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The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2021; 10(7): 269-273

www.thepharmajournal.com
Received: 18-04-2021
Accepted: 30-06-2021

# Heterosis for yield and maturity traits of maize (*Zea mays* L.)

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**Abstract**
The study was conducted using eight inbred lines at the research form of STRU, MPKV, Rahuri. An evaluation trial comprising of eight parents, fifty-six $F_1$s (including direct and reciprocal crosses) and two standard checks *viz*., Rajarshi and P3401 were conducted during *Rabi* 2018 with three replications in randomized block design. The heterosis investigates maturity and yield character over the two checks. For days to 50 percent tasseling heterosis was ranged from -10.95 to 10.43 percent for mid parent, from -9.85 to 18.39 percent for heterobeltiosis, from 7.74 to 42.58 percent for standard check over Rajarshi and from -12.11 to 16.32 percent for standard check over P 3401. The magnitude of variation in the relative heterosis for days to 50 percent silking was ranged from -10.96 to 10.12 percent over mid parent, from -8.61 to 18.89 percent over better parent, from 5.52 to 37.42 percent over the standard check Rajarshi and from -12.69 to 13.71 percent over standard check P3401. The heterosis for days to maturity ranged from -6.03 to 7.72 percent over mid parent and from -4.02 to 11.40 percent over better parent, from 3.91 to 23.49 percent over Rajarshi and from -8.75 to 8.44 percent over check P3401. Heterosis for kernel yield per plant was varied from -35.39 to 130.70 percent over mid parent, from -51.76 to 112.99 percent over better parent, from -65.12 to 38.35 percent over Rajarshi and from -65.94 to 35.11 percent over check P3401. The crosses, GPM-456 x HYD-08R-2453-2, HYD-09R-1204-1 x HYD-09R-2178-2 and HYD-09R-2178-2 x HYD-08R-2570-2 showed significant negative heterosis for days to 50 percent tasseling over the mid parent, better parent and over standard check P3401. The cross combination GPM-456 x HYD-08R-2453-2 and HYD-09R-1204-1 x HYD-09R-2178-2 showed significant negative heterosis for day to 50 percent silking over the mid parent, better parent and check P3401. The crosses HYD-09R-1204-1 x HYD-09R-2178-2, HYD-09R-2178-2 x HYD-08R-2570-2 and HYD-08R-656-1 x HYD-09R-2178-2 showed significant negative heterosis for days to maturity over the mid parent, better parent and check P3401. The crosses, GPM-456 x HYD-08R-656-1, GPM-456 x HYD-09R-1204-1 and HYD-08R-2453-2 x HYD-09R-1204-1 revealed highly significant and positive heterosis for kernel yield per plant (g) over the mid parent, better parent and both check *viz*., Rajarshi and P3401. These crosses are most suitable for exploitation of heterosis.

**Keywords:** Diallel, heterosis, mid parent, better parent, standard heterosis, kernel yield

## Introduction
Maize with chromosome number 2n = 20 is a new world coarse cereal belonging to the family Gramineae and tribe Maydeae, which includes eight genera. Maize is a crop with a versatile nature. It is grown in more than 166 countries across the globe, including tropical, subtropical and temperate regions, from sea level to 3000 m above sea level. In India, it grown in three season for various purposes that include grain, feed, fodder, green cobs, sweet corn, baby corn, popcorn, starch and industrial products. It is grown in all three seasons - Kharif (rainy), Rabi (winter) and Zaid (summer).
Worldwide maize is the most imperative cereal crop with the highest global production. It is used as food in humans, feed for poultry and livestock, and raw material for an array of industrial and processed products (Yadav *et al*. 2015) [16].
Heterosis breeding includes the identification of lines with high degree of heterosis which in turn, results in production of high kernel yield. Exploitation of heterosis and genetic improvement depends upon the choice of parent. Information on heterotic patterns among maize germplasm is essential in maximizing the effectiveness of hybrid development (Beck *et al*., 1990) [3].

## Material and Methods
The experimental material for the present study comprised of eight parental lines is collected from Maize Improvement Project, Kolhapur. All possible crosses n (n-1) were affected during Kharif 2018 at the research farm of Seed Technology Research Unit, Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist. Ahmednagar.

The final evaluation trial comprising of eight parents, fifty-six F1s (direct and reciprocal) and two standard checks were conducted during Rabi 2018 with three replications in randomized block design at the Research farm of Seed Technology Research Unit, Rahuri on a uniform piece of land. All the recommended practices were timely and properly followed to raise a good crop.
The observation on days to 50 percent tasseling, days to 50 percent silking and days to maturity were noted on a plot basis. For kernel yield per plant (g) traits, five competitive plants were randomly selected and tagged at the age of 35 days after sowing in each plot on which observation was recorded from each genotype and the average value calculated.

