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GENETIC VARIATION OF TROPICAL CORN INBRED LINES FOR SILAGE PRODUCTION

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GENETIC VARIATION OF TROPICAL CORN INBRED LINES FOR

SILAGE PRODUCTION

By

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CERTIFICATION

This project report entitled Genetic Variation of Tropical Corn Inbred Lines for Silage Production is prepared by Syazreena Binti Ibrahim and submitted to the Faculty of Agriculture in fulfilment of the requirement of PRT4999 (Final Year Project) for the award of the degree of Bachelor of Horticultural Science.

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ABSTRACT

A study was conducted to evaluate the genetic variation of eight tropical corn (*Zea mays* L.) inbred lines and one control variety (Hybrid 530). The study was conducted at Field 10, Faculty of Agriculture, Universiti Putra Malaysia and arranged in randomized complete block design (RCBD) with three replications. The objectives of this study were to evaluate the agronomic performance of selected inbred lines for silage purposes, estimate the heritability and correlation among traits measured and assigning the inbred lines into heterotic groups. Sixteen data on yield and agronomic traits were recorded. Analysis of variance indicated significant effects for inbred lines or genotype for all traits measured except for crude protein content in leaves and in stems, while blocks effects were not significant for all traits measured except for crude protein content in leaves. Means comparison of the traits showed that inbred lines CML152 and CML160 showed highest mean value in most of the traits measured except for days to tasseling, days to silking, and number of leaves per plant. The heritability estimates were ranged from low to high value (27.5% to 93.7%). Fresh leaf yield was found to be the most heritable trait (93.7%) followed by dry leaf yield (93.5%), dry stem yield (90.8%), fresh ear yield (90.8%), dry plant yield (88.4%), fresh plant yield (87.7%), dry ear yield (86.6%), plant height (85.6%), number of leaves per plant (82.8%), ear height (76.0%), fresh stem yield (75.5%), crude protein content in ears (73.5%), days to tasseling (63.8%) and days to silking (57.4%), while crude protein content in leaves showed the lowest heritability estimate among the traits measured (27.5%). In the correlation study, fresh plant yield was found to be highly significantly correlated with most of the traits (at $p \leq 0.01$) except for crude protein content in leaves, plant height, number of leaves per plant and days to tasseling. Four heterotic groups were formed using SAHN cluster

analysis by UPGMA method based on their performance *per se*. In conclusion, the inbred lines evaluated revealed wide genetic variations for yield and agronomic traits. These variations can be further exploited toward the production of corn hybrid for silage utilization.

ABSTRAK

Satu kajian telah dijalankan untuk menilai variasi genetik bagi lapan titisan inbred jagung tropika (*Zea mays* L.) dan satu varieti kawalan (Hybrid 530). Kajian telah dijalankan di Ladang 10, Fakulti Pertanian, Universiti Putra Malaysia dan disusun dalam Rekabentuk Blok Rawak Lengkap (RCBD) dengan tiga replikasi. Objektif kajian ini adalah untuk menilai prestasi dari aspek agronomi titisan inbred yang dipilih untuk tujuan penghasilan silaj, menganggarkan kebolehwarisan dan korelasi pada ciri-ciri yang diukur dan menentukan kumpulan heterotik antara titisan inbred tersebut. Enam belas data mengenai hasil serta ciri-ciri agronomi direkodkan. Analisis varians menunjukkan kesan yang signifikan untuk titisan inbred atau genotip bagi semua ciri yang diukur kecuali kandungan protein kasar di dalam daun dan di dalam batang, manakala kesan replikasi tidak signifikan untuk semua ciri yang diukur kecuali kandungan protein kasar di dalam daun. Perbandingan nilai minima menunjukkan titisan inbred CML152 dan CML160 mempunyai nilai tertinggi pada sebahagian besar ciri-ciri yang diukur kecuali pada bilangan hari pentaselan, hari perambutan serta bilangan daun per pokok. Anggaran kebolehwarisan adalah daripada nilai rendah kepada nilai tinggi (27.5% hingga 93.7%). Hasil daun segar menunjukkan kebolehwarisan yang paling tinggi (93.7%) diikuti oleh hasil daun kering (93.5%), hasil batang kering (90.8%), hasil tongkol kering (90.8%), hasil pokok kering (88.4%), hasil pokok segar (87.7%), hasil tongkol kering (86.6%), tinggi pokok (85.6%), bilangan daun per pokok (82.8%), tinggi tongkol (76.0%), hasil batang segar (75.5%), kandungan protein kasar di dalam tongkol (73.5%), hari pentaselan (63.8%) serta hari perambutan (57.4%), manakala kandungan protein kasar di dalam daun menunjukkan kebolehwarisan yang paling rendah (27.5%). Di dalam kajian korelasi, hasil tanaman segar didapati sangat signifikan berkolerasi dengan sebahagian besar ciri-ciri yang diukur kecuali kandungan protein kasar dalam

daun, tinggi pokok, bilangan daun sepokok dan hari untuk pentaselan (pada p≤0.01). Empat kumpulan heterotik dibentuk menggunakan analisis kluster SAHN dengan kaedah UPGMA berdasarkan prestasi setiap satu. Kesimpulannya, titisan inbred yang dinilai menunjukkan variasi genetik yang tinggi bagi hasil dan ciri-ciri agronomi. Variasi ini boleh terus dibangunkan ke arah penghasilan jagung hibrid untuk menghasilkan silaj.

