

Progress of five cycles of modified mass selection for ear length in waxy corn

การประเมินการตอบสนองของการคัดเลือกแบบหมู่ประยุกต์ 5 รอบของ ลักษณะความยาวฝักในข้าวโพดข้าวเหนียว

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บทคัดย่อ: การปรับปรุงความยาวฝักโดยการคัดเลือกแบบหมู่ประยุกต์เป็นแนวทางหนึ่งที่ช่วยเพิ่มผลผลิตของข้าวโพดข้าวเหนียวได้ วัตถุประสงค์ของการศึกษาในครั้งนี้ เพื่อประเมินการตอบสนองของการคัดเลือกแบบหมู่ประยุกต์ 5 รอบ ในลักษณะความยาวฝัก และการเปลี่ยนแปลงของลักษณะผลผลิตฝักก่อนปอกเปลือก ผลผลิตฝักหลังปอกเปลือก และองค์ประกอบผลผลิต ของประชากรข้าวโพดข้าวเหนียว KKU-VWX ที่ผ่านการคัดเลือกหมู่ประยุกต์ในลักษณะความยาวฝัก ทำการทดลอง ณ หนองพิชัย คณะเกษตรศาสตร์ มหาวิทยาลัยขอนแก่น ในฤดูฝน ปี 2554 ใช้แผนการทดลองแบบสุ่มสมบูรณ์ภายในซ้ำมี 4 ซ้ำ ผลการทดลองปรากฏว่า ความยาวฝักเพิ่มขึ้น โดยในรอบที่ 5 (C_5) มีความยาวฝัก 19.3 ซม. จากความยาวของจากประชากรเริ่มต้น (C_0) ที่ 18.0 ซม. และความยาวฝักเพิ่มขึ้นต่อรอบการคัดเลือก เท่ากับ 0.29 ซม. สัมประสิทธิ์สหสัมพันธ์ระหว่างความยาวฝักและผลผลิตก่อนปอกเปลือก ($r=0.66^{**}$) และผลผลิตหลังปอกเปลือก ($r=0.52^{**}$) เป็นบวกและมีนัยสำคัญทางสถิติ ซึ่งให้เห็นว่าการเพิ่มความยาวฝักสามารถเพิ่มผลผลิตในข้าวโพดข้าวเหนียวได้ สรุปได้ว่าการคัดเลือกแบบหมู่ประยุกต์มีประสิทธิภาพในการปรับปรุงลักษณะความยาวฝัก และประชากรที่ผ่านการคัดเลือกในรอบที่ 5 นี้ สามารถเผยแพร่เป็นพันธุ์ผสมเปิดต่อไปได้

คำสำคัญ: *Zea mays* L. var. *ceratina*, สหสัมพันธ์ องค์ประกอบผลผลิต การปรับปรุงประชากรและปรับปรุงพันธุ์

Abstract: Modified Mass Selection improvement for ear length is a way to increase fresh ear yield of waxy corn. The objectives of this study were to evaluate direct response of KKU-VWX waxy corn population to five cycles of modified mass selection for ear length and correlated responses of this population for husked ear yield, unhusked ear yield and yield components. The experiment was conducted at the Research Farm, Faculty of Agriculture, Khon Kaen University in the rainy season 2011. A randomized complete block design with four replications was used. After five cycles of selection, ear length increased from 18.0 to 19.3 cm and selection gain was 0.29 cm per cycle. Correlation coefficients between ear length and husked ear weight ($r=0.52^{**}$) and between ear length and unhusked ear weight ($r=0.66^{**}$) were positive and significant, indicating that selection for longer ears could improve ear yield in this population. Modified-mass selection for ear length is, therefore, an effective means to improve ear yield in this population, and the M_5 population can be released as an open-pollinated variety.

Keywords: *Zea mays* L. var. *ceratina*, correlation, yield components, population improvement and breeding

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Introduction

Waxy corn (*Zea mays* L. var. *ceratina*) has been grown as a cash crop, and it is consumed as special food or staple food by people in East Asia and South East Asia, including China, Myanmar, Laos, Vietnam, Cambodia, Korea, and Thailand (Kesornkeaw et al., 2009; Simla et al., 2009). At present, waxy corn hybrid varieties have replaced open-pollinated varieties (OPV) in these countries. However, OPV can offer some advantages for corn grower under variable growing conditions in developing countries.

