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Mean performance of maize (*Zea mays*) genotypes under non stress conditions

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Abstract
Maize is an important cereal crop in India and will treble by 2050 as a result of its extensive use in developing nations. In Himachal Pradesh, it is widely grown as it is a rich source of carbohydrates and starch which are main components of a balanced diet. As the increasing demand and the changing climate pose a huge threat for food security, it is very important to develop and study new cultivars that perform better than the previously existing varieties. The following experiment was laid down at the research farm of the School of Agriculture, Abhilashi University (H.P.), the experiment was carried out in the Kharif season of 2023. In terms of agriculture, the trial site represents Zone II, the mid-hill region of Himachal Pradesh. It has a hot, sub-humid tropical environment with a high mean annual rainfall of roughly 1876 mm. In this experiment total 20 genotypes were sourced from CSKHPKV Plamapur which included 17 accessions and 3 checks namely BMJHQM-1, BAJHQM-2, VL-892. The experiment was laid down in RBD design and the analysis of variance revealed a significant mean sum of square for different genotypes for each of the ten traits examined which were days to 50% flowering, days to 50% tassaling, plant height, ear height, number of leaves per plant, number of kernels per row, cob length, 100 kernel weight, shelling percentage, and yield per plant which suggests that there was enough genetic variability and room for selection for these traits in the accessions taken for the experiment.

Keywords: Randomized block design, mean, genetic variability, analysis of Variance

Introduction
Maize (*Zea mays* L.) is one of the most important cereal crop grown in India. It is known as the queen of cereals which has its origin from Central America. It is a monoecious, cross pollinating, diploid cereal crop with chromosome no. 2n = 20 belonging to family Poaceae. Maize has many types like normal yellow/white grain, sweet corn, baby corn, popcorn, waxy corn, high amylase corn, high oil corn, quality protein maize. It is cultivated globally on more than 160 m ha area across 166 countries having wider diversity of soil, climate, biodiversity and management practices. Maize contributes 15% of the world's protein and 19% of the calories derived from food crop (Anonymous 2022) [1]. The crop is also an important component of livestock feed, especially in developed nations where 78% of total maize production is used for livestock feed.

Maize is one of the most versatile emerging crops having wider adaptability under varied agro-climatic conditions. It is cultivated on nearly 150 m ha in about 160 countries having wider diversity of soil, climate, biodiversity and management practices that contributes 36% (782 m t) in the global grain production. The maize is cultivated throughout the year in all states of the country for various purposes including grain, fodder, green cobs, sweet corn, baby corn, pop corn in peri-urban areas.

India has experienced a notable increase in agricultural output recently, outpacing global demand and positioning itself as a major supplier of horticultural and agronomic products. It's crucial to remember that this industry has also been linked to environmental effects, having contributed to a number of pollutions that have a detrimental effect on soil, water, air quality, and human health. Evaluating the total environmental effects of the food supply chain it is crucial in order to address the environmental impact of food production.

The growing of maize has a big impact on the environment, particularly when it comes to the use of resources, the effects of pesticides and fertilizers. (Kumar, 2024) [6]

In 2023-24, it is expected that the United States will be the largest producer of corn worldwide with a production volume amounting to about 389.7 million metric tonnes. China and Brazil rounded of the top corn producing countries. The production volume of corn across India was 33.5 million metric tonnes, this was a decrease as compared to the previous year when the production volume of corn was about 36.6 million metric tonnes. (Anonymous 2023-24) [2].

Materials and Methods

The experiment was conducted during *kharif* season, 2023 at the Research Farm of School of Agriculture, Abhilashi University (H.P). Agro-climatically, the location of the trial represent the mid hill zone of Himachal Pradesh (Zone II) and is characterized into hot and sub -humid tropical climate which have high mean annual rainfall of about 1876 mm for annum. The soil pH was ranging from 5.0 to 5.6 and soil texture is clay loam. In total 20 maize genotypes which included seventeen genotypes along with three checks and were evaluated in RBD design with two replications. The list of genotypes along with their source is given in table 1:

Table 1: The list of genotypes along with their source

S. No.	Genotypes	Source
1.	AVT-122-3	CSKHPKV Palampur
2.	AVT-122-4	CSKHPKV Palampur
3.	AVT-122-6	CSKHPKV Palampur
4.	AVT-122-7	CSKHPKV Palampur
5.	IVT-510	CSKHPKV Palampur
6.	IVT-508	CSKHPKV Palampur
7.	IVT-677	CSKHPKV Palampur
8.	IVT-678	CSKHPKV Palampur
9.	IVT-679	CSKHPKV Palampur
10.	DMR-221230	CSKHPKV Palampur
11.	DMR-221231	CSKHPKV Palampur
12.	DMR-221232	CSKHPKV Palampur
13.	MLT-22-01	CSKHPKV Palampur
14.	MLT-22-02	CSKHPKV Palampur
15.	MLT-22-03	CSKHPKV Palampur
16	P-1789	CSKHPKV Palampur
17	P-1796	CSKHPKV Palampur
18	BAJHQM-1(c)	CSKHPKV Palampur
19	BAJHQM-2(c)	CSKHPKV Palampur
20	VL-892 (c)	CSKHPKV Palampur

Results and Discussion

Analysis of variance (ANOVA)

The success of any crop improvement programme depends upon the presence of sufficient amount of experimental variability in the material. A large amount of variation is necessary in a breeding population to enable breeder to carry out effective selection for crop Improvement.

