The Pharma Innovation Journal 2019; 8(5): 333-337

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.03
TPI 2019; 8(5): 333-337

www.thepharmajournal.com
Received: 12-03-2019
Accepted: 13-04-2019

Dixita K Patel
Department of Genetics and Plant Breeding, BA College of Agriculture, Anand Agricultural University, Anand, Gujarat, India

DA Patel
Department of Genetics and Plant Breeding, BA College of Agriculture, Anand Agricultural University, Anand, Gujarat, India

JR Patel
Castor-Mustard Research Station, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, Gujarat, India

KV Patel
Pulse Research Station, Anand Agricultural University, Vadodara, Gujarat, India

DJ Parmar
Department of Agricultural Statistics, Anand Agricultural University, Anand, Gujarat, India

Correspondence
Dixita K Patel
Department of Genetics and Plant Breeding, BA College of Agriculture, Anand Agricultural University, Anand, Gujarat, India

Heterosis and inbreeding depression for seed yield and its contributing characters in castor (*Ricinus communis* L.)

Dixita K Patel, DA Patel, JR Patel, KV Patel and DJ Parmar

Abstract

The present study was conducted in order to generate genetic information on heterosis and inbreeding depression for seed yield and its contributing characters using generation mean analysis in castor (*Ricinus communis* L.). The expression of heterosis and heterobeltiosis was maximum for seed yield per plant followed by number of effective branches per plant, number of total branches per plant, shelling out turn and 100 seed weight. For seed yield per plant, all the crosses depicted significant and positive relative heterosis and heterobeltiosis except cross JI 358 x SH 42 which showed only significant positive relative heterosis. These crosses also showed significant desirable heterosis and heterobeltiosis for number of others yield contributing traits. The crosses *viz.,* SKI 324 x PCS 124 and ANDCI 8 x SKI 324 also showed significant and desirable estimates of relative heterosis and/or heterobeltiosis for number of total and effective branches per plant, shelling out turn, 100-seed weight and oil content, while cross ANDCI 10-7 x JH 109 exhibited significant and desirable relative heterosis and/or heterobeltiosis for number of total and effective branches per plant, number of capsules on primary raceme, shelling out turn and oil content. The magnitude of inbreeding depression varied from cross to cross indicating influence of genetic constitution of crosses. Significant inbreeding depression was observed for the characters *i.e.,* days to flowering of primary raceme, days to maturity of primary raceme, effective length of primary raceme, shelling out turn and 100 seed weight in cross SKI 324 x PCS 124; days to maturity of primary raceme, plant height up to primary raceme and number of capsules on primary raceme in cross ANDCI 10-7 x JH 109; days to flowering and maturity of primary raceme, number of total and effective branches per plant, seed yield per plant and shelling out turn in cross ANDCI 8 x SKI 324; days to flowering and maturity of primary raceme, number of total and effective branches per plant, total length of primary raceme, effective length of primary raceme, number of capsules on primary raceme, seed yield per plant, 100 seed weight and oil content in cross JI 358 x SH 42 and days to flowering and maturity of primary raceme, plant height up to primary raceme and shelling out turn in cross ANDCI 10-7 x SKI 324.

Keywords: Heterosis, inbreeding depression and castor

1. Introduction

Castor, *Ricinus communis* L; is the only oilseed crop of India which earns about thousands of crore rupees of foreign exchange to the country every year. Though crop has wider adaptability and well responsive to irrigation and nutrients, its cultivation is mostly confined to arid and semi-arid regions of the country. Castor belongs to monospecific genus *Ricinus* of *Euphorbiaceae* family. Castor is a sexually polymorphic species with different sex forms *viz.*, monoecious, pistillate, hermaphrodite and pistillate with interspersed staminate flowers (ISF). Castor oil and cake are two major products obtained from castor seed. Castor oil has great industrial utility along with it is used in pharmaceutical and cosmetics. In world, India ranks first with respect to area and production, contributing about 40 per cent of the global requirements. The major castor growing states in India are Gujarat, Andhra Pradesh, Rajasthan, Tamil Nadu, Karnataka and Odisha. Among them, 60 per cent area of high yielding varieties/hybrids is in Gujarat, 5-10 per cent is in Andhra Pradesh and the rest is in Rajasthan, Tamil Nadu, Karnataka and Odisha.

