | -8.48** | 1.17 | -5.66 | 14.84** | 13.50** | 12.35** | 5.18 | 28.53** |
| **33.** | GC 3 x EC 738277 | 65.03** | 19.57** | -14.07** | -5.01 | -11.42** | 31.24** | 18.70** | 41.88** | 32.82** | 62.31** |
| **34.** | GC 3 x IC 622602 | -5.03 | -32.17** | -51.25** | -46.11** | -49.75** | -12.69** | -36.56** | 35.32** | 26.67** | 54.80** |
| **35.** | GC 3 x IC 626138 | 39.03** | -1.69 | -29.34** | -21.90** | -27.17** | 13.64** | -8.23** | 44.25** | 35.03** | 65.02** |
| **36.** | GC 3 x EC 724382 | 60.70** | 22.79** | -11.75** | -2.45 | -9.04** | -5.24 | -10.25* | -13.22** | -18.77** | -0.73 |
| **37.** | Phule Rakhumai x EC 101958 | 22.48** | 20.14** | -18.98** | -10.44** | -16.48** | -5.03 | -7.24 | -13.81** | -19.32** | -1.4 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **38.** | Phule Rakhumai x IC 68786 | 28.62** | 19.20** | -19.61** | -11.14** | -17.14** | 1.34 | -2.74 | -6.31 | -12.29** | 7.19 |
| **39.** | Phule Rakhumai x IC 329764 | -6.47 | -22.00** | -47.40** | -41.85** | -45.78** | 6.58 | 1.61 | -0.73 | -7.07 | 13.57** |
| **40.** | Phule Rakhumai x IC 599262 | 79.21** | 49.00** | 0.48 | 11.08** | 3.57 | 5.51 | 3.86 | -5.01 | -11.08** | 8.67 |
| **41.** | Phule Rakhumai x SNAGR 12-33 | 48.11** | 17.43** | -20.81** | -12.46** | -18.37** | 2.18 | -1.76 | -5.69 | -11.72** | 7.89 |
| **42.** | Phule Rakhumai x IC 326997 | 40.92** | 0.86 | -31.98** | -24.81** | -29.89** | 18.88** | 15.64** | 2.45 | -4.1 | 17.20** |
| **43.** | Phule Rakhumai x IC 202931 | -42.96** | -55.14** | -69.75** | -66.56** | -68.82** | 18.96** | 11.80** | 12.59** | 5.4 | 28.80** |
| **44.** | Phule Rakhumai x EC 724805 | 21.66** | -9.71* | -39.11** | -32.69** | -37.24** | 22.05** | 15.64** | 14.47** | 7.16 | 30.96** |
| **45.** | Phule Rakhumai x EC 738277 | 11.88* | -17.29** | -44.22** | -38.34** | -42.50** | 26.47** | 10.10** | 31.60** | 23.19** | 50.55** |
| **46.** | Phule Rakhumai x IC 622602 | -18.79** | -40.86** | -60.12** | -55.91** | -58.89** | 3.82 | -26.53** | 56.71** | 46.70** | 79.27** |
| **47.** | Phule Rakhumai x IC 626138 | 90.68** | 37.43** | -7.32* | 2.45 | -4.47 | 27.53** | -0.3 | 56.71** | 46.70** | 79.27** |
| **48.** | Phule Rakhumai x EC 724382 | 7.31 | -16.14** | -43.45** | -37.49** | -41.71** | 10.36** | 9.03* | -3.41 | -9.58* | 10.50* |
| **49.** | Phule Sonali x EC 101958 | 86.50** | 83.28** | 18.88** | 31.42** | 22.54** | -3.93 | -6.26 | -8.45* | -14.30** | 4.74 |
| **50.** | Phule Sonali x IC 68786 | 15.43** | 10.77* | -30.64** | -23.32** | -28.50** | -0.79 | -1.47 | -3.76 | -9.91** | 10.09* |
| **51.** | Phule Sonali x IC 329764 | 64.46** | 41.38** | -11.46** | -2.13 | -8.74** | 14.44** | 14.43** | 11.79** | 4.65 | 27.89** |
