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GENETIC REPEATABILITY, PHENOTYPIC AND GENOTYPIC COEFFICIENT OF VARIABILITY OFWHITE MAIZE (*Zea mays* L.) POPULATIONS

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ABSTRACT

A plant breeder's success in executing any breeding program depends greatly in the presence and amount of genetic variation including the genetic repeatability of the traits of interest. Fifteen white maize populations available at the Institute of Plant Breeding (IPB), University of the Philippines Los Baños (UPLB) were grown and evaluated at the Central Mindanao University (CMU) and UPLB on July and December 2011 respectively, to assess the genetic repeatability and the estimates of genetic coefficient. Different maize characters such as yield, days to anthesis , days to silking, plant and ear height, stand count, number of ears, ear length, ear diameter and shelling percentage were studied. The results revealed that in terms of repeatability, yield (31%), plant height (34.88), ear height (41.84%), and shelling percentage (35.54%) obtained moderate values while the rest of the traits indicated low values. Estimates of phenotypic coefficient of variation (PCV) exhibited moderate values for yield, stand count and number of ears while low values were indicated by all of the traits for genotypic coefficient of variation (GCV). Low magnitude of GCV as well as moderate genetic repeatability for the traits being investigated suggests that these parameters were under the control of environmental effects.

Keywords: maize; populations; genetic repeatability; PCV; GCV

1. INTRODUCTION

Maize (*Zea mays* L.) is the most extensively grown crop species in the world next to wheat and rice (Sezer et. al. 2011). In the Philippines, the production of this crop has become an important source of livelihood for many small scale farmers in the country. In particular, white maize is regarded as an important substitute staple in periods whenever there is shortage of rice. This local or traditional white maize are oftentimes preferred by farmers because of their good eating quality, low material input requirements and low production cost considering that seeds can be recycled.

In order to keep pace with its production and demand, superior maize cultivars must be developed through crop breeding activities to not only enhance its production, but to ultimately increase its yield as well. Developments in breeding also provide opportunities to make a certain crop superior in withstanding challenges brought about by climate change. Breeding efforts directed towards increasing corn yield can help augment a country's production and eventually contribute to the country's economic progress. This is very timely considering the onset of the ASEAN integration this year where there is an apparent economic demand for more stable and competitive products producing impacts on trades and investment.

Knowledge about the breeding capabilities of maize such as estimates of variances and repeatability will definitely create an edge in breeding a more competitive crop that would cater to the people's needs and later on generate a more competitive product that could contribute to the economic development of our country.

The main objective of the investigation was to estimate genetic repeatability and genetic variance among the different yield associated characters in maize to enhance its breeding program.

2. MATERIALS AND METHODS

2.1 Maize varieties used

A total of 15 white maize varieties were used in the study (Table I). Some of these white kernel populations have been undergoing population improvement at the Cereals Section of Institute of Plant Breeding at the University of the Philippines, Los Baños, Laguna.

Table 1: White maize populations used in the study

NO.	POPULATION CODE	SOURCE/ORIGIN
1	Phil 2-18	CIMMYT
2	Phil 2-19	CIMMYT
3	Phil 2-21	CIMMYT
4	Phil 2-24	CIMMYT
5	Phil 2-26	CIMMYT
6	IPB Var 4	IPB
7	IPB Var 6	IPB
8	IPB Var 8	IPB
9	POP 62	CIMMYT
10	POP 63	CIMMYT
11	SWQ 6	CIMMYT
12	SWQ 10	CIMMYT
13	SWQ 11	CIMMYT
14	SWQ 14	CIMMYT
15	SWQ 16	CIMMYT

Experimental Location. The study was carried out in two locations. One location was at the Experimental Station of the Institute of Plant Breeding in Los Baños, Laguna with Type I climate having two pronounced seasons; dry from November to April and wet during the rest of the year. The maximum rain period is from June to September. The other location was located at the Central Mindanao University at Musuan, Bukidnon. The climate type in Bukidnon is Type III with no very pronounced maximum rain period, with a short dry season lasting for one to three months, either from December to February or from March to May.

Field planting and hybridization. The 15 white maize populations were crossed in all possible combinations using the principle from the Gardner and Eberhart Analysis III. One hundred five F_1 crosses were generated from paired-row crosses. Crosses were made by bulking pollen from six to eight plants to pollinate six to eight plants of the female parent.

This procedure was repeated for each cross resulting to 12 to 16 pollination per cross (if each row contains 16 plants). The selfed seeds from the parental varieties were also pooled.