## Results and Discussion

### 1. Days to 50 percent tasseling

In maize earliness in days to 50 percent flowering is considered as desirable trait. Parents requiring less number of days to pollen shed are considered as better parents in the respective cross.
The heterosis was ranged from -10.95 percent (HYD-09R-2178-2 x HYD-08R-2570-2) to 10.43 percent (HYD-08R-2570-2 x HYD-09R-1204-1) for mid parent, from -9.85 (HYD-09R-2178-2 x HYD-08R-2570-2) to 18.39 percent (HYD-08R-2570-2 x HYD-08R-2453-2) for heterobeltiosis, from 7.74 (GPM-456 x HYD-08R-2453-2) to 42.58 percent (HYD-08R-2570-2 x HYD-08R-656-1) over check hybrid Rajarshi and from -12.11 (GPM-456 x HYD-08R-2453-2) to 16.32 percent (HYD-08R-2570-2 x HYD-08R-656-1) for standard check over P 3401 presented in Table 1.
Out of fifty six F1 hybrids, twenty three crosses gave highly significant negative heterosis over mid parent and eight crosses exhibited significant negative heterosis for better parent. However, none of the cross combinations exhibited significant negative heterosis over the standard checks Rajarshi. Ten crosses exhibited significant negative heterosis over second check P3401.
The crosses; HYD-09R-2178-2 x HYD-08R-656-1 and HYD-08R-656-1 x HYD-09R-2178-2 (-10.84%) over mid parent, HYD-09R-2178-2 x HYD-08R-656-1 and HYD-08R-656-1 x HYD-09R-2178-2 (-8.87%), HYD-08R-2570-2 x HYD-09R-2178-2(-5.91%) over better parent, none of crosses over standard check rajarshi and HYD-09R-2168-1 x HYD-08R-2453-2 (-10.53%), HYD-08R-2453-2 x HYD-09R-1204-1 (-9.47%), HYD-09R-1204-1 x HYD-08R-2453 (-8.95%), HYD-09R-2178-2 x HYD-08R-2453-2 (-8.42%) crosses over second check P3401 showed higher magnitude of desirable heterosis for this character days to 50 percent tasseling. Similar results reported by Arsode *et al*. (2017) [2] and Brahmbhatt *et al*. (2018) [5].

### 2. Days to 50 percent silking

In maize earliness in days to 50 percent silking is considered as desirable character. Therefore the crosses recorded negative heterosis for this character that considered as superior.
The magnitude of variation in the relative heterosis for days to 50 percent silking was ranged from -10.96 percent (HYD-08R-656-1 x HYD-09R-2178-2) to 10.12 percent (HYD-08R-2570-2 x HYD-09R-1204-1) over mid parent, from -8.61 percent (HYD-08R-656-1 x HYD-09R-2178-2) to 18.89 percent (HYD-08R-2570-2 x HYD-08R-2453-2) over better parent, from 5.52 percent (GPM-456 x HYD-08R-2453-2) to 37.42 percent (HYD-08R-2570-2 x HYD-08R-656-1) over the standard check Rajarshi and from -12.69 percent (GPM-456 x HYD-08R-2453-2) to 13.71 percent (HYD-08R-2570-2 x HYD-08R-656-1) over standard check P3401 presented in Table 1.
Among the fifty six F1 crosses, twenty four crosses over mid parent and ten crosses over better parent recorded significant negative heterosis. However, none of the cross combinations found negatively significant heterosis for days to 50 percent silking over check Rajarshi. Nine crosses recorded significantly negative heterosis over the second check P3401.
The crosses HYD-09R-2178-2 x HYD-08R-656-1 (-10.02%) and GPM-456 x HYD-08R-2453-2 (-9.95%), HYD-09R-1204-1 x HYD-09R-2178-2 (-8.99%) over mid parent HYD-09R-2178-2 x HYD-08R-656-1 and HYD-09R-2178-2 x HYD-08R-2570-2 (-7.66%) over better parent, none of crosses over standard check Rajarshi and HYD-09R-2168-1 x HYD-08R-2453-2 (-11.17%), HYD-08R-2453-2 x HYD-09R-1204-1 (-9.64%) and HYD-09R-1204-1 x HYD-08R-2453-2 (-9.14%) cross over check P3401, showed higher magnitude of desirable negative heterosis for this character. The result was correspondence with Arsode *et al*. (2017) [2] and Brahmbhatt *et al*. (2018) [5] for mid parent, better parent and standard heterosis.