| **52.** | Phule Sonali x IC 599262 | -22.80** | -33.85** | -58.57** | -54.21** | -57.30** | 13.73** | 10.12* | 7.55 | 0.68 | 23.04** |
| **53.** | Phule Sonali x SNAGR 12-33 | 85.85** | 51.54** | -5.11 | 4.90 | -2.18 | 8.81* | 7.88 | 5.36 | -1.37 | 20.54** |
| **54.** | Phule Sonali x IC 326997 | 8.05 | -20.88** | -50.45** | -45.23** | -48.93** | 17.96** | 9.56* | 7.01 | 0.18 | 22.42** |
| **55.** | Phule Sonali x IC 202931 | -19.70** | -35.08** | -59.34** | -55.06** | -58.09** | 24.45** | 22.57** | 23.44** | 15.55** | 41.21** |
| **56.** | Phule Sonali x EC 724805 | 75.53** | 33.54** | -16.38** | -7.56* | -13.80** | -3.95 | -4.59 | -5.55 | -11.59** | 8.05 |
| **57.** | Phule Sonali x EC 738277 | 75.12** | 27.35** | -8.48** | 1.17 | -5.66 | 14.84** | 13.50** | 12.35** | 5.18 | 28.53** |
| **58.** | Phule Sonali x IC 622602 | 65.03** | 19.57** | -14.07** | -5.01 | -11.42** | 31.24** | 18.70** | 41.88** | 32.82** | 62.31** |
| **59.** | Phule Sonali x IC 626138 | -5.03 | -32.17** | -51.25** | -46.11** | -49.75** | -12.69** | -36.56** | 35.32** | 26.67** | 54.80** |
| **60.** | Phule Sonali x EC 724382 | 39.03** | -1.69 | -29.34** | -21.90** | -27.17** | 13.64** | -8.23** | 44.25** | 35.03** | 65.02** |

## Table 4. Continue….

| Sr. No. | Crosses | Number of seeds per pod | | | | | 100 seed weight | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | MPH | BPH | $SH_1$ | $SH_2$ | $SH_3$ | MPH | BPH | $SH_1$ | $SH_2$ | $SH_3$ |
| **1.** | PL 4 x EC 101958 | -0.07 | -4.5 | -28.04** | -4.63 | 3.15 | 23.36** | -1.74 | 58.40** | 43.91** | 55.91** |
| **2.** | PL 4 x IC 68786 | -2.63 | -9.28* | -27.84** | -4.37 | 3.43 | 3.85 | -13.36** | 39.67** | 26.90** | 37.48** |
| **3.** | PL 4 x IC 329764 | -9.15** | -20.97** | -26.65** | -2.78 | 5.15 | 8.60* | -8.30* | 47.83** | 34.31** | 45.51** |
| **4.** | PL 4 x IC 599262 | -2.79 | -6.45 | -30.54** | -7.94 | -0.43 | 9.85** | 9.38* | 76.33** | 60.20** | 73.56** |
| **5.** | PL 4 x SNAGR 12-33 | 3.79 | 2.26 | -27.64** | -4.1 | 3.72 | 15.64** | 11.41** | 79.60** | 63.17** | 76.78** |
| **6.** | PL 4 x IC 326997 | 22.75** | 11.77* | -23.25** | 1.72 | 10.01* | 9.73** | 15.44** | 86.10** | 69.08** | 83.18** |
| **7.** | PL 4 x IC 202931 | 0.28 | -2.6 | -29.04** | -5.95 | 1.72 | 54.69** | 62.59** | 162.11** | 138.14** | 158.00** |
| **8.** | PL 4 x EC 724805 | 15.14** | 3.73 | -11.18** | 17.72** | 27.32** | 16.09** | 44.45** | 132.86** | 111.56** | 129.21** |
| **9.** | PL 4 x EC 738277 | 27.56** | 25.15** | -14.07** | 13.89** | 23.18** | 6.10* | 31.41** | 111.85** | 92.47** | 108.52** |
| **10.** | PL 4 x IC 622602 | -11.95** | -25.75** | -25.75** | -1.59 | 6.44 | 11.22** | 13.16** | 82.43** | 65.75** | 79.57** |
| **11.** | PL 4 x IC 626138 | -0.74 | -14.12** | -19.26** | 7.01 | 15.74** | 32.96** | 19.67** | 92.91** | 75.27** | 89.89** |