CHAPTER 1

INTRODUCTION

Corn (*Zea mays* L.) is widely grown throughout the world and used either for human consumption or for livestock feed. According to Food and Agriculture Organization (FAO) (2014), the three main world corn producers in 2013 are the USA, China and Brazil. Corn used for livestock feed is in the form of grains or processes into silage. The grains are rich in dietary fiber and calories which is a good source of energy to animal. According to Argillier *et al.* (2000), there is a current trend in the European countries and the USA in which, they are using the whole corn plant including the cob to make silage. The corn plants were planted purposely to be harvested and processed into silage to be fed to ruminants or dairy cows.

Corn as silage provides a large volume of digestible and palatable feed and contains higher amount of starch and protein content compared to legumes and grass silage such as from Napier Grass and Guinea Grass. According to Craig (2010), corn for silage production need to be harvested few weeks before physiological maturity because the starch and cell wall fractions have the most significant carbohydrate sources.

In Malaysia, sweet corn is widely planted and mainly used for human consumption. In the other hand, field corn for animal feed was only planted traditionally in smaller part in Sabah. Currently, there is no corn planted particularly for silage purpose, however, some farmers used the sweet corn stover after harvesting the cob to be processed into silage. The shortage of feedstuff for ruminants has forced the country to import big amount of corn from other countries

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and result in increasing operational expenses for ruminant feed. Therefore, there is a need to improve corn varieties with favorable forage traits for silage purposes.

Plant breeding can be achieved through many different techniques ranging from simple selecting plants with desirable traits for propagation to more complex molecular techniques (Craig, 2010). Currently, there are no superior local hybrids of corn for silage production and no specific corn varieties developed specifically for corn silage. The first step in hybrid production is the development of superior inbred lines and evaluation on the inbred line performance needs to be conducted to select the promising ones for further hybrid production. Therefore, this study was conducted as an effort to observe the tropical corn inbred lines performance which possesses good forage traits to be used for corn hybrid varieties production for silage.

The objectives of this study were:

i.   To evaluate agronomic performance of selected inbred lines for silage purposes.

ii. To estimate heritability of traits among those inbred lines.

iii. To determine correlations among traits measured on the inbred lines

iv. To identify heterotic groups among the inbred lines based on their performance *per se*.

REFERENCES

Akinwale, R.O., Badu-Apraku, B., Fakorede, M.A.B., and Vroh-Bi, I. (2014). Heterotic grouping of tropical early-maturing maize inbred lines based on combining ability in *Strigra*-infested and *Strigra*-free environments and the use of the SSR markers for genotyping. *Field Crops Research,* 156(2014), 48-62.

Ali, E.S., Saleh, G.B., Wahab, Z.B. and Rahim, A.A. (2003). Performance, heritability, and correlation studies on varieties and population cross of sweet corn. *Asian Journal.* Plant Sci., 2:756-760

Argilier, O., Barriere, Y. and Hebert, Y. (2000). Inbred line evaluation and breeding for digestibility-related traits in forage maize. *Crop Sci.*, 40:1569-1600.

Barrière, Y., Alber, D., Dolstra, O., Lapierre, C., Motto, M. *et al.* (2005). Past and prospects of forage maize breeding in Europe: The grass cell wall as a basis of genetic variation and future improvements in feeding value. *Maydica.* 50: 259-274.

Bates, G. (2000) Corn silage. University of Tennessee Agricultural Extension Service.

Bertoia, L.M. and Aulicino, M.B. (2014). Maize forage aptitude: Combining ability of inbred lines and stability of hybrids. *The Crop Journal.*

Choukan, R., Hossainzadeh, A., Ghannadha, M.R., Warburton, M.L., Talei, A.R. *et al.* (2005). Use of SSR data to determine relationships and potential heterotic groupings within medium to late maturing Iranian maize inbred lines. *Field Crop Research.* 95: 212-222.

Colless, J.M. (1992). Maize growing. Report No. P3.3.3 − Agdex 111, 2nd Edition. NSW Agriculture Grafton.

Craig, D. L. (2010). Current and future genetics in corn silage. Proceedings of 2010 California Alfafa & Forage Symposium and Corn/Cereal Silage Mini-Symposium, Visalia, CA, 1-2 December 2010.

Darrah, L.L., McCullen, M.D. and Zuber, M.S. (2003). Breeding, genetics and seed corn production. Chapter 2. In: White, P.J., Johnson, L.A. (eds). Corn: chemistry and technology. 2nd Edition. American Association of Cereal Chemists, Inc. St. Paul, Minnesota, USA. pp 35-68.

