International Journal of Ecology and Environmental Sciences
www.ecologyjournal.in
Online ISSN: 2664-7133; Print ISSN: 2664-7125; Impact Factor: RJIF 5.28
Received: 03-11-2020; Accepted: 17-11-2020; Published: 03-12-2020
Volume 2; Issue 4; 2020; Page No. 671-674

Study of genetic parameters for popping expansion ratio and yield traits in pop corn hybrids

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Abstract
The present study was carried out to investigate popping volume, yield and yield attributing traits in popcorn in order to generate information regarding the extent of genetic variability, heritability and genetic gain. The experiment was conducted with 20 hybrids with two checks during kharif, 2019 at Maize Research Centre, Rajendranagar, Hyderabad. Analysis of variance showed significantly superior for all the traits, indicated that considerable variability among the popcorn hybrids evaluated. Phenotypic Coefficient of Variation (PCV) was slightly higher than Genotypic Coefficient of Variation (GCV) for all the characters studied. Popping expansion ratio, grain yield per cob, number of kernels per row, cob length and ear height recorded higher estimates of genetic parameters indicating the predominance of additive gene action for expression of these traits and profuse scope for improvement of these traits through simple selection in pop corn.

Keywords: Popcorn, genetic parameters, popping volume

Introduction

Popcorn [*Zea mays* L. ssp everta (Sturt.) Zhuk] is a unique type of flint corn characterized by its ability to pop under heat and become an edible, direct-to-consumer snack product. Its consumption may have boomed over the past decade, especially with the mushrooming of multiplex cinemas, malls and food courts across metros and Tier-II cities. Only few pop varieties available in the market like Pearl Popcorn variety (Punjab Agricultural University in Ludhiana (PAU), Amber Popcorn and BPCH 6 hybrid (Maize Research Centre, PJTSAU, Hyderabad), Jawahar Popcorn (Jawaharlal Nehru Krishi Vishwa Vidyalaya's zonal research station at Chhindwara) and Bajaura Popcorn (Himachal Pradesh Agriculture University in Palampur) and Pant popcorn 1 (GBPUA & T, Pantnagar). Available popcorn varieties and single cross hybrids were having the low popping volume and yield. Hence there is an urgent need for development of high yielding pop corn hybrids along with high popping volume.

The outline and amount of genetic variability for various traits of interest in breeding populations grant a proposal for long term breeding programs. The genetic parameters greatly influence gene frequencies of desirable alleles that are why they can be entertained in the breeding procedures effectively. Of these, heritability estimates are of great importance as they influence the choice of procedures for selection and subsequent plant breeding manipulations by plant breeders. Plant breeders usually exploit heritability in making decision about breeding method and also in prediction of gain from selection as well (Laghari *et al*. 2010) [13]. The assessment of existing genetic variability in any crop species is essential for formulating effective breeding strategies as the existing variability can be used to enhance the yield level of the cultivars. The information on heritability alone may not help in identifying characters for enforcing selection; therefore, heritability estimates in conjunction with predicted genetic advance is more reliable (Johnson *et al*. 1955) [10].

In case of popcorn popping quality is critical factor along with yield. Hence, along with the pooping quality yield traits are also very important and need to quantify the relationship between popping quality traits and crucial agronomic traits. Many research workers reported the importance of expansion volume of popcorn (Shimoni *et al*. (2002) [24], Borras (2006) [4], Karababa (2006) [12] and Ertas *et al*. (2009) [6]. Lu *et al*. (2003) [15], Babu *et al*. (2006) [2] and Srdic Jelena *et al*. (2017) [9] reported the high estimates of heritability and Sleper and Poehlman (2006) [25] registered low heritability of pop corn yield because of effect of environmental influences. Moderate to high estimates of broad and narrow senses heritability for most of the yield attributing traits was reported by Noor *et al*. 2017 [18]. Moumi *et al*. (2020) [17] reported high heritability estimates for 1000 seed weight, cob length, shelling parentage and grain yield. Sridhar *et al*. (2017) [26] highlighted high heritability coupled with high genetic advance as per mean for the traits ear height, number of kernels per row, number of kernels per row, 100 kernel weight, grain yield per plant and popping expansion ratio.

As in semi urban and urban areas popcorn consumption increasing gradually and hence, need to improve the yield and popping volume of hybrids. The genetic information on popcorn is limiting for the development of new inbred lines with high popping volume. Keeping the importance, of aforesaid aspects, the present study was undertaken to estimate the genetic variability, heritability and genetic advance for yield and its attributing traits and popping volume among the pop corn hybrids.