The phenomenon of heterosis has proved to be the most important genetic tool in enhancing yield of often cross pollinated and cross pollinated crops in general and castor in particular. The exploitation of heterosis has been an important breeding tool in castor, which became feasible due to availability of 100% pistillate lines (Gopani *et al*., 1968) [6]. In Gujarat, real breakthrough in castor production has come with the development and release of hybrids for commercial cultivation. The first castor hybrid GCH 3 (TSP-10 R x JI 15) was released for general cultivation in Gujarat as early as 1968. Still there is potential to further increase in yield level of castor through genetic improvement.

For genetic improvement, selection of superior parents is one of the important steps for development of better hybrids.
Higher yield of hybrid is results due to the presence of hybrid vigour (heterosis) for yield and yield components. On the other hand, inbreeding depression reflects through reduction or loss in vigour and fertility ultimately decreases the seed yield. Consequently proportion of inbreeding depression becomes helpful to plant breeders. With this fact, the present experiment was conducted using generation mean analysis including six generations of five crosses in order to identify the most promising heterotic cross combinations.

2. Materials and Methods

The material consist of five hybrids *viz*., SKI 324 x PCS 124 (cross I), ANDCI 10-7 x JH 109 (cross II), ANDCI 8 x SKI 324 (cross III), JI 358 x SH 42 (cross IV) and ANDCI 10-7 x SKI 324 (cross V) involving seven diverse parents of castor. The entire experimental material comprised of parents (P_1 and P_2), F_1, F_2, B_1 (F_1 x P_1) and B_2 (F_1 x P_2) generations of all five crosses, which was conducted in compact family block design with three replications at Agronomy farm, B. A. College of Agriculture, Anand Agricultural University, Anand during *kharif* 2016-17. Each replication was divided into five compact blocks each consists of single cross and blocks were consisted of six plots comprised of six basic generations of each cross. The plots of various generations contained different number of rows *i.e.*, parents and F_1 in single row; B_1 and B_2 in two rows and F_2 in four rows. Total 10 plants were accommodated in each row. The crop was dibbled at 120 cm and 60 cm inter and intra row spacing, respectively. All the recommended agronomical practices and necessary plant protection measures were followed timely to raise a good crop. Observations were recorded on individual plant basis in each replication on randomly selected five plants from P_1, P_2 and F_1; twenty plants from backcross (B_1 and B_2) and forty plants from F_2 generations for thirteen traits. The heterotic effects in term of superiority of F_1 over better parent (heterobeltiosis) was worked our as per Fonseca and Patterson (1968) [4]; over mid parent value (relative heterosis) as per Turner (1953) [17] and inbreeding depression as loss in vigour due to inbreeding.