To evaluate the yield and other agronomic characters, the 15 populations, 105 crosses and the check variety (P30W40) were subjected to yield trial laid out in 11x11 alpha lattice design with two replications. Row plots consisted of two 5-meter long rows and spacing of 20 cm x 75 cm between rows. Two seeds were planted per hill and standard cultural management for maize trial was followed.

2.2 Data collection

Data on yield and yield components (yield, ear length, ear diameter, number of ears, shelling percentage), morphological (plant height, ear height, stand count) and maturity related characteristics (days to anthesis, days of silking) were taken.

2.3 Data analysis

The data collected for yield and other agronomic traits of white maize were subjected to combined analysis of variance (ANOVA) in SAS 9.1 (2003). Populations were considered fixed while environment were regarded as random.

For computation of the genetic parameters, the following formula was used:

a) Genotypic (GCV) and phenotypic (PCV) coefficients of variability

$$GCV = \frac{\sigma_G^2}{\bar{X}} \qquad PCV = \frac{\sigma_p^2}{\bar{X}}$$

Where: σ_G^2 *= genotypic standard deviation,* $\bar{X}$ *= general mean of the character and* σ_p^2 *= phenotypic standard deviation*

GCV and PCV values were categorized as low (0-10), moderate (10-20) or high (> 20).

b) Genetic repeatability

Genetic repeatability (H) or broad sense heritability was calculated as proportion of the genetic variance (σ_g^2) to phenotypic variance (σ_p^2). The repeatability/heritability percentage was categorized as low, moderate and high as followed by Robinson et. al. (1949).

0 –30%	:	Low
30 –60%	:	Moderate
> 60%	:	High

3. RESULTS AND DISCUSSION

3.1 Components of variation and related parameters

The information that will be provided by the estimates of variance lay out the effectivity of a certain breeding program. The data on the components of variation of the measured parameters including yield, days to anthesis, silking, plant and ear height, stand count, number of ears, ear length and diameter, and shelling percentage are shown in Table 2.

The genetic parameters being discussed here are functions of environmental variability, thus, estimates may differ in other environments. Most economically important traits are polygenic in nature which means that these traits (e.g. yield) can be significantly influenced by the interaction of several genes with various conditions of the environment. Information about the phenotypic (PCV) and genotypic (GCV) coefficient of variation of a certain cultivar can be useful in comparing these factors among traits. According to Bello (2012), reliability of a parameter to be selected for the breeding program among other factors will be dependent on the magnitude of its genotypic coefficient of variation.

In this study, yield, as well as other maize traits, exhibited low GCV. This result implicates low variability among genotypes for maize characteristics studied. In terms of PCV, traits such as yield, stand count, and number of ears exhibited moderate values. On the other hand, flowering characteristics, plant and ear height, ear length and diameter, as well as shelling percentage were recorded to have lower scores indicating lesser scope for selection as they were much under the environmental influence. Nzuve et. al. (2014), obtained a different finding wherein their study indicated a high range of genotypic, phenotypic variances (GCV and PCV) for plant height and ear height implying that maize genotypes used had sufficient variability existing for said two traits thus, genetic improvement could be achieved through selection. In support of the present study, low GCV and PCV values were also observed for days to maturity which could be attributed to the phenotypic plasticity for these traits and also the presence of both positive and negative alleles in the maize genotypes leading to low genetic variation (Akinwale et. al. 2011). Similar results were also reported by Shakoor et. al. (2007) and Manju and Sreelathakumary (2002).

Table 2: PCV, GCV components of variance for the agronomic traits of 15 white maize populations and their crosses evaluated at IPB Experimental Station at Los Banos, Laguna and CMU, Musuan, Bukidnon.

AGRONOMIC TRAIT	MEAN	RANGE		ESTIMATES OF COMPONENT VARIANCE		GCV (%)	PCV (%)
		Minimum	Maximum	δ^2_p	δ^2_g		
Yield	2.76	0.74	4.42	0.23	0.07	9.76	17.83
Days to Anthesis	55.76	54.15	57.72	0.56	0.11	0.60	1.34
Days to Silking	58.44	56.08	61.29	0.81	0.14	0.64	1.54
Plant height	164.89	130.54	182.35	47.69	16.53	2.47	4.19
Ear height	63.20	40.19	75.60	27.28	11.41	5.35	8.26
Stand Count	28.18	12.74	38.04	12.99	1.19	3.87	12.79
Number of Ears	28.77	15.72	37.47	14.71	3.52	6.53	13.33
Ear Length	13.87	11.84	15.51	0.43	0.02	1.05	4.75
Ear Diameter	4.21	3.15	6.78	0.10	0.01	2.25	7.41
Shelling Percentage	76.03	64.96	82.32	6.68	2.38	2.03	3.40

Genetic repeatability is defined as the ratio of the analysis of the main effect of genotype divided by the main effect of environment and the genotype by environment interaction (Werth 2007). It is appropriate to use in assessing the performance of the genotypes across environments.