Material and Methods

The experimental material consists of 20 single cross pop corn hybrids along with two checks (Amber popcorn and BPCH 6) were evaluated at Maize Research Centre, Rajendranagar,

Hyderabad (Altitude of 542.6 m and around 79º23'E longitude and 17º19'N latitude) during kharif, 2019 in two replications with 4m row length with a spacing of 60cm x 20 cm. All the recommended package of practice was followed to raise the good crop. Data recorded on nine yield and yielding attributing traits viz., days to 50 percent silking and polen shed, plant height (cm), ear height (cm), cob length (cm), cob girth (cm), number of rows per cob, number of kernels per row, popping expansion ratio and grain yield per cob. Popping expansion ratio recorded as per the guidelines of Indain Institute of Maize.

The data subjected for analysis of online software OPSTAT by using the standard procedures reported by Panse and Sukhatme 1985 [20] (analysis variance), Hanson *et al.* 1956 [7] (heritability in broad sense), Johnson *et al.*1955 [10] (genetic advance and genetic advance as per cent of the mean) and Burton 1952 [5] (phenotypic and genotypic coefficient of variation) as formulas detailed below

Table 1

i	Phenotypic coefficient of variation (PCV)	PCV= $\frac{\sqrt{\sigma^2 p}}{x}$ x 100	Where: σ^2p = phenotypic variance; X = mean of the trait
ii	Genotypic coefficient of variation (GCV)	GCV=$\frac{\sqrt{\sigma^2 g}}{x}$ x 100	Where: $\sigma^2 g$ = genotypic variance; X = mean of the trait
iii	Broad sense heritability	$h^2B=\frac{\sigma^2 g}{\sigma^2 p}$	Where: $\sigma^2 g$ = genotypic variance; $\sigma^2 p$ = phenotypic variance
iv	Expected genetic advance	GA=K x$\sqrt{\sigma^2 p}$ x h^2B	Where: K = constant that represents the selection intensity (when k is 5% the value is 2.06); $\sqrt{\sigma^2 p}$ = standard deviation of phenotypic variance; h^2B = heritability in a broad sense

Results and Discussions

Analysis of variance for the traits showed significantly superior it indicated that considerable variability among the popcorn hybrids evaluated (table 2). Wide range of variability was observed among the single cross hybrids. Days to 50% pollen shed varied from 52.5 days to 60.0 days and days to 50 % silking ranged from 55.0 days to 62.0 days. Similarly, plant height ranged from 172.5 cm to 250.0 cm and ear height ranged from 65.0 cm to 112.5 cm. The trait cob length ranged from 15.3 cm to 22.3 cm and cob girth registered with minimum was 9.0 cm and maximum 11.5 cm. Number of rows per cob and numbers of kernels per row were very important traits and recorded 12.0 to 17.0 and 22.5 to 48.0 respectively. Popping expansion ratio and grain yield per cob are most important traits. Popping expansion ratio recorded 10.0 to 22.5 range and nine hybrids registered more than 18 percent Popping expansion ratio. Grain yield per cob ranged from 55.5 to 122.5 g and four hybrids registered more than 100 g grain yield per cob. Moumi *et al*., 2020 [17] reported this considerable variability provides a good vision for improving traits of interest in popcorn breeding programs. Phenotypic Coefficient of Variation (PCV) was higher than Genotypic Coefficient of Variation (GCV) for all the characters studied and difference was very low indicates influence of environ on these character is very less. For the traits popping expansion ratio (23.5, 23.6) recorded highest GCV and PCV values followed by grain yield per cob (19.2, 20.7), number of kernels per row (14.8, 16.5) and ear height (11.7, 14.9). GCV and PCV values registered low for the characters number of rows/ cob (8.3, 10.5), cob girth (5.7, 7.7), cob length (8.4, 10.5), plant height (7.4, 8.8), days to 50% pollen shed (7.4, 8.8) and silking (3.1, 4.4). Selection based on Popping expansion ratio, grain yield per cob, number of kernels per row and ear height were the important traits for improvement of yield as these traits recorded medium to high range of GCV and PCV. Rather *et al*. (2003) [23], Jawaharlal *et al*. (2011) [8], Bello *et al*. (2012) [3], Vashistha (2013) [27], Rajesh *et al*. (2013) [22], Kage *et al*. (2013) [11], Sridhar *et al*. (2017) [26] and Moumi *et al*. (2020) reported medium to high PCV and GCV values for most of the yield and quality traits. Low values of PCV and GCV reported by Sesay *et al*. (2016) [23] and Sridhar *et al*. (2017) [26] for traits characters number of rows/ cob, cob girth, cob length, plant height, days to 50% pollen shed. Misra, 1981 reported the information on heritability in broad sense h^2 (BS) and genetic advance of yield attributing characters and their association helps plant breeder to identify characters for effective selection. The concept of heritability explains whether differences observed among individuals rose as a result of differences in genetic makeup or due to environmental forces. The high heritability in broad sense was observed for Popping expansion ratio (98.9%) followed by grain yield per cob (85.9%), number of kernels per row (80.2%), plant height (71.2%), days to 50% silking, cob length (64.0%), ear height (62.6%) and number of rows per cob (62.5%). Moderate range of heritability was recorded for the traits days to 50% pollen shed (49.3%) and cob girth (53.7%). Moderate to high genetic advance was reported by Lorenzana & Bemardo (2008) [14], Aminu & Izge (2012) [1], Noor *et al*. (2017) [18], Sridhar *et al* (2017) [26] and Moumi *et al*. (2020) [17] for yield and its attributing traits and quality traits. Genetic advance refers to the improvement of the mean genotypic value of the selected lines over the mean genotypic value of the parental population. It is usually expressed as a percent of the mean. According to Johnson *et al*, 1955 [10], selection of genotypes based on broad sense heritability alone is misleading as it is not sufficiently informative about the existence of gene action (additive/non-additive) and involvement of other factors in the expression of traits. Thus heritability along with genetic advance together is helpful in predicting genetic gain under selection. The estimates of genetic value percent of mean was found highest for the trait Popping expansion ratio (48.2%) followed by grain yield per cob (36.6%), number of kernels per row (27.3%), ear height (19.2%), plant length (13.9%), number of rows per cob (13.5%) and plant height (12.9%). Among the characters studied Popping expansion ratio, grain yield per cob, number of rows per cob, cob length and