3. Results and discussion

The estimates of heterosis expressed as percentage over mid parent (RH) and heterobeltiosis expressed as percentage over better parent (HB) in F_1 hybrids and inbreeding depression in F_2 population for various characters calculated in five crosses of castor are presented in Table 1. While graphical representation of relative heterosis, heterobeltiosis and inbreeding depression for days to maturity, seed yield per plant and oil content are presented in Fig.1. The degree of heterosis varied from cross-to-cross for all the thirteen characters studied. For the characters like days to flowering of primary raceme, days to maturity of primary raceme, plant height and number of nodes up to primary raceme, the low scoring parent was considered as better parent. Hence, negative heterosis is useful for these traits.
All the crosses except ANDCI 10-7 x JH 109 exhibited highly significant negative relative heterosis for days to flowering of primary raceme, days to maturity of primary raceme, plant height up to primary raceme and number of nodes up to primary raceme indicating early flowering and maturity, dwarf plant height and less number of nodes which was desirable. Significant positive relative heterosis for number of total and effective branches per plant, seed yield per plant and oil content was observed in all the five crosses which were indicated by an increase in number of total and effective branches per plant, seed yield per plant and oil content in F_1 than the mid parental value. None of the hybrids were found significant relative heterosis in desired direction for total length of primary raceme and effective length of primary raceme. Cross ANDCI 10-7 x JH 109 depicted significant and positive relative heterosis for number of capsules on primary raceme indicating the higher number of capsules on primary raceme in F_1 than its mid parental value. Significant positive relative heterosis for shelling out turn was observed in four crosses except cross JI 358 x SH 42, whereas all the crosses except cross ANDCI 10-7 x JH 109 were exhibited significant positive relative heterosis for 100 seed weight which is desirable for these traits.
Lavanya and Chandramohan (2003) [10] also found significant negative relative heterosis for days to flowering of primary raceme. Several research workers has been reported relative heterosis in desire direction for various characters in castor like number of total branches per plant (Patel and Pathak 2006 [11] and Kanwal and Pathak 2008 [8]), number of effective branches per plant and number of capsules on primary raceme (Sapovadiya *et al.* 2015 [14]; Chaudhari *et al.* 2017 [2] and Kugashiya *et al.* 2017 [9]), seed yield per plant (Patel and Pathak 2006 [11]; Aher *et al.* 2015 [1] and Sapovadiya *et al.* 2015 [14]), 100 seed weight (Golakia *et al.* 2004 [5]; Chaudhari *et al.* 2017 [2] and Kugashiya *et al.* 2017 [9]) and oil content (Lavanya and Chandramohan 2003 [10] and Thakkar *et al.* 2005 [16]).
Thus, the high degree of heterosis in all the five crosses and heterobeltiosis in all the crosses except JI 358 x SH 42 for seed yield per plant indicated the presence of large scale genetic diversity among the parents of these crosses and also the unidirectional dominance of the allelic constitutions contributing towards heterosis in the F_1.
Joshi *et al.* (2002) [7] and Chaudhari *et al.* (2017) [2] have also showed significant negative heterosis over better parent for days to maturity of primary raceme, plant height up to primary raceme and number of nodes up to primary raceme as observed in the present study. Several researchers had reported significant positive estimates of heterobeltiosis in castor for various traits *i.e*., number of total branches per plant (Punewar *et al.* 2017 [13]), effective length of primary raceme (Singh *et al.* 2013 [15] and Sapovadiya *et al.* 2015 [14]), seed yield per plant (Joshi *et al.* 2002 [7]; Sapovadiya *et al.* 2015 [14]; Chaudhari *et al.* 2017 [2]; Kugashiya *et al.* 2017 [9] and Punewar *et al.* 2017 [13]), shelling out turn (Sapovadiya *et al.* 2015 [14]), 100 seed weight (Joshi *et al.* 2002 [7]; Sapovadiya *et al.* 2015 [14] and Punewar *et al.* 2017 [13]) and oil content (Sapovadiya *et al.* 2015 [14] and Punewar *et al.* 2017 [13]).
High inbreeding depression for seed yield and its component traits is undesirable in castor crop as vigour decline from generation to generation and delay the development of inbred lines. The estimates of inbreeding depression was found significant but negative for days to flowering of primary raceme in all the crosses except ANDCI 10-7 x JH 109; days to maturity of primary raceme in all the crosses; plant height up to primary raceme in the crosses ANDCI 10-7 x SKI 324 and ANDCI 10-7 x JH 109; number of total branches per plant in ANDCI 10-7 x JH 109; seed yield per plant in ANDCI 10-7 x JH 109; 100 seed weight in ANDCI 10-7 x JH 109; oil content in ANDCI 10-7 x JH 109. The cross ANDCI 10-7 x JH 109 exhibited significant negative inbreeding

depression for seed yield per plant, 100 seed weight and oil content, hence this cross would likely to yield beneficial transgressive segregants for these traits and possibility of selecting superior recombination's for high seed yield, bold seed and high oil content in F_2 and succeeding generations