### 3. Days to maturity

In maize early maturity is desirable hence the early maturing parents are considered as better parent and the negative heterosis effects are considered as desirable for this trait.
The heterosis for this character ranged from -6.03 percent (HYD-09R-1204-1 x HYD-09R-2178-2) to 7.72 percent (HYD-08R-2570-2 x HYD-09R-1204-1) over mid parent and from -4.02 percent (HYD-09R-2178-2 x HYD-08R-2570-2) to 11.40 percent (HYD-08R-2570-2 x HYD-09R-1204-1) over better parent, from 3.91 percent (HYD-09R-2168-1 x HYD-08R-2453-2) to 23.49 percent (HYD-08R-2570-2 x HYD-08R-656-1) over the first standard check and from -8.75 percent (HYD-09R-2168-1 x HYD-08R-2453-2) to 8.44 percent (HYD-08R-2570-2 x HYD-08R-656-1) over check P3401 presented in Table 2.
Among all fifty six crosses, twelve and four crosses had highly significant and negative heterosis over mid and better parent heterosis respectively. However, none of the cross combinations were observed significantly negative heterosis over the check Rajarshi and eighteen crosses were displayed significant negative heterosis over the check P3401. The crosses *viz*., HYD-08R-656-1 x HYD-09R-2178-2 (-5.04%) and HYD-09R-2178-2 x HYD-08R-2570-2 (-4.76%) over mid parent, HYD-08R-656-1 x HYD-09R-2178-2 (-3.72%), HYD-09R-1204-1 x HYD-09R-2178-2 (-3.58%) and HYD-09R-2178-2 x HYD-08R-656-1 (-3.10%) over better parent, HYD-09R-1204-1 x HYD-09R-2178-2, HYD-09R-1204-1 x HYD-08R-2453-2, GPM-456 x HYD-08R-2453-2 and GPM-342 x HYD-08R-2453-2 (-7.50%) over the second check P3401 it recorded negative significant heterosis. Findings similar wth Bekele and Rao (2013) [4] and Sharma *et al*. (2017) [14]. Standard heterosis results were similar with Gebre *et al*. (2019) [8] and Onejeme *et al*. (2020) [13]. These results are in similarity with the findings of earlier workers Arsode *et al*. (2017) [2] and Hassan *et al*. (2019) [9].

### 4. Kernel yield per plant (g)

Heterosis for kernel yield per plant was varied from -35.39 percent (GPM-342 x HYD-09R-2168-1) to 130.70 percent (HYD-09R-2178-2 x HYD-08R-2570-2) over mid parent, from -51.76 percent (HYD-08R-656-1 x HYD-09R-1204-1) to 112.99 percent (HYD-09R-2178-2 x HYD-08R-2570-2) over the better parent, from -65.12 percent (HYD-08R-656-1 x HYD-09R-2178-2) to 38.35 percent (GPM-456 x HYD-08R-656-1) over Rajarshi and from -65.94 percent (HYD-08R-656-1 x HYD-09R-2178-2) to 35.11 percent (GPM-456 x HYD-08R-656-1) over check P3401 presented in Table 2.

Among all fifty six F1 crosses, thirty six and twenty nine crosses were recorded as highly significant positive heterosis over mid and better parent, respectively. While twenty three and twenty two crosses revealed highly significant and positive heterosis over the check Rajarshi and P3401.

The cross combinations *viz*., HYD-08R-2570-2 x HYD-08R-656-1 (130.66%), GPM-456 x HYD-08R-656-1 (111.23%), HYD-08R-2570-2 x HYD-09R-2178-2 (99.40%), HYD-08R-2570-2 x HYD-09R-2168-1 (83.45%), HYD-09R-1204-1 x HYD-09R-2178-2 (83.17%), HYD-09R-2178-2 x HYD-08R-2453-2 (79.90%), GPM-456 x HYD-09R-2178-2 (73.82%) and HYD-08R-656-1 x HYD-08R-2453-2 (73.50%) over mid parent, HYD-08R-2570-2 x HYD-08R-656-1 (97.07%), HYD-08R-2570-2 x HYD-09R-2178-2 (84.10%), HYD-08R-2570-2 x HYD-09R-2168-1 (56.60%) and HYD-08R-2453-2 x HYD-09R-1204-1 (54.31%) over better parent, GPM-456 x HYD-09R-1204-1 (34.44%), HYD-08R-2453-2 x HYD-09R-1204-1 (33.64%), HYD-08R-2570-2 x HYD-09R-2168-1 (25.92%) over the check Rajarshi and GPM-456 x HYD-09R-1204-1 (31.30%), HYD-08R-2453-2 x HYD-09R-1204-1 (30.52%) and HYD-08R-2570-2 x HYD-09R-2168-1 (22.97%) over the standard check P3401 were revealed highly significant and positive heterosis for this character. Mid parent and better parent results in tune with Aminu *et al*. (2014) [1] and Dash *et al*. (2020) [6]. Better parent and standard heterosis results in accordance with the findings of Netravati *et al*. (2013) [12] and Naggar *et al*. (2016) [11]. Similar to above standard heterosis results reported by Gebre *et al*. (2019) [8] and Onejeme *et al*. (2020) [13]. Brahmbhatt *et al*. (2018) [5] and Hassan *et al*. (2019) [9] reported mid parent, better parent and standard heterosis for this trait in maize.