| **12.** | PL 4 x EC 724382 | 9.18* | 5.41 | -22.26** | 3.04 | 11.44* | 19.54** | 13.29** | 82.64** | 65.94** | 79.77** |
| **13.** | Phule Vithai x EC 101958 | -14.76** | -15.50** | -36.33** | -15.61** | -8.73 | 48.97** | 37.65** | 55.17** | 40.98** | 52.73** |
| **14.** | Phule Vithai x IC 68786 | 6.82 | 3.14 | -17.96** | 8.73* | 17.60** | 0.8 | -1.41 | 11.13 | 0.97 | 9.39 |
| **15.** | Phule Vithai x IC 329764 | -3.47 | -13.23** | -19.46** | 6.75 | 15.45** | 42.72** | 41.65** | 59.68** | 45.08** | 57.17** |
| **16.** | Phule Vithai x IC 599262 | 4.98 | 4.84 | -22.16** | 3.17 | 11.59* | -13.83** | 4.17 | 17.43** | 6.69 | 15.58* |
| **17.** | Phule Vithai x SNAGR 12-33 | 3.93 | 1.62 | -24.75** | -0.26 | 7.87 | 5.59 | 22.77** | 38.39** | 25.74** | 36.22** |
| **18.** | Phule Vithai x IC 326997 | 8.03 | -4.85 | -29.54** | -6.61 | 1 | -3.81 | 24.03** | 39.82** | 27.03** | 37.63** |
| **19.** | Phule Vithai x IC 202931 | 18.34** | 17.39** | -13.07** | 15.21** | 24.61** | 6.87 | 37.65** | 55.17** | 40.98** | 52.73** |
| **20.** | Phule Vithai x EC 724805 | -6.38 | -12.70** | -25.25** | -0.93 | 7.15 | 17.21** | 83.35** | 106.69** | 87.79** | 103.45** |
| **21.** | Phule Vithai x EC 738277 | 23.93** | 17.25** | -13.17** | 15.08** | 24.46** | -4.23 | 49.03** | 68.00** | 52.64** | 65.37** |
| **22.** | Phule Vithai x IC 622602 | 9.63** | -4.59 | -4.59 | 26.46** | 36.77** | 1.52 | 25.89** | 41.92** | 28.94** | 39.69** |
| **23.** | Phule Vithai x IC 626138 | -4.04 | -14.23** | -19.36** | 6.88 | 15.59** | 16.25** | 24.63** | 40.49** | 27.64** | 38.29** |
| **24.** | Phule Vithai x EC 724382 | 9.79** | 9.57* | -18.86** | 7.54 | 16.31** | -5.39 | 7.89 | 21.62** | 10.5 | 19.71** |
| **25.** | GC 3 x EC 101958 | 3.56 | 1.99 | -23.15** | 1.85 | 10.16* | -13.18* | -19.57** | -9.83 | -18.08** | -11.25 |
| **26.** | GC 3 x IC 68786 | 8.57* | 4.14 | -17.17** | 9.79* | 18.74** | 1.56 | -0.39 | 11.66 | 1.45 | 9.91 |
| **27.** | GC 3 x IC 329764 | 15.52** | 3.23 | -4.19 | 26.98** | 37.34** | 18.67** | 18.11** | 32.40** | 20.29** | 30.32** |
| **28.** | GC 3 x IC 599262 | 7.45* | 6.59 | -20.86** | 4.89 | 13.45** | -2.9 | -17.40** | 32.02** | 19.95** | 29.95** |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **29.** | GC 3 x SNAGR 12-33 | 17.14** | 15.30** | -15.77** | 11.64** | 20.74** | 6.78 | -6.55 | 39.61** | 26.84** | 37.42** |
| | **Crosses** | **Number of seeds per pod** | | | | | **100 seed weight** | | | | |
| | | **MPH** | **BPH** | **$SH_1$** | **$SH_2$** | **$SH_3$** | **MPH** | **BPH** | **$SH_1$** | **$SH_2$** | **$SH_3$** |
| **30.** | GC 3 x IC 326997 | 13.03** | 0.14 | -26.85** | -3.04 | 4.86 | 2.18 | -16.73** | 48.21** | 34.65** | 45.88** |