Analysis of variance of the present investigation revealed significant mean sum of square due to genotypes for all the 10 traits under study *viz*., days to 50% flowering, days to 50% tasseling, plant height (cm), ear height, number of leaves per plant, no. of kernels per row, cob length (cm), 100 kernel weight (g), shelling percentage, yield per plant indicating thereby presence of sufficient genetic variability and scope of selection for these traits.

Table 2: ANOVA Summary

Sl. No.	Source	Mean Sum of Squares (MSS)		
		Replication	Treatment	Error
	Degrees of freedom	2	20	40
1	Days to 50% flowering	16.4440	77.663**	14.81
2	Days to 50% tasselling	3.9210	78.321**	13.895
3	Plant Height (cm)	9.8660	46.814**	19.762
4	Ear Height (cm)	30.5210	109.993**	10.174
5	Number of Leaves per plant	1.4140	7.378**	0.472
6	Cob length (cm)	8.1670	9.753**	2.723
7	Number of kernels per row	8.4360	20.086**	2.812
8	100 Kernel weight	4.9520	6.691**	2.476
9	Shelling (%)	3.0640	14.53**	6.133
10	Yield per plant (g)	7.6960	36.498**	15.407

The range and mean performance of 10 characters in 20 genotypes for yield per plant and its attributing traits are presented in Table (2). The details of the results obtained are elaborated in table 3. The variation for days to 50 percent flowering ranged from 63 to 81.67 days. The mean for this characters was 69.97 days. IVT-510 (63) was earliest for days to 50 percent flowering followed by AVT-122-3 (64.33), VL-892 (64.67). The variation for days to 50 percent tasseling ranged from 56.33 to 74.33 days. The mean for this character was 64.27 days. IVT-510 (56.33) was earliest for days to 50 percent tasselling followed by AVT-122-3 (58.67). Plant height ranged from 164.43 to 177.03 cm with a mean value 171.81 cm. The maximum plant height was observed in variety AVT-122-3 (177.03 cm) and MLT-22-03 (177.03 cm) followed by IVT-510 (176.40) and IVT-677 (175.07). Ear height ranged from 27.17 to 52.53 cm with a mean value 36.94 cm. The best performing variety AVT-122-3 (27.17cm) followed by IVT-510 (28.70 cm) and DMR-221232 (30.10 cm). The no. of leaves per plant ranged from 9 to 14.33 with a average mean value of 11.22. The maximum number of leaves per plant was observed in variety IVT-510 (14.33) followed by AVT-122-3 (13) and MLT-22-02 (13).Cob length ranged from 65.40 to 73.03 cm with mean value of 69.05 cm. The maximum cob length was observed in variety IVT-510 (26.73 cm) followed by AVT-122-3 (26.33 cm) and AVT-122-7 (26.30 cm).

Table 3: Mean performance of different qualitative character

Sl. No.	Genotypes	Days to 50% flowering	Days to 50% tasselling	Plant Height (cm)	Ear Height (cm)	Number of Leaves per plant	Cob length (cm)	Number of kernels per row	100 Kernel weight	Shelling (%)	Yield per plant (g)
1	AVT-122-3	64.33	58.67	177.03	27.17	13.00	26.33	31.33	27.83	65.40	76.60
2	AVT-122-4	72.33	67.67	165.03	52.53	10.00	25.63	26.33	25.90	67.50	73.40
3	AVT-122-6	74.67	70.00	164.43	45.00	11.67	24.67	28.33	24.93	67.63	72.03
4	AVT-122-7	67.33	61.00	173.23	31.50	9.33	26.30	26.33	24.17	67.07	75.27
5	IVT-510	63.00	56.33	176.40	28.70	14.33	26.73	31.67	26.20	65.80	76.47
6	IVT-508	65.33	60.00	166.77	35.17	11.00	23.87	25.67	21.80	73.03	65.60
7	IVT-677	69.33	65.00	175.07	34.07	11.67	20.20	24.67	22.33	72.07	66.83
8	IVT-678	77.00	71.33	166.30	43.30	11.00	25.73	30.67	25.37	68.77	73.07
9	IVT-679	69.00	62.67	167.07	35.17	10.00	23.17	31.00	25.70	67.13	66.97
10	DMR-21230	81.67	74.33	171.87	40.43	12.33	25.03	27.67	25.27	66.70	73.37
11	DMR-21231	70.00	64.00	174.37	34.97	10.00	25.00	29.33	24.93	67.23	75.67
12	DMR-21232	68.67	63.67	174.03	30.10	9.00	24.70	30.00	25.30	71.87	67.20
13	MLT-22-01	69.00	63.67	174.53	46.87	10.67	22.30	24.67	23.20	69.53	72.10
14	MLT-22-02	70.00	65.00	170.77	36.37	13.00	21.17	23.67	22.53	72.03	66.77
15	MLT-22-03	66.67	60.33	177.03	36.30	10.67	23.67	26.67	24.17	70.27	73.07
16	P-1789	76.67	71.00	171.23	35.10	9.67	22.73	24.67	23.13	69.57	71.67
17	P-1796	70.00	63.67	169.37	37.03	9.33	21.20	23.33	22.67	71.23	68.60
18	BAJHQM-1	66.00	60.00	172.20	38.97	14.00	23.53	27.33	24.37	68.27	72.13
19	BAJHQM-2	78.33	72.67	171.67	34.73	10.33	23.10	25.33	23.30	70.57	68.47
20	VL-892	64.67	59.67	174.50	35.30	11.67	22.77	26.00	23.57	69.70	67.70