The crosses with significant and positive inbreeding depression was observed for total length of primary raceme in the cross JI 358 x SH 42; effective length of primary raceme in the crosses SKI 324 x PCS 124 and JI 358 x SH 42; number of capsules on primary raceme in the crosses ANDCI 10-7 x JH 109 and JI 358 x SH 42; seed yield per plant in the cross ANDCI 8 x SKI 324 and cross JI 358 x SH 42; shelling out turn in three crosses *viz.*, SKI 324 x PCS 124, ANDCI 8 x SKI 324 and ANDCI 10-7 x SKI 324; 100 seed weight in crosses JI 358 x SH 42 and SKI 324 x PCS 124 and oil content in the cross JI 358 x SH 42.

The main cause of heterosis as of inbreeding depression is the dominance effect and heterosis is absent when traits are influence only by additive gene action (Pirchner, 1969 [12]). If several loci are involved, the unidirectional dominance is required for realizing heterosis, otherwise heterosis may be absent even when the loci show dominance (Falconer, 1977 [3]).

The significant and positive inbreeding depression was also noted by Golakia *et al.* (2004) [5] and Singh *et al.* (2013) [15] for total length of primary raceme, effective length of primary raceme, number of capsules on primary raceme and 100 seed weight; Golakia *et al.* (2004) [5], Thakkar *et al.* (2005) [16] and Singh *et al.* (2013) [15] for seed yield per plant and Singh *et al.* (2013) [15] for oil content which supports the results obtained in the present study.

From the foregoing discussion it can be concluded that **s**ignificant heterosis and heterobeltiosis in desired direction observed for seed yield and its majority of the components *i.e.*, total and effective branches per plant, number of capsules on primary raceme, shelling out turn and 100 seed weight suggested the possibility of utilizing hybrid vigour on commercial scale. It is being suggested that the parental genotypes SKI 324, ANDCI 10-7 and ANDCI 8 due to their presence in high heterotic combinations *viz.*, ANDCI 10-7 x JH 109 and ANDCI 8 x SKI 324 need to be further exploited in future castor breeding programme.

Table 1: Relative Heterosis (RH %), heterobeltiosis (HB %) and inbreeding depression (ID %) for various characters in five crosses of castor