| **31.** | GC 3 x IC 202931 | 1.37 | 1.23 | -26.05** | -1.98 | 6.01 | 34.60** | 9.76** | 95.01** | 77.18** | 91.95** |
| **32.** | GC 3 x EC 724805 | 4.4 | -3.26 | -17.17** | 9.79* | 18.74** | -3.51 | -29.21** | 69.85** | 54.32** | 67.18** |
| **33.** | GC 3 x EC 738277 | 24.53** | 18.58** | -13.37** | 14.81** | 24.18** | -8.99** | -33.08** | 59.36** | 44.79** | 56.86** |
| **34.** | GC 3 x IC 622602 | 13.84** | -1.5 | -1.5 | 30.56** | 41.20** | 8.25* | -9.51* | 50.98** | 37.17** | 48.61** |
| **35.** | GC 3 x IC 626138 | 22.34** | 8.70* | 2.2 | 35.45** | 46.49** | 18.29** | 10.55* | 42.59** | 29.55** | 40.35** |
| **36.** | GC 3 x EC 724382 | -13.39** | -13.80** | -36.43** | -15.74** | -8.87 | 91.32** | 69.93** | 145.33** | 122.90** | 141.49** |
| **37.** | Phule Rakhumai x EC 101958 | -16.00** | -21.06** | -40.52** | -21.16** | -14.74** | 17.79** | 17.26* | 13.11* | 2.76 | 11.33 |
| **38.** | Phule Rakhumai x IC 68786 | -5.82 | -13.68** | -31.34** | -8.99* | -1.57 | 29.36** | 22.57** | 32.10** | 20.02** | 30.03** |
| **39.** | Phule Rakhumai x IC 329764 | -7.40* | -20.65** | -26.35** | -2.38 | 5.58 | 14.34** | 6.84 | 18.62** | 7.77 | 16.76* |
| **40.** | Phule Rakhumai x IC 599262 | 3.69 | -1.88 | -27.15** | -3.44 | 4.43 | -15.37** | -32.14** | 8.45 | -1.47 | 6.75 |
| **41.** | Phule Rakhumai x SNAGR 12-33 | 3.57 | 0.28 | -29.04** | -5.95 | 1.72 | 20.36** | -0.97 | 47.96** | 34.43** | 45.63** |
| **42.** | Phule Rakhumai x IC 326997 | 20.26** | 11.30* | -26.25** | -2.25 | 5.72 | 17.94** | -9.07* | 61.84** | 47.04** | 59.30** |
| **43.** | Phule Rakhumai x IC 202931 | -1.87 | -6.3 | -31.74** | -9.52* | -2.15 | 34.25** | 3.56 | 84.00** | 67.17** | 81.11** |
| **44.** | Phule Rakhumai x EC 724805 | 4.86 | -6.99 | -20.36** | 5.56 | 14.16** | -7.42* | -35.10** | 55.71** | 41.47** | 53.27** |
| **45.** | Phule Rakhumai x EC 738277 | 23.98** | 23.80** | -17.96** | 8.73* | 17.60** | -6.86* | -34.56** | 55.82** | 41.57** | 53.37** |
| **46.** | Phule Rakhumai x IC 622602 | 0.84 | -16.17** | -16.17** | 11.11** | 20.17** | 16.27** | -8.26* | 53.07** | 39.07** | 50.67** |
| **47.** | Phule Rakhumai x IC 626138 | 15.07** | -1.91 | -7.78* | 22.22** | 32.19** | 17.12** | 2.36 | 32.02** | 19.95** | 29.95** |
| **48.** | Phule Rakhumai x EC 724382 | 0.36 | -4.74 | -29.74** | -6.88 | 0.72 | -3.96 | -19.90** | 15.64* | 5.07 | 13.83* |
| **49.** | Phule Sonali x EC 101958 | -11.14** | -16.56** | -37.13** | -16.67** | -9.87* | 32.24** | 13.00** | 52.36** | 38.43** | 49.97** |
| **50.** | Phule Sonali x IC 68786 | 15.21** | 5.52 | -16.07** | 11.24** | 20.31** | -0.29 | -10.30* | 20.95** | 9.89 | 19.05** |
| **51.** | Phule Sonali x IC 329764 | 7.97* | -7.53* | -14.17** | 13.76** | 23.03** | 27.93** | 16.64** | 57.27** | 42.88** | 54.80** |