ear height recorded high heritability along genetic advance as percent of mean, indicating the predominance of additive gene action and limited role environment on expression of these traits. Hence, while selection of genotypes these characters considered as these traits are fixable in nature. High heritability with moderate genetic advance as percent of mean observed for the traits like days to 50% silking, plant height, number of rows per cob suggesting the combing or conditional role of additive and non additive gene action in governing these traits and high heritability may be resulted from favourable influence of environ mental forces. Days to 50% pollen shed and cob girth registered moderate values of heritability as well as genetic advance as percent of mean indicating the these traits are highly influenced by environmental effects and selection for it would be ineffective. Different trends of heritability, genetic advance and genetic advance as percent mean was reported by Ogunniyan and Olkojo (2015) [19], Patil *et al*. (2016) [21], Noor *et al*. (2017) [18], Sridhar *et al*. (2017) [26] and Moumi *et al*. (2020) [17] for yield and quality traits in popcorn.

From the present study it can be conclude that popping volume, grain yield per cob, number of kernels per row, cob length and ear height recorded higher estimates of genetic parameters like GCV, PCV, broad sense heritability and genetic advance as percent of mean indicating the predominance of additive gene action. Hence, these traits fixable and considered for selection high yielding and popping volume genotypes in popcorn.

Table 2: Analysis of variance of yield and yield attributing traits of pop corn hybrids

Characters/ Source of variation		D.F	Days to 50% pollen shed	Days to 50% silking	Plant height (cm)	Ear height (cm)	Cob length (cm)	Cob girth (cm)	Number of rows/ cob	number of kernels /row	Popping expansion ratio	Grain yield/ cob
Mean sum of squares	Replication	1	1.84	1.46	14.21	7.36	2.51	2.05	0.09	19.11	0.36	0.82
	Treatment	21	181.66**	9.035**	601.975**	297.377**	5.764**	1.000**	3.693**	67.776**	27.788**	535.615**
	Error	21	61.66	1.65	101.11	68.46	1.27	0.30	0.85	7.45	0.15	40.72

*, ** significant at 5 and 1 % level significance

Table 3: Estimates of genetic parameters in pop corn hybrids

Characters	Mean	Range	GCV	PCV	Heritability (%)	Genetic Advance	Genetic Advance value % of means
Days to 50% pollen shed	55.295	52.5-60.0	3.057	4.353	49.318	2.445	4.422
Days to 50% silking	57.773	55.0-62.0	3.327	4.00	69.193	3.294	5.701
Plant height (cm)	213.977	172.5-250.0	7.396	8.762	71.238	27.515	12.859
Ear height (cm)	90.955	65.0-112.5	11.763	14.87	62.574	17.434	19.167
Cob length (cm)	17.77	15.3-22.3	8.44	10.549	64.013	2.472	13.911
Cob girth (cm)	10.411	9.0-11.5	5.68	7.748	53.728	0.893	8.576
Number of rows/ cob	14.318	12.0-17.0	8.322	10.529	62.476	1.94	13.551
Number of kernels /row	37.068	22.5-48.0	14.817	16.545	80.2	10.132	27.334
Popping expansion ratio	15.818	10.0-22.5	23.501	23.628	98.931	7.617	48.153
Grain yield/ cob	81.955	55.5-122.5	19.194	20.713	85.868	30.028	36.64

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