Characters	I. SKI 324 x PCS 124			II. ANDCI 10-7 x JH 109			III. ANDCI 8 x SKI 324		
	RH (%)	HB (%)	ID (%)	RH (%)	HB (%)	ID (%)	RH (%)	HB (%)	ID (%)
Days to flowering of primary raceme	-8.26** (0.90)	0.43 (0.88)	-13.93** (0.97)	2.11 (1.40)	8.81** (1.50)	-4.05 (1.51)	-11.03** (0.96)	-8.88** (1.30)	-13.08** (1.15)
Days to maturity of primary raceme	-8.24** (1.01)	-3.69** (1.14)	-11.04** (1.40)	-0.40 (1.58)	1.81 (1.85)	-3.14* (1.81)	-5.12** (1.62)	-4.06** (1.90)	-7.99** (1.85)
Plant height up to primary raceme (cm)	-17.62** (3.46)	19.39** (3.31)	-0.85 (3.48)	-6.30 (3.95)	-5.25 (4.43)	-19.47** (3.89)	-18.98** (4.43)	-8.62 (4.72)	-7.06 (4.57)
Number of nodes up to primary raceme	-11.70** (0.50)	8.70 (0.55)	-1.43 (0.48)	8.07** (0.49)	10.89 (0.59)	-0.18 (0.54)	-13.71** (0.53)	-12.14** (0.51)	-3.66 (0.50)
Number of total branches per plant	24.90** (0.85)	-0.33 (1.04)	5.43 (1.00)	19.21** (0.78)	18.09* (0.90)	-22.38** (0.98)	26.68** (1.03)	13.64 (1.29)	18.28** (1.02)
Number of effective branches per plant	38.73** (0.74)	3.14 (0.97)	8.76 (0.79)	33.33** (0.70)	28.83* (0.76)	-15.34 (0.80)	41.40** (0.75)	28.14** (0.89)	15.83* (0.76)
Total length of primary raceme (cm)	-7.92 (2.04)	-30.08** (2.28)	7.72 (2.27)	5.94 (3.12)	-3.42 (3.12)	7.41 (3.20)	-1.19 (2.98)	-5.21 (3.07)	8.82 (2.80)
Effective length of primary raceme (cm)	-8.85* (1.70)	-31.70** (2.00)	13.49** (1.85)	-1.57 (2.76)	-15.14** (2.80)	4.69 (2.68)	-7.17 (2.52)	-9.75* (2.71)	4.11 (2.60)
Number of capsules per plant	-15.20** (3.83)	-37.54** (4.61)	4.77 (3.76)	14.31* (5.49)	9.03 (6.40)	18.79** (5.33)	-14.07* (5.75)	-17.07** (5.96)	-2.39 (5.68)
Seed yield per plant (g)	30.44** (15.78)	27.35** (17.51)	8.85 (17.59)	45.57** (21.25)	28.38** (23.53)	-19.61* (26.24)	35.38** (22.90)	29.80* (29.39)	19.85** (22.37)
Shelling out turn (%)	7.26** (0.63)	6.85** (0.65)	3.28** (0.72)	8.20** (1.07)	7.13** (0.92)	1.48 (0.83)	5.03** (0.68)	2.49* (0.84)	4.79** (0.83)
100 Seed weight (g)	7.30** (0.31)	2.40* (0.31)	3.33** (0.32)	0.81 (0.47)	-3.28* (0.50)	-6.47** (0.51)	8.77** (0.58)	8.62** (0.61)	-0.21 (0.63)
Oil content (%)	4.17** (0.46)	4.17** (0.57)	1.46 (0.45)	2.85** (0.25)	2.35** (0.32)	-1.73** (0.25)	2.85** (0.25)	0.50 (0.26)	0.18 (0.33)

Note:*, ** Significant at 5 and 1 % levels, respectively and () – figures in parentheses represent S.Em. values

Table 1: Contd....

Characters	IV. JI 358 x SH 42			V. ANDCI 10-7 x SKI 324		
	RH (%)	HB (%)	ID (%)	RH (%)	HB (%)	ID (%)
Days to flowering of primary raceme	-6.18** (0.98)	-1.37 (1.09)	-10.74** (1.05)	-5.90** (0.93)	-2.32 (0.98)	-6.12** (1.08)
Days to maturity of primary raceme	-4.02* (2.29)	2.07 (2.51)	-4.57* (2.34)	-6.34** (1.70)	-5.89** (1.98)	-8.31** (1.85)
Plant height up to primary raceme (cm)	-17.05** (4.30)	-15.94* (5.96)	5.47 (3.78)	-23.37** (4.26)	-21.27** (4.43)	-31.43** (4.50)
Number of nodes up to primary raceme	-7.56* (0.54)	-3.26 (0.62)	2.58 (0.46)	-7.41* (0.57)	-0.46 (0.55)	-6.53 (0.54)
Number of total branches per plant	19.28** (1.04)	3.78 (1.10)	16.16** (1.00)	23.13** (0.71)	15.42* (0.76)	-8.36 (0.84)
Number of effective branches per plant	37.17** (0.63)	10.70 (0.71)	17.52** (0.68)	35.98** (0.47)	32.02** (0.52)	-2.54 (0.52)
Total length of primary raceme (cm)	2.86 (3.84)	-2.33 (4.04)	12.37* (3.86)	-8.74** (1.59)	-11.55** (2.35)	-2.96 (2.03)
Effective length of primary raceme (cm)	0.98 (3.65)	-3.19 (3.94)	12.68* (3.68)	-10.98** (2.28)	-17.95** (2.95)	2.33 (2.48)
Number of capsules per plant	1.88 (4.34)	-9.39* (5.05)	19.88** (4.88)	-16.54** (4.04)	-17.84** (4.56)	-0.24 (4.54)
Seed yield per plant (g)	19.29* (31.67)	6.19 (30.15)	29.09* (30.71)	27.97** (11.62)	24.96**(13.53)	-4.35 (15.80)