Number of kernels per row ranged from 23.33 to 31.67 with mean value of 27.19 kernels per row. The maximum numbers of kernels per row were found in variety IVT-510 (31.67) followed by AVT-122-3 (31.33) and IVT-679 (31). 100 kernel weight (g) ranged from 21.80 to 27.83 (g) with mean value 24.35 (g).The maximum 100 kernel weight (g) was observed in variety AVT-122-03 (27.83 g) followed by IVT-510 (26.20 g) and AVT-122-4 (25.90 g). The shelling percentage was found to be having a range of 65.40 to 73.30 percent with a mean value of 69.05 percent. The best performing variety for shelling percentage AVT-122-3 (65.40) followed by IVT-510 (65.80) and DMR-221230 (66.70). The yield per plant (g) had a range from 65.60 g to 76.60 g with a mean value of 71.18 g. The maximum yield per plant (g) was found in variety AVT-122-3 (76.60 g) followed by IVT-510 (76.47 g) and DMR-221232 (75.67 g).

Similar results were shown by Sinha *et al*. 2022 showed similar results for yield per plant, no. of kernels per row, ear height, 100-seed weight and plant height. Results revealed highly significant differences among the characters after direct selection. Niraula *et al*. 2023 conducted a experiment in which analysis of variance for different characters plant height, ear height, 100-seed weight, cob length and no. of kernels per row revealed significant differences for most of the characters among the genotypes used. Bamboriya *et al*. 2023 [5] conducted a experiment which showed a significant result in no. of leaves, plant height after the application of nitrogen. Sharma *et al*. 2020 conducted a experiment for local variety of Nagaland with a check in which the result showed significant differences for all characters including days to 50% flowering, days to 50% tassalling, plant height, ear height, cob length, 100 seed weight. Rashmi *et al*. 2021 [7] conducted an experiment on babycorn for 10 phenotypic characters including days to 50% flowering, days to 50% tassalling, plant height, ear height, cob length, 100 seed weight, yield per plant for which analysis of variance showed significant variation in genotypes for all the traits. Vasudevan *et al*. 2022 conducted an experiment for maize hybrids in which the results revealed that mean sum of squares indicated significant differences for growth and yield parameters which included plant height, cob weight, number of rows per cob, seed yield per and seed yield per hectare. Kumar P *et al*. 2024 [6] conducted an experiment for 39 genotypes for following characters which included days to fifty percent tasseling, days to fifty percent flowering, days to maturity, plant height, ear height, ear length, ear diameter, number of kernel rows/ear, number of kernels/row, 100kernels weight, shelling% and grain yield/plant for which the mean sum of squares indicated significant differences in analysis of variance. High to moderate genotypic and phenotypic coefficients of variation as well as genetic advance were observed in the traits yield per plant, plant height, ear height, number of kernels per row, and 100-kernel weight.

Conclusion

Higher estimates of range and mean values for many traits were seen for numerous characters based on the analysis of 20 distinct genotypes. It was concluded that AVT-122-3 was early for mean days to 50% flowering and IVT-510 was early days to 50% tassaling. It is a high-performing variety for the character because AVT-122-03 and MLT-22-03 shown the maximum plant height (cm) and AVT-122-03 displayed the least ear height. The maximum number of leaves per plant was displayed by IVT-510. IVT-510 displayed the maximum number of leaves and kernels per row. Among the other 20 genotypes, IVT-510 displayed the longest cob length.

Variety AVT-122-03 was found to have the highest maximum weight of 100 kernels (g) and the best shelling percentage (65.40%), both of which are necessary for a higher-performing variety. The variety AVT-122-03 had the highest yield per plant (g), yielding 76.60 g from a single plant. Because the results reveal higher performance for all the features impacting plant yield, the accessions AVT-122-3 and IVT-510 were judged to be superior and can be employed for further research as well as multiplication for the development of new varieties.

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