| **52.** | Phule Sonali x IC 599262 | -3.34 | -8.60* | -32.14** | -10.05* | -2.72 | 9.25* | 0.71 | 60.96** | 46.24** | 58.43** |
| **53.** | Phule Sonali x SNAGR 12-33 | 10.79** | 7.19 | -24.15** | 0.53 | 8.73 | 23.44** | 17.42** | 75.42** | 59.38** | 72.67** |
| **54.** | Phule Sonali x IC 326997 | 44.63** | 33.94** | -11.38** | 17.46** | 27.04** | 36.61** | 20.05** | 113.67** | 94.13** | 110.32** |
| **55.** | Phule Sonali x IC 202931 | 13.42** | 8.22 | -21.16** | 4.5 | 13.02** | 19.44** | 5.04 | 86.62** | 69.56** | 83.69** |
| **56.** | Phule Sonali x EC 724805 | -21.50** | -30.42** | -40.42** | -21.03** | -14.59** | -15.35** | -33.89** | 58.63** | 44.12** | 56.14** |
| **57.** | Phule Sonali x EC 738277 | 21.36** | 21.27** | -19.76** | 6.35 | 15.02** | -21.84** | -38.79** | 45.75** | 32.43** | 43.47** |
| **58.** | Phule Sonali x IC 622602 | 3.78 | -13.77** | -13.77** | 14.29** | 23.61** | 13.96** | 3.03 | 71.90** | 56.18** | 69.21** |
| **59.** | Phule Sonali x IC 626138 | -8.04* | -21.66** | -26.35** | -2.38 | 5.58 | 41.80** | 38.72** | 87.04** | 69.94** | 84.11** |
| **60.** | Phule Sonali x EC 724382 | 9.84* | 4.19 | -23.15** | 1.85 | 10.16* | 23.11** | 19.04** | 71.86** | 56.14** | 69.16** |

**Table 4. Continue….**

| **Sr. No.** | **Crosses** | **Yield per plant** | | | | | **Protein** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **MPH** | **BPH** | **$SH_1$** | **$SH_2$** | **$SH_3$** | **MPH** | **BPH** | **$SH_1$** | **$SH_2$** | **$SH_3$** |
| **1.** | PL 4 x EC 101958 | 41.59** | 16.07** | -28.03** | -1.27 | 1.13 | 6.21** | -0.66 | 0.6 | -2.45 | -1.48 |
| **2.** | PL 4 x IC 68786 | -10.52 | -13.49* | -46.36** | -26.41** | -24.62** | 5.38** | -3.84** | -2.62 | -5.56** | -4.63** |
| **3.** | PL 4 x IC 329764 | 53.57** | 26.16** | -21.77** | 7.32 | 9.93 | 8.54** | 1.2 | 2.49 | -0.61 | 0.37 |
| **4.** | PL 4 x IC 599262 | 2.91 | -3.26 | -40.01** | -17.71** | -15.70** | -0.95 | -5.41** | -4.21** | -7.10** | -6.18** |
| **5.** | PL 4 x SNAGR 12-33 | 93.01** | 63.84** | 1.59 | 39.37** | 42.76** | 6.63** | 1.54 | 2.83* | -0.28 | 0.71 |
| **6.** | PL 4 x IC 326997 | 40.85** | 11.86 | -30.64** | -4.85 | -2.53 | 2.24 | -4.80** | -3.59* | -6.50** | -5.58** |
| **7.** | PL 4 x IC 202931 | 28.89** | 20.35** | -25.38** | 2.37 | 4.86 | 0.81 | -1.85 | -0.6 | -3.61** | -2.66 |
| **8.** | PL 4 x EC 724805 | 109.41** | 109.16** | 29.99** | 78.34** | 82.67** | 3.42** | -3.18* | -1.94 | -4.91** | -3.97** |
| **9.** | PL 4 x EC 738277 | 127.02** | 79.77** | 11.46** | 52.92** | 56.64** | 4.40** | -2.35 | -1.11 | -4.10** | -3.15* |
| **10.** | PL 4 x IC 622602 | 58.69** | 28.62** | -20.25** | 9.41 | 12.07* | -17.63** | -21.33** | -12.46** | -15.11** | -14.27** |