Shelling out turn (%)	0.65 (1.13)	-1.18 (1.16)	2.46 (1.16)	10.50** (0.79)	9.49** (0.93)	5.93** (0.83)
100 Seed weight (g)	3.66** (0.43)	-5.38** (0.46)	4.90** (0.42)	5.31* (0.67)	4.31 (0.69)	-1.07 (0.70)
Oil content (%)	1.80* (0.35)	0.82 (0.41)	1.43* (0.36)	2.54** (0.30)	0.92 (0.35)	0.27 (0.27)

Note:*, ** Significant at 5 and 1 % levels, respectively and () – figures in parentheses represent S.Em. values

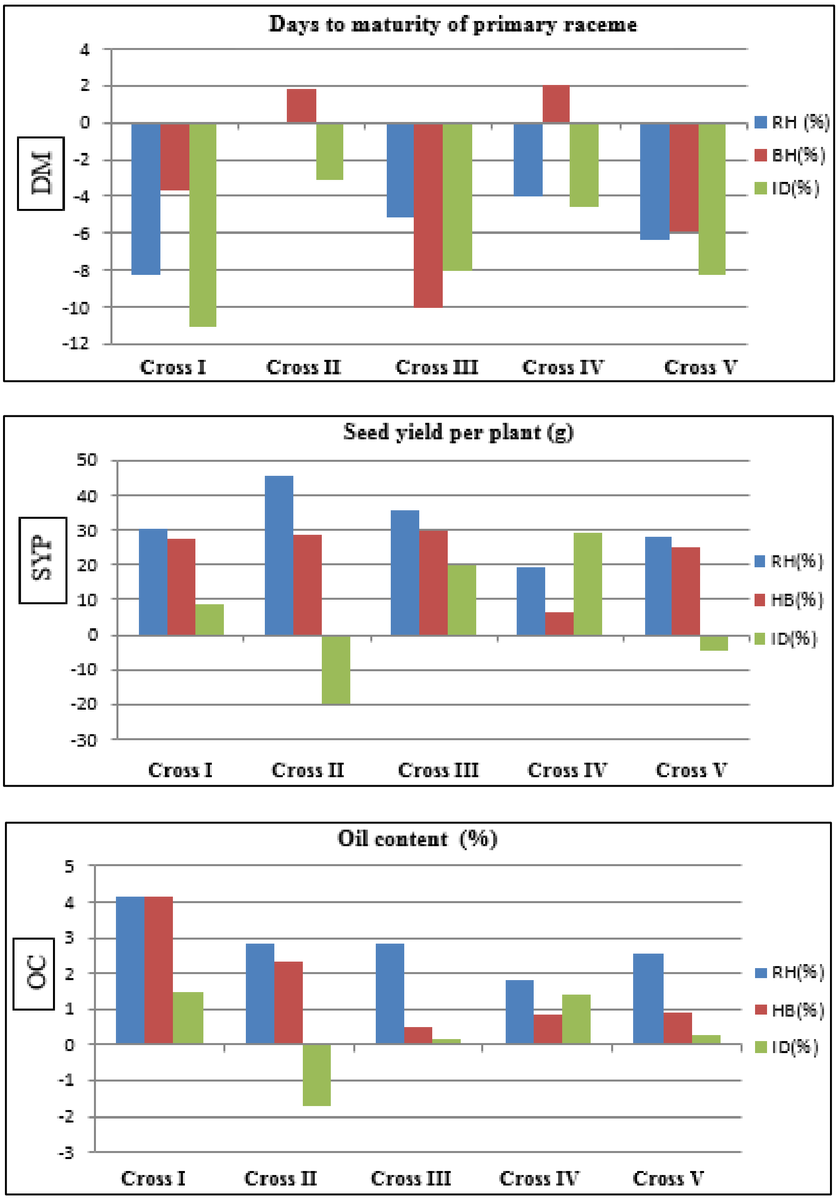

Fig 1: Relative heterosis (RH%), heterobeltiosis (HB%) and inbreeding depression (ID%) in five crosses for days to maturity of primary raceme, seed yield per plant (g) and oil content (%) in castor