**Table 1:** Percent heterosis over mid parent, better parent and standard checks for days to 50 percent tasseling and days to 50 percent silking in maize

| Sr. No. | Crosses | | Days to 50 percent tasseling | | | | Days to 50% silking | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | MP | BP | SH-1 | SH-2 | MP | BP | SH-1 | SH-2 |
| 1 | HYD-09R-2168-1 x HYD-09R-2178-2 | D | -2.80 | 0.53 | 23.23** | 0.53 | -2.72 | 0.51 | 20.86** | 0.00 |
| 2 | HYD-09R-2178-2 x HYD-09R-2168-1 | R | -1.27 | 2.11 | 25.16** | 2.11 | -0.25 | 3.06 | 23.93** | 2.54 |
| 3 | HYD-09R-2168-1 x HYD-08R-656-1 | D | -2.49 | 3.16 | 26.45** | 3.16 | -2.88* | 3.06 | 23.93** | 2.54 |
| 4 | HYD-08R-656-1 x HYD-09R-2168-1 | R | -3.48* | 2.11 | 25.16** | 2.11 | -1.92 | 4.08* | 25.15** | 3.55* |
| 5 | HYD-09R-2168-1 x HYD-08R-2570-2 | D | -6.03** | -1.58 | 20.65** | -1.58 | -5.37** | -1.02 | 19.02** | -1.52 |
| 6 | HYD-08R-2570-2 x HYD-09R-2168-1 | R | -7.04** | -2.63 | 19.35** | -2.63 | -6.83** | -2.55 | 17.18** | -3.05 |
| 7 | HYD-09R-2168-1 x HYD-09R-1204-1 | D | 0.27 | 1.62 | 21.29** | -1.05 | 1.29 | 2.62 | 20.25** | -0.51 |
| 8 | HYD-09R-1204-1 x HYD-09R-2168-1 | R | -1.33 | 0.00 | 19.35** | -2.63 | -1.29 | 0.00 | 17.18** | -3.05 |
| 9 | HYD-09R-2168-1 x HYD-08R-2453-2 | D | -6.59** | -2.30 | 9.68** | -10.53** | -6.91** | -2.78 | 7.36** | -11.17** |
| 10 | HYD-08R-2453-2 x HYD-09R-2168-1 | R | 3.30* | 8.05** | 21.29** | -1.05 | 4.26** | 8.89** | 20.25** | -0.51 |
| 11 | HYD-09R-2168-1 x GPM-456 | D | -1.04 | 0.00 | 22.58** | 0.00 | -2.51 | -1.02 | 19.02** | -1.52 |
| 12 | GPM-456 x HYD-09R-2168-1 | R | -0.52 | 0.53 | 23.23** | 0.53 | 0.00 | 1.53 | 22.09** | 1.02 |
| 13 | HYD-09R-2168-1 x GPM-342 | D | -4.39** | -2.63 | 19.35** | -2.63 | -5.21** | -2.55 | 17.18** | -3.05 |
| 14 | GPM-342 x HYD-09R-2168-1 | R | -0.78 | 1.05 | 23.87** | 1.05 | -1.24 | 1.53 | 22.09** | 1.02 |
| 15 | HYD-09R-2178-2 x HYD-08R-656-1 | D | -10.84** | -8.87** | 19.35** | -2.63 | -10.02** | -7.66** | 18.40** | -2.03 |
| 16 | HYD-08R-656-1 x HYD-09R-2178-2 | R | -10.84** | -8.87** | 19.35** | -2.63 | -10.96** | -8.61** | 17.18** | -3.05 |
| 17 | HYD-09R-2178-2 x HYD-08R-2570-2 | D | -10.95** | -9.85** | 18.06** | -3.68* | -8.75** | -7.66** | 18.40** | -2.03 |
| 18 | HYD-08R-2570-2 x HYD-09R-2178-2 | R | -7.06** | -5.91** | 23.23** | 0.53 | -5.91** | -4.78** | 22.09** | 1.02 |
| 19 | HYD-09R-2178-2 x HYD-09R-1204-1 | D | -6.19** | -1.62 | 17.42** | -4.21* | -6.00** | -1.57 | 15.34** | -4.57** |
| 20 | HYD-09R-1204-1 x HYD-09R-2178-2 | R | -9.28** | -4.86** | 13.55** | -7.37** | -8.99** | -4.71** | 11.66** | -7.61** |
| 21 | HYD-09R-2178-2 x HYD-08R-2453-2 | D | -7.69** | 0.00 | 12.26** | -8.42** | -6.43** | 1.11 | 11.66** | -7.61** |
| 22 | HYD-08R-2453-2 x HYD-09R-2178-2 | R | -1.33 | 6.90** | 20.00** | -2.11 | -1.80 | 6.11** | 17.18** | -3.05 |
| 23 | HYD-09R-2178-2 x GPM-456 | D | -0.76 | 1.55 | 27.10** | 3.68* | -1.22 | 0.50 | 24.54** | 3.05 |
| 24 | GPM-456 x HYD-09R-2178-2 | R | -2.77 | -0.52 | 24.52** | 1.58 | -3.16* | -1.49 | 22.09** | 1.02 |
| 25 | HYD-09R-2178-2 x GPM-342 | D | -1.00 | 0.51 | 27.74** | 4.21* | -1.44 | -0.97 | 25.77** | 4.06* |
| 26 | GPM-342 x HYD-09R-2178-2 | R | -5.00** | -3.55* | 22.58** | 0.00 | -5.77** | -5.31** | 20.25** | -0.51 |
| 27 | HYD-08R-656-1 x HYD-08R-2570-2 | D | 0.00 | 0.96 | 35.48** | 10.53** | -0.92 | 0.47 | 31.90** | 9.14** |
| 28 | HYD-08R-2570-2 x HYD-08R-656-1 | R | 5.24** | 6.25** | 42.58** | 16.32** | 3.23* | 4.67** | 37.42** | 13.71** |