| **11.** | PL 4 x IC 626138 | 102.41** | 66.28** | 3.1 | 41.44** | 44.88** | -8.73** | -9.23** | -8.07** | -10.85** | -9.97** |
| **12.** | PL 4 x EC 724382 | 90.44** | 66.86** | 3.46 | 41.94** | 45.39** | 8.03** | 0.54 | 1.82 | -1.26 | -0.28 |
| **13.** | Phule Vithai x EC 101958 | 82.49** | 69.91** | -21.85** | 7.22 | 9.83 | 11.45** | 5.55** | 4.07** | 0.93 | 1.92 |
| **14.** | Phule Vithai x IC 68786 | -10.06 | -19.30** | -53.28** | -35.91** | -34.35** | 5.36** | -2.68 | -4.04** | -6.94** | -6.02** |
| **15.** | Phule Vithai x IC 329764 | 20.91** | 12.85 | -48.09** | -28.78** | -27.05** | 6.96** | 0.98 | -0.43 | -3.44* | -2.48 |
| **16.** | Phule Vithai x IC 599262 | 13.26* | 4.36 | -43.04** | -21.86** | -19.96** | 1.11 | -2.2 | -3.57* | -6.48** | -5.56** |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **17.** | Phule Vithai x SNAGR 12-33 | 101.94** | 95.92** | -9.88** | 23.64** | 26.65** | 4.31** | 0.61 | -0.8 | -3.80** | -2.85* |
| **18.** | Phule Vithai x IC 326997 | 63.29** | 46.39** | -32.66** | -7.62 | -5.37 | 3.87** | -2.08 | -3.44* | -6.36** | -5.44** |
| **19.** | Phule Vithai x IC 202931 | 24.57** | 15.55* | -37.85** | -14.74** | -12.66* | 2.38 | 0.99 | -0.42 | -3.43* | -2.48 |
| **20.** | Phule Vithai x EC 724805 | -0.8 | -13.69* | -46.36** | -26.41** | -24.62** | 7.83** | 2.23 | 0.8 | -2.25 | -1.28 |
| **21.** | Phule Vithai x EC 738277 | 34.04** | 19.75* | -44.92** | -24.43** | -22.59** | 4.30** | -1.22 | -2.6 | -5.54** | -4.61** |
| **22.** | Phule Vithai x IC 622602 | 132.08** | 113.17** | -1.95 | 34.52** | 37.79** | -12.63** | -17.60** | -8.32** | -11.09** | -10.22** |
| **23.** | Phule Vithai x IC 626138 | 126.70** | 111.60** | -2.67 | 33.53** | 36.78** | -2.54* | -3.29* | -3.14* | -6.07** | -5.14** |
| **24.** | Phule Vithai x EC 724382 | 11.28 | 10.51 | -48.45** | -29.28** | -27.56** | 4.21** | -1.8 | -3.17* | -6.10** | -5.17** |
| **25.** | GC 3 x EC 101958 | -23.31** | -34.16** | -63.59** | -50.05** | -48.83** | 16.01** | 9.48** | 8.76** | 5.47** | 6.51** |
| **26.** | GC 3 x IC 68786 | 21.78** | 19.05** | -31.07** | -5.44 | -3.14 | 4.08** | -4.19** | -4.82** | -7.70** | -6.79** |
| **27.** | GC 3 x IC 329764 | 80.30** | 55.15** | -14.20** | 17.71** | 20.57** | 3.11* | -3.00* | -3.63** | -6.55** | -5.63** |
| **28.** | GC 3 x IC 599262 | -2.62 | -3.26 | -46.50** | -26.61** | -24.82** | 0.95 | -2.70 | -3.35* | -6.27** | -5.34** |
| **29.** | GC 3 x SNAGR 12-33 | 128.38** | 103.52** | 12.55** | 54.40** | 58.16** | 0.06 | -3.84** | -4.47** | -7.36** | -6.45** |
| | **Crosses** | **Yield per plant** | | | | | **Protein** | | | | |
| | | **MPH** | **BPH** | **$SH_1$** | **$SH_2$** | **$SH_3$** | **MPH** | **BPH** | **$SH_1$** | **$SH_2$** | **$SH_3$** |
| **30.** | GC 3 x IC 326997 | 89.95** | 57.63** | -12.83** | 19.58** | 22.49** | 5.81** | -0.59 | -1.24 | -4.23** | -3.28* |
