Original Research Article

Standard ~~Heterosis~~ heterosis for grain yield and its attributing traits in early maturing maize hybrids

Running title: Heterosis studies in maize

Abstract

The present study was conducted at the ~~Research~~ research ~~Farm~~ farm of Dryland Agriculture Research Station, SKUAST-Kashmir during the ~~kharief~~ kharif -of 2019. Range of heterosis was calculated over standard check. The most ~~suited~~ desirable cross ~~combination~~ combinations *viz*., KDM-440 x KDM-914A (-5.879), KDM-440 x V-335 (-4.468), KDM-930 x V-351(-4.165), KDM-927A x V-335 (-3.986), CML-470 x KDM-914A (-3.808) for ~~Days~~ days to maturity, KDM-347 x V-351 (4.967) CML-470 x KDM-914A (4.610), CML-474 × V-351(-4.396), KDM-927 A x V-351 (-3.110), KDM-930 x V 335 (2.896) for ~~Number~~ number of ~~kernels~~ kernel rows per cob, KDM-347 x V-351(-7.544), KDM-440 x V-351 (6.438), KDM-916A x KDM-914 A(6.117), CML-470 × V-351(5.992), CML-474 x V-335 (5.274) for ~~Number~~ number of kernels per row, KDM-340 x V-351 (3.966), KDM340 x KDM-914A (3.150), KDM-930 x V-351(3.165), KDM-440 x KDM-914 (3.556), KDM-347 x V-351(3.324) for 100-grain weight, KDM-347 x V351 (34.197), KDM-440 x V335 (28.933), CML470 x KDM-914A (29.380), KDM-895 x KDM914A (25.383), KDM927A x KDM-914A (19.549) for grain yield per plant were observed in the present study. The range of heterosis over standard check ~~ranged~~ for ~~one of a kind traits like for~~ days to maturity ~~ranged~~ from -3.796 (CML-425 × KDM-914A) to (2.414) CML-474 × KDM-914A. The ~~Extent~~ extent of heterosis for number of kernel rows per ear over standard check ranged from CML-470 x V-335(28.576) to KDM-916A × V -335(-2.143), for quantity of kernels per row maximum well known heterosis ranged from CML-470 × V-351 (19.079) to KDM-347 × V-351 (-15.132), for 100- grain weight, ~~Extent of~~ heterosis ~~extended~~ ranged from 22.3% for CML-470 x KDM-914 A ~~(22.321)~~ to -3.5% for KDM-916A × V-335 ~~(-3.464)~~. For grain yield per plant, heterosis ~~extended~~ ranged from 61.9% for CML-470 x K DM-914 A~~(61.923)~~ to 9.3% for KDM916A x V-335~~(9.321)~~. Standard ~~Heterosis~~ heterosis (for

Comment [C.M1]: The problem and objectives are not stated in the abstract. Methodology not described.

Comment [C.M2]: Is heterosis exressed as percentage in this manuscript? If so, put the symbol %

Comment [C.M3]: Since the germplasm used is not fully described, there is no point in having these pedigrees

Describe the germplasm and tell readers why was this material used in the breeding process

Comment [C.M4]: Be consistent. In one of the sentences above you used the word 'cob' for the same trait crosses CML -470 × KDM-914 A, CML-474 × V-351, KDM-440 × V-335) should be tested for multilocation to arrive make valid conclusion related to their use in commercial maize cultivation.

Key words: Heterosis, hybrids, yield and yield attributes, early maturing, maize

Introduction

Heterosis is the hybrid vigour which is generally represented as performance of offspring over parents. Charles Darwin had achieved lot of experiments in order to check his concept of origin of species. In which comparison of inbred lines with open pollinated maize was once compared. From this they concluded that cross pollinated vegetation has gained 25 percentage higher than offspring of self pollinated crops and in addition had super cold tolerance. Later in 1876 it was concluded from these experiments that hybrids outshined in discipline because of "great innate constitutional vigour" (Darwin *et al*., 1989). Meanwhile two very eminent scientists of time laid foundations for new maize breeding methods. , Scientist Scientists describe hybrid vigour as it was very important to have some term for it so "Shull" was the first person who marked the "heterosis" term for the rationalization of hybrid vigour. "East and Shull" working independently in 1908 had rediscovered phenomena of inbreeding depression and hybrid vigour in maize, consequently hybrids as soon as identified would possibly be reproduced year after year except a change. In maize hybrids can be developed with the aid of de tasselling of one of the inbred and pollination is carried from different inbred lines planted in close by adjacent blocks.