| 29 | HYD-08R-656-1 x HYD-09R-1204-1 | D | -5.29** | 1.62 | 21.29** | -1.05 | -4.62** | 2.62 | 20.25** | -0.51 |
| 30 | HYD-09R-1204-1 x HYD-08R-656-1 | R | -2.27 | 4.86** | 25.16** | 2.11 | -1.70 | 5.76** | 23.93** | 2.54 |
| 31 | HYD-08R-656-1 x HYD-08R-2453-2 | D | 1.55 | 12.64** | 26.45** | 3.16 | 2.50 | 13.89** | 25.77** | 4.06* |
| 32 | HYD-08R-2453-2 x HYD-08R-656-1 | R | 2.07 | 13.22** | 27.10** | 3.68* | 1.50 | 12.78** | 24.54** | 3.05 |
| 33 | HYD-08R-656-1 x GPM-456 | D | -7.39** | -3.09 | 21.29** | -1.05 | -8.06** | -3.96* | 19.02** | -1.52 |
| Sr. No. | Crosses | | Days to 50 percent tasseling | | | | Days to 50% silking | | | |
| | | | MP | BP | Rajarshi | P3401 | MP | BP | Rajarshi | P3401 |
| 34 | GPM-456 x HYD-08R-656-1 | R | -3.45* | 1.03 | 26.45** | 3.16 | -3.79** | 0.50 | 24.54** | 3.05 |
| 35 | HYD-08R-656-1 x GPM-342 | D | 0.73 | 4.57** | 32.90** | 8.42** | -0.70 | 2.42 | 30.06** | 7.61** |
| 36 | GPM-342 x HYD-08R-656-1 | R | -0.73 | 3.05 | 30.97** | 6.84** | -0.70 | 2.42 | 30.06** | 7.61** |
| 37 | HYD-08R-2570-2 x HYD-09R-1204-1 | D | 10.43** | 17.30** | 40.00** | 14.21** | 10.12** | 16.75** | 36.81** | 13.20** |
| 38 | HYD-09R-1204-1 x HYD-08R-2570-2 | R | 8.91** | 15.68** | 38.06** | 12.63** | 8.64** | 15.18** | 34.97** | 11.68** |
| 39 | HYD-08R-2570-2 x HYD-08R-2453-2 | D | 7.85** | 18.39** | 32.90** | 8.42** | 8.63** | 18.89** | 31.29** | 8.63** |
| 40 | HYD-08R-2453-2 x HYD-08R-2570-2 | R | 5.76** | 16.09** | 30.32** | 6.32** | 5.58** | 15.56** | 27.61** | 5.58** |
| 41 | HYD-08R-2570-2 x GPM-456 | D | 1.00 | 4.64** | 30.97** | 6.84** | 1.44 | 4.46** | 29.45** | 7.11** |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 42 | GPM-456 x HYD-08R-2570-2 | R | -1.99 | 1.55 | 27.10** | 3.68* | 0.00 | 2.97 | 27.61** | 5.58** |
| 43 | HYD-08R-2570-2 x GPM-342 | D | -1.73 | 1.02 | 28.39** | 4.74** | -1.19 | 0.48 | 27.61** | 5.58** |
| 44 | GPM-342 x HYD-08R-2570-2 | R | -4.20** | -1.52 | 25.16** | 2.11 | -4.99** | -3.38* | 22.70** | 1.52 |
| 45 | HYD-09R-1204-1 x HYD-08R-2453-2 | D | -3.62* | -0.57 | 11.61** | -8.95** | -3.50* | -0.56 | 9.82** | -9.14** |
| 46 | HYD-08R-2453-2 x HYD-09R-1204-1 | R | -4.18* | -1.15 | 10.97** | -9.47** | -4.04* | -1.11 | 9.20** | -9.64** |
| 47 | HYD-09R-1204-1 x GPM-456 | D | 1.85 | 4.32* | 24.52** | 1.58 | 1.27 | 4.19* | 22.09** | 1.02 |
| 48 | GPM-456 x HYD-09R-1204-1 | R | -0.79 | 1.62 | 21.29** | -1.05 | -1.78 | 1.05 | 18.40** | -2.03 |
| 49 | HYD-09R-1204-1 x GPM-342 | D | 2.62 | 5.95** | 26.45** | 3.16 | 0.50 | 4.71** | 22.70** | 1.52 |
| 50 | GPM-342 x HYD-09R-1204-1 | R | -1.57 | 1.62 | 21.29** | -1.05 | -1.51 | 2.62 | 20.25** | -0.51 |
| 51 | HYD-08R-2453-2 x GPM-456 | D | -4.35** | 1.15 | 13.55** | -7.37** | -5.24** | 0.56 | 11.04** | -8.12** |
| 52 | GPM-456 x HYD-08R-2453-2 | R | -9.24** | -4.02* | 7.74** | -12.11** | -9.95** | -4.44* | 5.52** | -12.69** |
| 53 | HYD-08R-2453-2 x GPM-342 | D | 0.81 | 7.47** | 20.65** | -1.58 | 0.26 | 7.78** | 19.02** | -1.52 |
| 54 | GPM-342 x HYD-08R-2453-2 | R | -5.66** | 0.57 | 12.90** | -7.89** | -6.46** | 0.56 | 11.04** | -8.12** |
| 55 | GPM-456 x GPM-342 | D | -2.30 | -1.55 | 23.23** | 0.53 | -2.69 | -1.49 | 22.09** | 1.02 |
| 56 | GPM-342 x GPM-456 | R | -5.37** | -4.64** | 19.35** | -2.63 | -6.11** | -4.95** | 17.79** | -2.54 |
| | S.E.D. | | 0.97 | 1.12 | 1.12 | 1.12 | 0.96 | 1.11 | 1.11 | 1.11 |
| | CD 95% | | 1.99 | 2.29 | 2.29 | 2.29 | 1.97 | 2.27 | 2.27 | 2.27 |
| | CD 99% | | 2.53 | 2.92 | 2.92 | 2.92 | 2.51 | 2.89 | 2.89 | 2.89 |