Downes, S.M. Heritability. The Stanford Encyclopedia of Philosophy. Spring 2014 Edition. http://plato.stanford.edu/archives/spr2014/entries/heredity/ (accessed on 18 August 2014).

Duncan, W.G. (1975). Maize. Chapter 2. In: Evans, L.T., ed. Crop Physiology: Some Case Histories. Cambridge University Press. pp 23-50.

Dwyer, L. M., Stewart, D. W., Ma, B. L., and Glenn, F. (1998). Silage maize yield response to plant populations. In: Proceedings of the 53rd Annual Corn and Sorghum Industry Research Conference, Chicago, IL. Am Seed Trade Assoc., Washington, DC.

Eastridge, M.L. (1999). Brown midrib corn silage. In: Proceeding of Tri-State Dairy Nutrition Conference. The Ohio State University, Columbus. pp 179-190

Esau, K. (1997b). The stem: primary state of growth. Chapter 16. In: Anatomy of seed plants, Edition 2. Wiley, J. & Sons, Inc. New York. pp 257-374.

Farrell, T. and O'Keeffe, K. (2007) Maize. NSW Department of Primary Industries. http://www.dpi.nsw.gov.au/pubs/summer-crop-production-guide (accessed 23 September 2014).

Hallauer, A.R., Miranda, J.B., (1988). Quantitative genetics in maize breeding. Iowa State University, Ames, Iowa, USA.

Hanson C.H., Robinson, H.G., and Comstock, R.E. (1956). Biometrical studies of yield in segregating populations of Korean Lespediza. *Agronomy Jaournal.* 48: 268-272.

Hassanat, F., Gervais, R., Julien, C., Massé, D.I., Lettat, A., Chouinard, P.Y., . . . Benchaar, C. (2013). Replacing alfalfa silage with corn silage in dairy cow diets: Effects on enteric methane production, ruminal fermentation, digestion, N balance, and milk production. *Journal of Dairy Science, 96(7).* pp 4553-4567.

Kashiani, P., Saleh, G., Abdullah, N. A. P., & Abdullah, S. N. (2010). Variation and genetic studies on selected sweet corn inbred lines. *Asian Journal of Crop Science, 2*(2), 78-84.

Lee, E.A. and Tracy, W.F. (2009). Modern maize breeding. In: Bennetzen, J.L, Hake, S. (eds). Maize Handbook – Volume II: Genetics and Genomics.

Lee, E.A. and Tollenaar, M. (2007). Physiological basis of successful breeding strategies for maize grain yield. *Crop Science* 47(S3): S202-S215.

Paliwal, R.L. (2000f). Tropical maize morphology. In: Paliwal, R.L., Granados, G., Lafitte, H.R., Vlollc, A.D., eds. Tropical Maize: Improvement and Production, Volume 28. Food and Agriculture Organization of the United Nations Rome. pp 13-20.

Pulam, R. (2011). The effect of shoot maturation on total biomass production in maize.

Saleh, G.B., Alawi, S.A.S., and Panjaitan, K. (2002). Performance, Correlation and Heritability Studies on Selected Sweet Corn Synthetic Populations. *Pakistan Journal of Biological Science, 5*(3), 251-254.

Shaver, D. (1983). Genetics and breeding of maize with extra leaves above the ear. In: Proceedings of the 38th Annual Corn and Sorghum Industry Research Conference. Chicago, IL. American Seed Trade Association, Washington, DC. pp 161-180.

Staller, J.E. (2010). An introduction to maize cobs and cultures. Maize Cobs and Cultures: History of Zea Mays L.

Sultan, M. S., Abdel-Monaem, M. A., & Haffez, S. H. (2014). Phenotypic and genotypic correlations, heritability and expected gains from selection for some traits of maize under two plant densities conditions. *Asian Journal of Crop Science, 6*(1), 49-57.

Tolenaar, M., McCullough, D.E. and Dwyer, L.M. (1994). Physiological basis of the genetic improvement of corn. In: Slafer, G.A., Dekker, M. (Eds). Genetic Improvement of Field Crops. USA. pp 83-236.

Tryfos, P. (1997). Clustering methods. Cluster Analysis. Printed on: 14 March 2001.

Vera, G.A. and Crane, P.L. (1970). Effects of lower ear height in synthetic populations of maize. *Crop Sci*. 10: 286-288.

Vollbrecht, E. and Schmidt, R.J. (2009). Development of the inflorescences. In: Bennetzen, J.L. and Hake, S.C., eds. Handbook of Maize: Its Biology. pp 13-40.

Wallace, D.H., Baudoin, J.P., Beaver, J., Coyne, D.P. and Halseth D.E. *et al.* (1993). Improving efficiency of breeding for higher crop yield. Theor. Applied Genetic, 86: 27-40.

Williams II, M.M. (2014). Few crop traits accurately predict variables important to productivity of processing sweet corn. *Field Crop Research 157(2014).* pp 20-26.