Repeatability is sometimes referred to as broad sense heritability if reference will be made to the formula which is the ratio of genotypic to phenotypic variance. However, the use of the word "heritability" is sometimes misleading because heritability implies that the trait is inherited from one to the next generation. However, sometimes the expression is used for one generation with no genetically constant selection units (hybrids, crosses) which are evaluated in different environments with varying repetitions per environment. In this study, genetic repeatability was adopted since the materials were not extracted from one common population and it's more appropriate to use since the interest was to assess how repeatable a trait was in two different environments.

In Table 3, it shows that the range of heritability estimates was low to moderate for the traits being studied. In particular, yield, plant and ear height, including shelling percentage recorded moderate heritability, whereas the rest of the traits indicated low values. This finding indicates that the difference seen between genotypes is moderate due to environmental effects and its interactions rather than genotypic differences. Therefore, performance of genotypes to the aforementioned traits might be moderately consistent across environments. On the other hand, different findings were gained by Tengan et. al. (2012), where the authors revealed that high broad sense heritability estimates were detected in plant and ear height indicating that dominance variation was the major component of genetic variation in the inheritance of these traits.

Table 3: Genetic repeatability/heritability of 15 white maize populations and their crosses evaluated at IPB Experimental Station at Los Banos, Laguna and CMU, Musuan, Bukidnon.

AGRONOMIC TRAIT	HERITABILITY (%)
Yield	31.53
Days to Anthesis	19.87
Days to Silking	17.27
Plant height	34.88
Ear height	41.84
Stand Count	9.15
Number of Ears	23.96
Ear Length	4.92
Ear Diameter	9.22
Shelling Percentage	35.54

4. CONCLUSION AND RECOMMENDATION

Phenotypic and genotypic variances revealed distant values, indicating the presence of environmental influence in the traits being examined. Knowledge gained in this study can be vital in enhancing the efficiency of IPB breeding programs of white maize populations. Yield, the trait exhibiting moderate PCV value also indicating moderate genetic repeatability, can still be improved through breeding efforts. The study suggests conduct of multi-location trial.

REFERENCES

Akinwale, MG, Gregorio, G, Nwilene, F, Akinyele, BO, Ogunbayo, SA & Odiyi, AC 2011, 'Heritability and correlation coefficient analysis for yield and its components in rice (*Oryza sativa* L.).'*African Journal of Plant Science,* Vol. 5 (3), pp 207-212

Bello, OB, Ige, SA, Azeez, MA, Afolabi, MS & Abdulmaliq, SY 2012, 'Heritability and genetic advance for grain yield and its component characters in maize (*Zea mays* L.).' *International Journal of Plant Research,* Vol. 2(5), pp 138-145

Manju, PR & Sreelathakumary, I 2002, 'Genetic variability, heritability and genetic advance in hot chilli *(Capsicum chinense* Jacq.).' *Journal of Tropical Agriculture* Vol*.* 40, pp. 4-6

Nzuve, F, Githiri, S, Mukunya, DM & Gethi, J 2014, 'Genetic Variability and Correlation Studies of Grain Yield and Related Agronomic Traits in Maize.' *Journal of Agricultural Science*, Vol. 6 (9), pp 166-176

Robinson, HF, Comstock, RE & Harvey, PH 1949, 'Estimates of heritability and degree of dominance in corn.' *Agronomy Journal*, Vol. 41, pp 353-359

Sezer, L, Balkaya, A, Baraagac, O & Oner, F 2011, 'Moisture dependent of some physical and morphological properties of dent corn (*Zea mays L.* var. indentatasturt) seeds.' *African Journal of Biotechnology,* Vol. 10 (15), pp. 2857-2866.

Shakoor, MS, Akbar, M & Hussain, A 2007, 'Correlation and path coefficients studies of some morphophysiological traits in maize double crosses.' *Pakistan Journal of Agricultural Science,* Vol. 44(2), pp. 213-216

Tengan, KM, Obeng-Antwi K & Akromah, R 2012, 'Genetic variances, heritability and correlation studies on selected phenotypic traits in a backcross breeding program involving normal and opaque-2 maize,' *Agriculture and Biology Journal of North America*, Vol. 3 (7), pp. 287-291.

Werth, LC 2007, 'Characterization and Classification of Native American maize landraces from the Southwestern United States.' *MS Thesis*, Iowa State University, Ames, Iowa