| **31.** | GC 3 x IC 202931 | 87.18** | 84.62** | 2.09 | 40.06** | 43.47** | -2.01 | -3.69** | -4.33** | -7.22** | -6.31** |
| **32.** | GC 3 x EC 724805 | 130.82** | 118.10** | 35.54** | 85.95** | 90.48** | 2.31 | -3.34* | -3.98** | -6.88** | -5.96** |
| **33.** | GC 3 x EC 738277 | 137.98** | 96.87** | 8.87* | 49.36** | 52.99** | 9.70** | 3.53* | 2.85* | -0.26 | 0.73 |
| **34.** | GC 3 x IC 622602 | 57.72** | 33.77** | -26.03** | 1.48 | 3.95 | -5.62** | -10.68** | -0.62 | -3.62** | -2.67 |
| **35.** | GC 3 x IC 626138 | 116.97** | 86.70** | 3.24 | 41.64** | 45.09** | -1.11 | -1.52 | -1.36 | -4.34** | -3.40* |
| **36.** | GC 3 x EC 724382 | 148.94** | 129.47** | 26.89** | 74.09** | 78.32** | 10.05** | 3.35* | 2.67 | -0.44 | 0.55 |
| **37.** | Phule Rakhumai x EC 101958 | 15.72* | 11.88 | -52.49** | -34.82** | -33.23** | 5.58** | -0.61 | -0.74 | -3.74** | -2.79* |
| **38.** | Phule Rakhumai x IC 68786 | 37.93** | 19.55** | -30.79** | -5.04 | -2.74 | 17.54** | 7.94** | 7.79** | 4.53** | 5.57** |
| **39.** | Phule Rakhumai x IC 329764 | 11.73 | 8.32 | -54.00** | -36.89** | -35.36** | 19.00** | 11.68** | 11.53** | 8.16** | 9.23** |
| **40.** | Phule Rakhumai x IC 599262 | 58.40** | 40.82** | -23.14** | 5.44 | 8 | -0.67 | -4.50** | -4.63** | -7.52** | -6.60** |
| **41.** | Phule Rakhumai x SNAGR 12-33 | 80.15** | 78.50** | -22.78** | 5.93 | 8.51 | 3.99** | -0.31 | -0.45 | -3.46* | -2.5 |
| **42.** | Phule Rakhumai x IC 326997 | 112.79** | 97.79** | -16.01** | 15.23** | 18.03** | 4.83** | -1.75 | -1.88 | -4.85** | -3.91** |
| **43.** | Phule Rakhumai x IC 202931 | -24.19** | -32.17** | -63.52** | -49.95** | -48.73** | -1.37 | -3.32* | -3.45* | -6.37** | -5.44** |
| **44.** | Phule Rakhumai x EC 724805 | 33.29** | 12.18* | -30.28** | -4.35 | -2.03 | 4.17** | -1.83 | -1.97 | -4.93** | -3.99** |
| **45.** | Phule Rakhumai x EC 738277 | 81.30** | 67.91** | -28.70** | -2.18 | 0.2 | 4.75** | -1.38 | -1.52 | -4.50** | -3.55** |
| **46.** | Phule Rakhumai x IC 622602 | 28.58** | 22.58* | -47.95** | -28.59** | -26.85** | -6.28** | -11.08** | -1.07 | -4.06** | -3.11* |
| **47.** | Phule Rakhumai x IC 626138 | 174.61** | 166.21** | 13.05** | 55.09** | 58.87** | -2.46* | -2.6 | -2.45 | -5.40** | -4.46** |
| **48.** | Phule Rakhumai x EC 724382 | 30.74** | 24.88** | -41.74** | -20.08** | -18.14** | 0.38 | -5.97** | -6.09** | -8.94** | -8.03** |
| **49.** | Phule Sonali x EC 101958 | 109.72** | 68.17** | 10.45** | 51.53** | 55.22** | 2.68* | -4.65** | -1.94 | -4.91** | -3.97** |
| **50.** | Phule Sonali x IC 68786 | -3.62 | -9.33 | -40.45** | -18.30** | -16.31** | 2.77* | -6.86** | -4.22** | -7.12** | -6.20** |