4. References

1. Aher AR, Patel MP, Patel KV, Patel JA. Heterotic effects for pistillate x pistillate crosses in castor (*Ricinus communis* L.). Bioinfolet. 2015; 12(1b):125-130.
2. Chaudhari GR, Chaudhary JH, Gupta SA, Patel SR, Parmar SK. Heterosis for seed yield and its contributing attributes in castor (*Ricinus communis* L.). International Journal of Current Microbiology and Applied Sciences. 2017; 6(4):2088-2092.
3. Falconer DS. Introduction to Quantitative Genetics. Oliver and Boyd. Ltd., Edinburgh and London, 1977.
4. Fonseca S, Patterson F. Hybrid vigour in a seven parental diallel crosses in common winter wheat (*Triticum aestivum* L.). Crop Science. 1968; 8:85-88.
5. Golakia PR, Madaria RB, Kavani RH, Mehta DR. Gene effects, heterosis and inbreeding depression in castor, *Ricinus communis* L. Journal of Oilseeds Research. 2004; 21:270-273.
6. Gopani DD, Kabaria MM, Patel RH. Study of hybrid vigour in castor. Indian Journal of Agricultural Sciences. 1968; 38(3):520-527.
7. Joshi HL, Mehta DR, Jadon BS. Heterosis for seed yield and its components in castor hybrids. Indian Journal of Agricultural Research. 2002; 36(4):264-268.
8. Kanwal AK, Pathak HC. Heterosis studies for yield and its components in castor (*Ricinus communis* L.). International Journal of Bioscience Reporter. 2008; 6(1):167-169.
9. Kugashiya KG, Patel BN, Vekariya KJ. Study of heterosis for seed yield and its component traits in castor (*Ricinus communis* L.). International Journal of Current Microbiology and Applied Sciences. 2017; 6(8):66-74.
10. Lavanya C, Chandramohan Y. Combining ability and heterosis for seed yield and yield components in castor,

Ricinus communis L. Journal of Oilseeds Research. 2003; 20(2):220-224.
11. Patel JB, Pathak HC. Heterosis for seed yield and its components in castor (*Ricinus communis* L.). Journal of Oilseeds Research. 2006; 23(1):93-95.
12. Pirchner F. Population Genetics in Animal Breeding. W. H. Freeman and Co., Son. Francisco, Tata, 1969.
13. Punewar AA, Patil AS, Nandanwar HR, Patel SM, Patel BN. Genetic dissection of heterosis and combining ability in castor (*Ricinus communis* L.) with line x tester analysis. Journal of Experimental Biology and Agricultural Sciences. 2017; 5(1):77-86.
14. Sapovadiya MH, Dobariya KL, Babariya CA, Mungra KS, Vavdiya PA. Heterosis for seed yield and its components over environments in castor (*Ricinus communis* L.). Electronic Journal of Plant Breeding. 2015; 6(4):1118-1123.
15. Singh AP, Mehta DR, Desale CS. Heterosis and inbreeding depression for seed yield and its component traits in castor (*Ricinus communis* L.). Electronic Journal of Plant Breeding. 2013; 4(2):1180-1183.
16. Thakkar DA, Jadon BS, Patel KM, Patel CJ. Heterosis over environment for seed yield and other attributes in castor (*Ricinus communis* L.). Journal of Oilseeds Research. 2005; 22(2):324-426.
17. Turner JH. A study of heterosis, combining ability and inbreeding effects in upland cotton. Agronomy Journal. 1953; 45:487-490.