Heterozygosis is accountable for diversity which makes the crosses to range from each other. Where as homozygosis is diminished mechanically due to inbreeding (Dar *et al* 2017). Generally F_1 hybrids of "outcrossed" inbred strains show a incredible increase in vigour and viability. Even if the inbred lines, are degenerated due to inbreeding and there will be decrease of vigour. This phenomenon is termed heterosis or hybrid vigour. So, for assessment in deciding the parents, crosses and any future breeding programme.

MATERIAL AND METHODS

Ten diverse maize inbred lines viz., KDM-340, KDM-440, KDM-916, KDM-927A, KDM-895, CML-470, CML-474, CML-425, KDM-347, KDM-930 and three widely adapted testers V-351, V-335, KDM-914A were crossed in line x tester mating design in order to obtain a set of thirty

Comment [C.M5]: Objectives of the study are not stated in the introduction.

The introduction is not justified. It does not say anything about the need to breed early maturing maize hybrids. Standard heterosis should be defined in the introduction. Why is evaluation for standard heterosis important in maize hybrid cultivar development?

Comment [C.M6]: Do you mean 'realization'?

crosses during ~~Rabi~~ *rabi* season of 2018 at Winter Nursery, Agricultural centre of Research Institute, Rajendranagar, Hyderabad then F_1 was evaluated at Dryland Agriculture Research Station Srinagar during *kharief* seaso of 2019 in randomized block design with three replications with experimental plot of 75 x 20 cm. The data was recorded on morphological, maturity, ~~,~~yield and yield attributing traits *viz*., ~~Days~~ days to 50 per cent tasseling, ~~Days~~ days to 50 per cent silking, ~~Days~~ days to maturity (Seed to seed), ~~Plant~~ plant height (cm), ~~Ear~~ ear height (cm): ~~Ear~~ ear length (cm), ~~Ear~~ ear diameter (cm), ~~No.~~number of kernel rows ear^{-1}, ~~No.~~number of kernels row^{-1}, ~~Prolificacy~~ prolificacy index: ~~Grain~~ grain yield plant^{-1} (g). Combinig ability procedure was done according to kempthrone (1957).

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Comment [C.M7]: Not clear what you mean. Is this plot area?

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RESULTS AND DISCUSSIONS

Comment [C.M8]: You mentioned combining ability analysis in the M&M section but you were completely silent about it in this section

Heterosis is regarded as the ideal performance of offspring over its parents and is the effect of variances. ~~Its~~ It is set up as a primary tool for enhacement of manufacturing of crops. Plant breeders have extensively used and exploited heterosis in analyzing yield of numerous plants in particular cross pollinated crop species. Therefore, the heterotic studies can supply the groundwork for the utilization of precious hybrid mixtures in the future breeding programmes and their profitable utilization. The presence of sufficient hybrid vigour is an full-size pre-requisite for triumphing manufacturing of hybrid varieties. In the cutting-edge reading, preferred heterosis *viz*., parental heterosis for each trait were computed. The consequences confirmed a wide ~~aary~~ array of patterns of heterosis for maturity the traits underneath study (Table 1). Maximum amount of heterosis was once calculated for general check for maturity traits. Out of thirty cross combinations, noteworthy heterosis over standard check (SMH 2) was recorded in KDM-440 x KDM-914A (-5.879), KDM-440 × V-335 (-4.468), KDM-930 x V-351(-4.165), KDM-927 x V-335 (-3.986), CML-470 × KDM-914A (-3.808) for Days to maturity. KDM-347 x V-351 (4.967), CML-470 x KDM-914A (4.610), CML-474 × V-351(-4.396), KDM-927 x V-351 (-3.110), KDM-930 x V 335(2.896) for wide variety of kernels rows per cob, KDM-347 x V-351(-7.544), KDM-440 x V-351(6.438), KDM-916A x KDM-914A (6.117), CML-470 × V-351 (5.992), CML-474 x V-335(5.274) for Number of kernels per row, KDM-340 x V-351 (3.966), KDM340 x KDM-914 A (3.150), KDM-930 x V-351(3.165), KDM-440 x KDM-914 A(3.556), KDM-347 x V-351(3.324) for 100 grain weight, KDM-347 x V351 (34.197), KDM-440 x V335(28.933), CML470 x KDM-914A (29.380), KDM-895 x KDM914A (25.383), KDM927A

