

## Locational Testing of Superior Hybrid Grain Maize Varieties for Commercial Production

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### Introduction

Maize growing has not attracted local growers because of its high cost of production and unavailability of high yielding varieties. As an effort to increase productivity, through previous maize breeding projects conducted at UPM since 1987, many potential hybrid and composite maize populations have been identified. Location trials play an important role in plant breeding and agronomic research, where knowledge on genotype x environment (G x E) interaction and stability of the genotypes could be determined. Potential genotypes are usually evaluated across locations and years before releasing for commercial production. This research project was conducted to evaluate performance and adaptability of selected superior locally-developed maize hybrids at various locations in Malaysia, and to study the potential of these new maize hybrids for local commercial production.

### Materials and Methods

Fourteen selected hybrids and composites of grain maize were evaluated for adaptability and stability at four locations in Peninsular Malaysia, in two planting seasons each, in 1999 to 2002. The locations represented various range of soil types and geographical regions, namely Rhu Tapai in Terengganu, Sungai Udang in Melaka, Padang Rengas in Perak, and Serdang in Selangor. The project was conducted in collaboration with the States' Department of Agriculture and also farmers. The genotypes used in this study were single cross, three way cross and double cross hybrids, as well as synthetic populations previously developed from the maize breeding programme at Universiti Putra Malaysia (UPM). The experiment at each location was arranged in a randomized complete block design (RCBD) with four replications following recommended cultural practices at each location. Plants from each plot were harvested from the middle three rows of 3 m long. Grain yields were adjusted to 15% moisture content. Various stability parameters were used to determine stability of the genotypes evaluated. Genetics of the genotypes evaluated were also investigated, in particular, the estimation of broad-sense heritability ( $h^2_B$ ) for traits in the hybrid populations at each location using the components of variance in the ANOVA table procedure, as proposed by Becker (1984).

### Results and Discussion

Significant year and location effects were found, indicating that there were fluctuations in the environmental conditions throughout the experiments. Genotype and genotype x location interaction effects were highly significant, indicating the variability of genotypes evaluated. Statistically significant *F* values were found for environment (linear) and G x E (linear) interaction for the yield measurements, indicating that the response to the environments was predictable. The significant effects of G x E interaction indicate that all the genotypes tested were not consistent in their relative ranking, which confirms the importance of location trials in a variety development process. Results of various methods of stability analyses (regression of individual means on the environmental index, the regression coefficient, *b*, the deviation from the regression,  $s^2_d$ , ecovalance,  $W_i$ , stability variance statistics,  $\theta^2_i$ , coefficient of determination,  $r^2$ , environmental variance,  $s^2$ , and the grouping technique of mean against coefficient of variation, CV) were in close agreement with each other in revealing the stability of the genotypes evaluated. Genotype UPM-GS 2000 (5.73 tons/ha) was identified as the genotype with highest grain yield and most stable in performance, followed by the DC-1, while SC-2 was the lowest yielding and unstable genotype. Broad-sense heritability estimates for grain yield, ear diameter and number of kernel rows per ear were generally, moderate. This indicates that, in the population of hybrids evaluated, the contribution of genetic factors on the expression of the phenotypes was moderate. Shelling percentage, 100-grain weight, days to flowering, plant height, ear height, ear weight per plant, grain weight per plant and number of kernels per row showed low heritability. Using the same method of estimation, i.e. variance components in ANOVA table, Saleh et al. (1994, 2001) reported similar moderate estimates of heritability for grain yield, while other components showed low heritability estimates. The breeding programme undertaken and the stability trials conducted

at the four locations over the years have produced and revealed UPM-GS 2000 as the high yielding and highly stable synthetic population, suitable for production in large scale plantings.

### Conclusions

The different maize genotypes were found to have greatly varied in performance among each other. In general, they also varied greatly at the different locations and years, indicating the significant genotype by environment interaction on the performance of the genotypes. The various methods of stability determination have found quite similar trends on stability of the genotypes. Genotype UPM-GS 2000 and DC-1 were found to be most stable across environments, indicating their good potential for further testing towards release of a new variety. In contrast, SC-2 was the least stable. Broad-sense heritability estimates for grain yield ear diameter and number of kernel rows per ear were generally, moderate, while the estimates for the remaining traits were low.

### Benefits from the study

The project has revealed stable maize genotypes that could be recommended for growing in a wider range of locations in Peninsula Malaysia. The project has also identified genotypes that are superior only at specific location/locations, and therefore should be used only for plantings at those locations. The potential beneficiaries would be maize growers who would use seeds of these genotypes for plantings at various locations in the country. The best genotype UPM-GS 2000, when released would be an intellectual property of UPM and the researcher involved. From the project activities, one PhD, one M.S. and six Bachelor degree students were trained. Five journal publications and four seminar papers were produced from this project. These publications become good references to researchers in the same and related areas. A presentation from this project entitled 'UPM-GS 2000: Superior and highly stable grain maize synthetic' has been awarded the Gold Medal in the Innovations and Research Exhibition, UPM, 2003, on 8-10 July 2003.

### Patent(s), if applicable:

Nii

### Stage of Commercialization, if applicable:

Early stage of trial plantings in Sabah

### Project Publications in Refereed Journals

1. Saleh, G.B., Daud, A. and Anuar, A.R. 2002. Performance, heterosis and heritability in selected tropical maize single, double and three-way cross hybrids. *J. Agri. Sci. Cambridge* 138:21-28.
2. Saleh, G.B., Daud, A. and Anuar, A.R. 2002. Effects of location on performance of selected tropical maize hybrids developed in Malaysia. *Pertanika J. Trop. Agricultural Sci.* 25(2):75-86.
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4. Min, T. D. and Saleh, G.B. 2003. Phenotypic stability of selected tropical maize genotypes at four locations. *Asian J. Plant Sciences* 2(10):743-747.
5. Min, T.D., Saleh, G.B., Halim, R.A., Anuar, A.R. and Panjaitan, K. 2003. Genotype by environment interaction and stability of maize genotypes for grain yield, maturity and harvest index. *Malays. Applied Biology* (accepted for publication).

### Project Publications in Conference Proceedings

1. Saleh, G.B., Min, T.D., Halim, R.A. and Anuar, A.R. 2001. Multi-locational trials on locally-developed maize hybrids and synthetics. In: Zulkifli, I. et al. (eds.). Proceedings of the 2001 Research Workshop, Faculty of Agriculture, UPM, 16-18 Oct., 2001, UNITEN, Bangi. p.53-55
2. Saleh, G.B., Panjaitan, K., Anuar, A.R. and Mihdzar, A.K. 2001. Heterosis, combining ability and heritability studies on grain maize hybrids. In: Zulkifli, I. et al. (eds.). Proceedings of the 2001 Research Workshop, Faculty of Agriculture,

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4. Saleh, G, Min, T.D. and Panjaitan, K. 2002. Genotype x environment interaction studies on maize hybrids and synthetics in Malaysia. *Proc. Fourth Regional Conference of IMT-GT Uninet 2002*, Penang, Malaysia, 14-17 Oct. 2002

**Graduate Research**

Name of Graduate	Research Topic	Field of Expertise	Degree Awarded	Graduation Year
Than Da Min	Yield stability analysis among grain maize genotypes	Plant Breeding and Genetics	PhD	2003
Khayamuddin Panjaitan	Combining ability, genotype performance, heterosis and heritability in grain maize hybrids	Plant Breeding and Genetics	M.Agric Sc.	2003

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