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Elucidation the association between yield and agronomic traits in popcorn

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Abstract
Maize (*Zea mays* L., 2n =20) is the most diversified and versatile crop among cereal crops. Among the popcorn inbredlines a significant positive correlation was observed between the number of primary branches per tassel and plant height. Days to 50% anthesis exhibited a strong positive correlation with days to 50% silking and days to 75% maturity. Furthermore, ear length and ear diameter were significantly correlated with the number of kernels per row. The number of kernel rows per ear and the number of kernels per row also showed a significant positive correlation with yield per plant at the genotypic level. Additionally, ear length and ear diameter were significantly correlated with the number of kernels per row. At the genotypic level, ear length, the number of kernel rows per ear, and the number of kernels per row all showed a significant positive correlation with yield per plant. This analysis highlights key associations that influence plant performance and yield, providing valuable insights for maize breeding and selection programs.

Keywords: Popcorn, association, agronomic, yield popping traits

Introduction
Maize is an annual, monoecious, cross-pollinated plant with a native range of Mexico and Central Africa. It was domesticated from a wild maize ancestor (*Teosinte*) and is referred to as the "queen of cereals" due to its vast genetic base and high yield potential. It is a C_4 plant, a short-duration crop that demands three times more water compared to other crops. It is considered a "climate-resilient crop" as well as a "future crop" because of its high grain yield, productivity, greater adaptability to various environmental stresses, soil moisture regime and revenue for farmers. Presently, 193.7 million ha of land are used to grow approximately 1147.7 million MT of corn, with an average productivity of 5.75 t/ha across 170 countries. Globally, total consumption of corn *viz.* animal feed (61%), grain (17%) and other industrial uses (22%).
It has become a global industrial crop, with 83% of the world's production going to the feed, grain, starch and bio-fuel industries. Corn is one of the world's most adaptable crops, with two main kinds, *viz;* field corn and specialty corn. Field corn is classified based on underlying consumer priorities, such as quality protein maize (nutritional security), waxy maize (paper industry), high-oil and others. Specialty corn sorted based on special uses, such as sweet corn, baby corn and popcorn, offers corn growers better economic opportunities. It has multiple uses, *viz;* grain, fodder, poultry, livestock and industrial products such as starch, oil, pharmaceuticals, paper, film, biofuel, tyres, alcoholic beverages, sweeteners, cosmetics, packaging, cornmeal, grits, starch, flour, tortillas and snacks.
Popcorn is an extremely unique form of flint corn with a very hard endosperm and a low portion of soft starch and is characterised by its popping ability on heating the kernel, which is a unique quality of the endosperm. Popcorn swells and puffs up when heated and is a popular recreational snack with a high nutritional content. It is an excellent source of carbohydrates, energy, fibrous and a globally popular snack. It is a healthy, enjoyable food that assists digestion by supplying essential roughage. Indian popcorn cultivars have a lower popping ratio as compared to European and American cultivars. The high demand for popcorn has spurred research to discover traits that dictate its idiosyncratic popping ability and many attempts have been made

to develop a popcorn industry, but it has been a hurdle because of the absence of stable and optimal hybrids with high popping volume and efficiency and also a lack of superior popcorn germplasm for popping characteristics, popping volume, flake size, and high-yielding genotypes. Popcorn germplasm has a narrow genetic background because most of the popcorn lines are descended from flint germplasm. However, it has relatively poor agronomic, yield, and popping performance and also more susceptible and prone to disease and pests.

Materials and Methods

The experimental material was comprised of the available 26 popcorn inbred lines as listed in (Table 1) from the ICAR-AICRP on Maize at the Department of Genetics and Plant Breeding, Institute of Agricultural Sciences, B.H.U., obtained from various sources.