**Table 2:** Percent heterosis over mid parent, better parent and standard checks for days to maturity and Kernel yield per plant (g) in maize

| Sr. No. | Crosses | | Days to maturity | | | | Kernel yield per plant (g) | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | MP | BP | Rajarshi | P3401 | MP | BP | Rajarshi | P3401 |
| 1 | HYD-09R-2168-1 x HYD-09R-2178-2 | D | -0.32 | 1.61 | 12.46** | -1.25 | 10.87** | -11.38** | -28.74** | -30.41** |
| 2 | HYD-09R-2178-2 x HYD-09R-2168-1 | R | 1.58 | 3.54* | 14.59** | 0.63 | -3.73 | -23.05** | -38.12** | -39.57** |
| 3 | HYD-09R-2168-1 x HYD-08R-656-1 | D | -0.47 | 2.89* | 13.88** | 0.00 | 1.96 | -23.46** | -38.46** | -39.90** |
| 4 | HYD-08R-656-1 x HYD-09R-2168-1 | R | 1.09 | 4.50** | 15.66** | 1.56 | 4.61 | -21.47** | -36.86** | -38.34** |
| 5 | HYD-09R-2168-1 x HYD-08R-2570-2 | D | -1.72 | 0.96 | 11.74** | -1.88 | 6.79* | -8.84** | -26.70** | -28.42** |
| 6 | HYD-08R-2570-2 x HYD-09R-2168-1 | R | -2.66* | 0.00 | 10.68** | -2.81* | 83.45** | 56.60** | 25.92** | 22.97** |
| 7 | HYD-09R-2168-1 x HYD-09R-1204-1 | D | 0.65 | 1.30 | 10.68** | -2.81* | -25.03** | -26.36** | -38.61** | -40.05** |
| 8 | HYD-09R-1204-1 x HYD-09R-2168-1 | R | 0.65 | 1.30 | 10.68** | -2.81* | 23.05** | 20.87** | 0.76 | -1.60 |
| 9 | HYD-09R-2168-1 x HYD-08R-2453-2 | D | -4.42** | -2.67 | 3.91* | -8.75** | 45.96** | 40.73** | 21.88** | 19.03** |
| 10 | HYD-08R-2453-2 x HYD-09R-2168-1 | R | 2.78* | 4.67** | 11.74** | -1.88 | 44.26** | 39.10** | 20.47** | 17.65** |
| 11 | HYD-09R-2168-1 x GPM-456 | D | 1.12 | 1.61 | 12.46** | -1.25 | 43.28** | 35.16** | 22.57** | 19.70** |
| 12 | GPM-456 x HYD-09R-2168-1 | R | 1.44 | 1.93 | 12.81** | -0.94 | 43.63** | 35.50** | 22.87** | 19.99** |
| 13 | HYD-09R-2168-1 x GPM-342 | D | -0.32 | 0.64 | 11.39** | -2.19 | -6.84** | -16.46** | -32.83** | -34.40** |
| 14 | GPM-342 x HYD-09R-2168-1 | R | 0.96 | 1.93 | 12.81** | -0.94 | -35.39** | -42.06** | -53.41** | -54.50** |
| 15 | HYD-09R-2178-2 x HYD-08R-656-1 | D | -4.43** | -3.10* | 11.39** | -2.19 | -15.77** | -22.62** | -62.75** | -63.62** |
| 16 | HYD-08R-656-1 x HYD-09R-2178-2 | R | -5.04** | -3.72** | 10.68** | -2.81* | -21.14** | -27.56** | -65.12** | -65.94** |
| 17 | HYD-09R-2178-2 x HYD-08R-2570-2 | D | -4.76** | -4.02** | 10.32** | -3.12* | 130.70** | 112.99** | 21.13** | 18.30** |
| 18 | HYD-08R-2570-2 x HYD-09R-2178-2 | R | -2.61* | -1.86 | 12.81** | -0.94 | 99.40** | 84.10** | 4.70* | 2.25 |
| 19 | HYD-09R-2178-2 x HYD-09R-1204-1 | D | -2.54* | 0.00 | 9.25** | -4.06** | 6.18* | -16.25** | -30.19** | -31.82** |
| 20 | HYD-09R-1204-1 x HYD-09R-2178-2 | R | -6.03** | -3.58* | 5.34** | -7.50** | 83.17** | 44.48** | 20.44** | 17.62** |
| 21 | HYD-09R-2178-2 x HYD-08R-2453-2 | D | -3.05* | 0.67 | 7.47** | -5.63** | 79.90** | 39.95** | 21.20** | 18.37** |
| 22 | HYD-08R-2453-2 x HYD-09R-2178-2 | R | -0.16 | 3.67* | 10.68** | -2.81* | 41.43** | 10.03** | -4.71* | -6.94** |
| 23 | HYD-09R-2178-2 x GPM-456 | D | 1.41 | 2.87* | 14.95** | 0.94 | 71.18** | 31.03** | 18.82** | 16.04** |
| 24 | GPM-456 x HYD-09R-2178-2 | R | -0.47 | 0.96 | 12.81** | -0.94 | 73.82** | 33.05** | 20.65** | 17.83** |
| 25 | HYD-09R-2178-2 x GPM-342 | D | 0.00 | 0.95 | 13.88** | 0.00 | 20.02** | 5.30 | -32.83** | -34.40** |
| 26 | GPM-342 x HYD-09R-2178-2 | R | -1.88 | -0.95 | 11.74** | -1.88 | 12.70** | -1.12 | -36.92** | -38.40** |
| 27 | HYD-08R-656-1 x HYD-08R-2570-2 | D | 1.52 | 2.13 | 19.22** | 4.69** | 25.74** | 7.43 | -38.90** | -40.33** |
| 28 | HYD-08R-2570-2 x HYD-08R-656-1 | R | 5.15** | 5.79** | 23.49** | 8.44** | 130.66** | 97.07** | 12.08** | 9.46** |