| **51.** | Phule Sonali x IC 329764 | 128.42** | 83.53** | 20.55** | 65.38** | 69.40** | -0.61 | -7.98** | -5.37** | -8.23** | -7.32** |
| **52.** | Phule Sonali x IC 599262 | -22.30** | -28.87** | -53.28** | -35.91** | -34.35** | -2.05 | -7.14** | -4.51** | -7.40** | -6.48** |
| **53.** | Phule Sonali x SNAGR 12-33 | 101.06** | 66.74** | 9.52* | 50.25** | 53.90** | 9.81** | 3.81** | 6.75** | 3.53** | 4.55** |
| **54.** | Phule Sonali x IC 326997 | 43.40** | 11.53* | -26.75** | 0.49 | 2.94 | 0.81 | -6.80** | -4.15** | -7.05** | -6.13** |
| **55.** | Phule Sonali x IC 202931 | 3.68 | -5.71 | -38.07** | -15.03** | -12.97* | -1.11 | -4.44** | -1.72 | -4.70** | -3.76** |
| **56.** | Phule Sonali x EC 724805 | 29.50** | 26.02** | -17.23** | 13.55** | 16.31** | -0.76 | -7.74** | -5.13** | -8.00** | -7.09** |
| **57.** | Phule Sonali x EC 738277 | 30.36** | 1.1 | -33.60** | -8.9 | -6.69 | 3.46** | -3.92** | -1.19 | -4.18** | -3.23* |
| **58.** | Phule Sonali x IC 622602 | 26.92** | 0.66 | -33.89** | -9.3 | -7.09 | -14.14** | -17.39** | -8.09** | -10.87** | -9.99** |
| **59.** | Phule Sonali x IC 626138 | 73.09** | 39.08** | -8.65* | 25.32** | 28.37** | 5.42** | 4.04** | 7.00** | 3.76** | 4.78** |
| **60.** | Phule Sonali x EC 724382 | 42.62** | 21.95** | -19.90** | 9.89 | 12.56* | 0.57 | -7.06** | -4.42** | -7.31** | -6.39** |

## Conclusion

From the present study it was concluded that large number of crosses exhibited good performance over bot mid parent as well as better parent.The cross Phule Sonali x SNAGR 12-33 exhibited highest mid parent heterosis, better parent heterosis and standard heterosis over check DC15 in desirable directions for days to 50% flowering. The significantly superior standard heterosis over checks, DC 15, PL 3 and RC 101 in desirable direction was noticed in crosses *viz.*, PL 4 x IC599262, Phule Sonali x SNAGR 12-33 and PL 4 x IC 599262 for days to maturity.The cross combination, Phule Sonali x IC 68786 exhibited highest negatively significant heterobeltosis and standard heterosis over the check PL 3 for plant height.

The crosses GC 3 × IC 68786 for number of branches per plant, Phule Sonali × EC 101958 for number of pods per plant, Phule Sonali x IC 622602, Phule Vithai x IC 622602 and Phule Sonali x IC 626138 for pod length, GC 3 x IC 626138, GC 3 x IC 622602 and GC 3 x IC 329764 for number of seeds per pod, PL 4 x IC 202931 and GC 3 x EC 724382 for 100 seed weight, GC 3 x EC 724805, PL 4 x EC 724805, GC 3 x EC 724382, Phule Sonali x 329764 and Phule Rakhumai x IC 626138 for seed yield per plant and Phule Rakhumai x IC 329764, GC 3 x EC 101958 and Phule Rakhumai x EC 68786 for protein percentage found promising by showing highest significant standard heterosis.

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