Table 1: Description of popcorn inbred lines used in genetic polymorphism

Sr. No.	Popcorn Inbred lines	Sr. No.	Popcorn Inbred lines
1	WINPOP-3	14	HKIPC-6
2	WINPOP-8	15	HKIPC-7
3	WINPOP-8-1	16	HKIPC-8
4	WINPOP-8-2	17	HKIPC-8-1
5	WINPOP-8-3	18	HKIPC-8-2
6	WINPOP-13	19	HKIPC-8-3
7	WINPOP-20	20	HKIPC-8-4
8	WINPOP-29	21	BAUJIPOP-162
9	WINPOP-47	22	BAUJI POP-163
10	WINPOP-III×APC-1	23	BAUJI POP-164
11	WINPOP-III ×APC-2	24	BAUJI POP-165
12	WINPOP-III× APC-3	25	BAUJI POP-166
13	HKIPC-5	26	BAUJI POP-167

During *rabi* 2016-17, the inbred lines were planted in a completely randomised block design with three replications with each entry planted in a single row plot of 4m length, with inter-row spacing of 60 cm and plant to plant spacing of 25 cm maintained in each season during *rabi*, 2017-18, *kharif*, 2018 and *rabi*, 2018-19. The two seeds were planted per hill and after three weeks, thinning was conducted in each row to maintain the plant population at an optimal level. All agronomic practises were carried out in accordance with the maize crop.

Result and Discussion

The present experiment, The phenotypic twenty different observations were record based on underlying agro-morphological and phenological, yield and popping quality traits. Estimation of genetic and phenotypic correlations among characters is useful in planning and evaluating breeding programme as it gains knowledge of interconnection among the traits. Plant breeders generally emphasis on genotypic correlation rather than phenotypic correlation as later is values recorded is result of sum of genetic and environmental causes, whereas genotypic correlation coefficient is the only heritable portion of total correlation coefficient. Yield is a complex trait associated with a number of different quantitative characters and is the prime concern of the plant breeder. Hence, all the changes in yield must be accompanied by changes in one or more character.

In parents phenotypic and genotypic character association were studied for twenty different qualitative and quantitative traits. Number of primary branches per tassel recorded positively significant correlation with plant height, whereas days to 50% anthesis showed positively significant correlation with days to 50% silking and day's to75% maturity. Ear length and Ear diameter recorded positively significant correlation with number of kernels per row. Number of kernel rows per ear and number of kernels per row showed significant positive correlation with yield per plant at genotypic level. In hybrids phenotypic and genotypic character association were studied for twenty different qualitative and quantitative traits (Table 1 and 2). Number of primary branches per tassel recorded positively significant correlation with, Number of kernel rows per ear and number of kernels per row, whereas days to 50% anthesis showed positively significant correlation with days to 50% silking and days to75% maturity. Ear length and Ear diameter recorded positively significant correlation with number of kernels per row. Ear length, number of kernel rows per ear and number of kernels per row showed significant positive correlation with yield per plant at genotypic level.

Among inbredlines, significant positive correlation with yield per plant at genotypic level recorded by number of kernel rows per ear and number of kernels per row, two traits can be considered breeding programme for developing high yielding genotypes. This findings is congruity with Sridhar *et al.*, (2016) by number of kernel rows per ear and number of kernels per row. By Sharma and Kumar (1987). The association of 100-kernel weight with popping expansion was significantly negative (-0.549), which is in conformity with the findings of Valéria Carpentieri-Pípolo *et al*. (2003). Ceylan and Karababa (2002) stated that the smallest sized kernel gave the highest expansion volume. Song *et al*. (1991) and Allred-Coyle *et al*. (2002) [1] reported that middle sized kernels had the highest expansion volume. But, large sized kernels generally give lower popping volume than small kernels, because they contain a high percentage of soft endosperm (Pajic and Babic, 1991) [9]. Dofing *et al*. (1990) and Gökmen (2004) reported that large kernel samples had large flake size than small kernel samples, and higher expansion. The inconsistency in the relationship of 100-kernel weight with popping expansion could possibly describe to variations in kernel size (Souza Júnior *et al*., 1985) and the environmental effects (Li *et al*., 2003) and popping methods (Dofing *et al*., 1990). Correlation between popping expansion and single plant yield was nonsignificant. This is accordance with the findings of Dofing *et al*. (1991); Sawazaki, (1996); Valéria Carpentieri-Pípolo *et al*. (2003) and Freddy Mora and Carlos Alberto Scapim, (2007).

Conclusion

This analysis highlights key associations that influence plant performance and yield, providing valuable insights for popcorn breeding and selection programs.

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