| 29 | HYD-08R-656-1 x HYD-09R-1204-1 | D | -1.72 | 2.28 | 11.74** | -1.88 | -34.97** | -51.76** | -59.79** | -60.73** |
| 30 | HYD-09R-1204-1 x HYD-08R-656-1 | R | 0.16 | 4.23** | 13.88** | 0.00 | -10.47** | -33.59** | -44.64** | -45.94** |
| 31 | HYD-08R-656-1 x HYD-08R-2453-2 | D | 2.22 | 7.67** | 14.95** | 0.94 | 73.50** | 27.13** | 10.10** | 7.52** |
| 32 | HYD-08R-2453-2 x HYD-08R-656-1 | R | 2.22 | 7.67** | 14.95** | 0.94 | 49.45** | 9.50** | -5.17* | -7.38** |
| 33 | HYD-08R-656-1 x GPM-456 | D | -2.79* | 0.00 | 11.74** | -1.88 | -29.85** | -49.33** | -54.05** | -55.13** |
| Sr. No. | Crosses | | Days to maturity | | | | Kernel yield per plant (g) | | | |
| | | | MP | BP | Rajarshi | P3401 | MP | BP | Rajarshi | P3401 |
| 34 | GPM-456 x HYD-08R-656-1 | R | -0.93 | 1.91 | 13.88** | 0.00 | 111.23** | 52.57** | 38.35** | 35.11** |
| 35 | HYD-08R-656-1 x GPM-342 | D | 2.31 | 4.73** | 18.15** | 3.75** | -28.52** | -41.67** | -62.79** | -63.66** |
| 36 | GPM-342 x HYD-08R-656-1 | R | 1.39 | 3.79** | 17.08** | 2.81* | 9.24* | -10.87** | -43.14** | -44.47** |
| 37 | HYD-08R-2570-2 x HYD-09R-1204-1 | D | 7.72** | 11.40** | 21.71** | 6.88** | 58.11** | 32.99** | 10.86** | 8.27** |
| 38 | HYD-09R-1204-1 x HYD-08R-2570-2 | R | 6.46** | 10.10** | 20.28** | 5.63** | -10.18** | -24.45** | -37.02** | -38.49** |
| 39 | HYD-08R-2570-2 x HYD-08R-2453-2 | D | 5.73** | 10.67** | 18.15** | 3.75** | -18.66** | -32.62** | -41.65** | -43.01** |
| 40 | HYD-08R-2453-2 x HYD-08R-2570-2 | R | 3.82** | 8.67** | 16.01** | 1.88 | 39.32** | 15.41** | -0.05 | -2.39 |
| 41 | HYD-08R-2570-2 x GPM-456 | D | 2.49* | 4.78** | 17.08** | 2.81* | -17.36** | -32.77** | -39.03** | -40.46** |
| 42 | GPM-456 x HYD-08R-2570-2 | R | 0.62 | 2.87* | 14.95** | 0.94 | -34.65** | -46.83** | -51.79** | -52.91** |
| 43 | HYD-08R-2570-2 x GPM-342 | D | 1.71 | 3.47* | 16.73** | 2.50 | -40.46** | -43.69** | -64.08** | -64.92** |
| 44 | GPM-342 x HYD-08R-2570-2 | R | -0.78 | 0.95 | 13.88** | 0.00 | -25.44** | -29.48** | -55.02** | -56.07** |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 45 | HYD-09R-1204-1 x HYD-08R-2453-2 | D | -2.47 | -1.33 | 5.34** | -7.50** | 39.57** | 36.96** | 18.61** | 15.84** |
| 46 | HYD-08R-2453-2 x HYD-09R-1204-1 | R | -1.48 | -0.33 | 6.41** | -6.56** | 57.26** | 54.31** | 33.64** | 30.52** |
| 47 | HYD-09R-1204-1 x GPM-456 | D | 2.09 | 3.26* | 12.81** | -0.94 | 17.47** | 12.73** | 2.22 | -0.17 |
| 48 | GPM-456 x HYD-09R-1204-1 | R | 0.16 | 1.30 | 10.68** | -2.81* | 54.50** | 48.26** | 34.44** | 31.30** |
| 49 | HYD-09R-1204-1 x GPM-342 | D | 3.21** | 4.89** | 14.59** | 0.63 | -25.90** | -34.60** | -45.48** | -46.76** |
| 50 | GPM-342 x HYD-09R-1204-1 | R | 0.64 | 2.28 | 11.74** | -1.88 | -13.93** | -24.04** | -36.68** | -38.16** |
| 51 | HYD-08R-2453-2 x GPM-456 | D | 0.33 | 2.67 | 9.61** | -3.75** | 36.71** | 33.64** | 21.19** | 18.35** |
| 52 | GPM-456 x HYD-08R-2453-2 | R | -3.58** | -1.33 | 5.34** | -7.50** | 36.60** | 33.53** | 21.08** | 18.25** |
| 53 | HYD-08R-2453-2 x GPM-342 | D | 0.81 | 3.67* | 10.68** | -2.81* | 29.63** | 12.56** | -2.52 | -4.80* |
| 54 | GPM-342 x HYD-08R-2453-2 | R | -4.05** | -1.33 | 5.34** | -7.50** | 59.00** | 38.06** | 19.56** | 16.77** |
| 55 | GPM-456 x GPM-342 | D | 0.48 | 0.96 | 12.81** | -0.94 | 57.85** | 34.45** | 21.92** | 19.06** |
| 56 | GPM-342 x GPM-456 | R | -1.43 | -0.96 | 10.68** | -2.81* | 53.82** | 31.01** | 18.80** | 16.02** |
| | S.E.D. | | 1.26 | 1.45 | 1.45 | 1.45 | 2.40 | 2.77 | 2.77 | 2.77 |
| | CD 95% | | 2.58 | 2.98 | 2.98 | 2.98 | 4.93 | 5.69 | 5.69 | 5.69 |
| | CD 99% | | 3.29 | 3.80 | 3.80 | 3.80 | 6.28 | 7.25 | 7.25 | 7.25 |