Comment [C.M9]: Significant heterosis has been observed when the offspring is superior or inferior to the parents. So, even when the performance of the offspring is poor (not ideal) significant heterosis can be realized

Comment [C.M10]: Explain!

Comment [C.M11]: This is meaningless!

x KDM-914 (19.549) for Grain yield per plant. Significant heterosis for yield and yield related constituent qualities and most flowering traits have been said by way of a variety of people (Jain and Bharadwaj, 2014; Rajesh *et al*., 2014; Alam *et al*., 2008; Amiruzzaman *et al*., 2010; Amanullah *et al*., 2011; Jawaharlal *et al*., 2012; Ali *et al*., 2012; Abauli *et al*., 2012; Izhar and Chakraborty, 2013 and Singh *et al*., 2013).

Comment [C.M12]: In trying to avoid plagiarism you may end up using terms that are not appropriate. Make sure the technical terms are appropriate

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Table 1: Estimation of heterosis over standard check for days to maturity, yield & yield attributing traits in maize (*Zea mays* L.)

Crosses	Days to maturity	Kernel rows cob^{-1}	Number of kernels row^{-1}	100- grain weight(g)	Grain yield $plant^{-1}$ (g)
CML470 × V-351	-3.793*	14.286*	19.079*	19.321*	51.154*
CML470 × KDM-914 A	1.690	15.195*	18.421*	22.321*	61.923*
CML470 × V335	0.992	28.576*	19.316*	6.071*	41.50*
CML474 × V351	-0.172*	10.714*	12.500*	14.821*	58.077*
CML474 × KDM-914A	-2.414*	3.571*	15.132*	10.250	50.769*
CML474Xv335	-3.241	7.143*	9.868*	13.143*	39.231*
KDM-916A xV335	-2.052*	-2.234	-5.921	-3.464	9.231
KDM-347x V351	-0.517*	9.700	-15.132	9.607*	13.462
KDM-347x KDM-914 A	-1.897*	-3.571	6.579*	12.214*	22.692*
KDM-347 xV335	2.241	5.809	5.921*	17.321*	48.462*
KDM-895 × V351	3.103	-3.670	4.605*	7.250*	33.846*
KDM-895 × KDM-914A	4.276	14.286*	11.842*	15.536*	45.769*
KDM-895 × V335	4.897	5.122*	-1.316	11.607*	18.077*
KDM-440 xV351	-1.962*	19.245*	15.789	6.964*	28.846*
KDM-440 × KDM914A	9.034	12.700	-10.526	11.443*	53.462*
KDM-440 xV335	1.823	8.571*	11.421*	9.571*	31.154*
KDM-930A × V351	-4.991*	6.243*	12.500*	12.500*	24.615*
KDM -930A × KDM914A	1.552	12.234*	5.550*	14.718*	37.308*
KDM930AxV335	-4.203*	7.183*	2.921*	10.107*	25.769*
KDM-340 × V351	2.241	2.193*	17.763*	14.821*	13.846
KDM-340 × KDM-914A	-0.142*	6.445*	24.652*	15.000*	36.215*
KDM-340 × V335	-0.163*	4.700	7.895*	18.893*	26.992*