## Conclusion
The crosses, GPM-456 x HYD-08R-2453-2, HYD-09R-1204-1 x HYD-09R-2178-2 and HYD-09R-2178-2 x HYD-08R-2570-2 showed significant heterosis for days to 50 percent tasseling over the mid parent, better parent and over standard check P3401. The cross combination GPM-456 x HYD-08R-2453-2 and HYD-09R-1204-1 x HYD-09R-2178-2 showed significant heterosis for day to 50 percent silking over the mid parent, better parent and check P3401. The crosses HYD-09R-1204-1 x HYD-09R-2178-2, HYD-09R-2178-2 x HYD-08R-2570-2 and HYD-08R-656-1 x HYD-09R-2178-2 showed significant heterosis for days to maturity over the mid parent, better parent and check P3401. The cross combination, GPM-456 x HYD-08R-656-1, GPM-456 x HYD-09R-1204-1 and HYD-08R-2453-2 x HYD-09R-1204-1 showed highly significant positive heterosis over the mid parent, better parent and both check *viz*., Rajarshi and P3401.These crosses were identified as potential high yielder which, could be utilized in heterosis breeding.

## Acknowledgment
The authors are especially thankful to the Seed Technology Research Unit and Department of Agricultural Botany, Post Graduate Institute, Mahatma Phule Krishi Vidyapeeth, Rahuri for providing all essential facilities during research work. The financial support was provided by the UGC-NFOBC fellowship is kindly acknowledged.

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