Selection for yield *per se* is difficult because of the complex inheritance of multiple genes that control yield. Selection for traits with simple inheritance that are closely related to yield should improve yield. Modified mass selection for prolificacy has been used effectively for yield improvement in waxy corn (Kesornkeaw et al., 2009). Studies have shown that yield could be improved by selection for ear length in field maize and super sweet corn (Jadhav et al., 1995; Fountain and Hallauer, 1996; Ali and Saleh, 2003). Positive association between yield and yield components indicates the correlated responses of yield to selection for ear length, and, therefore, improvement of yield by selecting longer ears is possible. However, Salazar and Hallauer, (1986) reported that ear length selection was not effective for improving yield in maize.

Therefore, the correlated response of yield to selection for ear length is still not conclusive, and the response to selection may be population-dependent because of germplasm difference. Yield increase as a result of selection for ear length in waxy corn populations is still in question. The objective of this study was to evaluate selection response of five cycles

of modified mass selection for ear length in KCU-VWX waxy corn population and correlated responses in yields and yield components.

Materials and Methods

Population Development: Modified mass selection utilizing the original KCU-VWX waxy corn, Cycle 0 (C_0), population was begun in 2008. All five cycles were conducted by growing plants in the breeding nursery at the Research Farm, Faculty of Agriculture, Khon Kaen University. The selected plants were intermated by bulked pollens collected from long ears plants with good standability, freedom from disease, etc. The plants were harvested and seed from long ears with good filled tip were bulked to produce the next cycle population. The fifth cycle, Cycle 5 (C_5) was completed in 2010 (**Figure 1**).

Field Experiment: Six populations consisting of C_0 - C_5 were evaluated in the rainy season 2011 at the Research Farm, Faculty of Agriculture, Khon Kaen University. A randomized complete block design with four replications was used in this study. Each plot included four rows 5 m long with spacing of 0.75 meter between rows and 0.25 meter between plants within rows, resulting in a plant population density of 5 plants m^{-2} (50,000 plants ha^{-1}).

Data collection: Data were collected for husked ear weight (kg/Rai) (1 ha=6.25 Rai), unhusked ear weight (kg/Rai), ear diameter (cm), ear length (cm), days to tasseling, ear height (cm) and plant height (cm) at 18 days after silking by harvesting two center rows of each plot.

Data analysis: Analysis of variance according to a randomized complete block design was performed for husked ear weight, unhusked ear weight, ear diameter,

ear length, days to tasseling, ear height and plant height to evaluate the effects of six cycles of modified mass selection for ear length on these traits (Gomez and Gomez, 1984). Regression analysis was used to assess the correlated responses to selection of these traits.

Results and Discussion

The populations (C_0 , C_1 , C_2 , C_3 , C_4 and C_5) were significantly different ($P < 0.05$ or $P < 0.01$) for husked ear weight, unhusked ear weight ear length, ear diameter and days to tasseling except for ear height and plant height (**Table 1**).

Differences in ear length among populations ranged from 18.0 to 19.6 cm in the initial population (C_0) and cycle four population (C_4), respectively (**Figure 2**). Correlation coefficient between cycles of selection and ear length was positive and significant ($r^2 = 0.84^{**}$), showing the positive response to selection for ear length, and gain per cycle was calculated as 0.29 cm.

Ear length was significantly and positively correlated with un-husked ear weight ($r = 0.66^{**}$) and husked ear weight ($r = 0.52^{**}$) (**Figure 3**), indicating that husked ear yield and unhusked ear yield are dependent on ear length for some extent. The correlation coefficient ($r = 0.46^*$) between ear length and ear diameter was also positive and significant, implying larger ears can also improve yield.

The findings were in agreement with previous studies in maize (Jadhav et al., 1995; Fountain and Hallauer, 1996) and super sweet corn (Ali and Saleh, 2003), but the results were not in line with the study of Hallauer (1986), who found that selection for ear length to improve yield was not effective in maize. The contrasting results of different studies should be mainly

due to the differences in genetic background of corn populations. In this study, husked ear yield and unhusked ear yield of waxy corn can be improve through modified mass selection for ear length and the selection is much easier than selection for yield per se as the trait is less complex than husked ear yield and unhusked ear yield.

Conclusions

Five cycles of modified mass selection for ear length was completed in KKU-VWX waxy corn population, and the selection gain was estimated as 0.29 cm per cycle. Positively-correlated responses to selection were also observed for husked ear yield and unshuked ear yield. The changes are favorable as selection for ear length can ultimately increase yield. This information is useful for corn breeders, who want to improve ear yield by using ear length as a surrogate trait.

Acknowledgments

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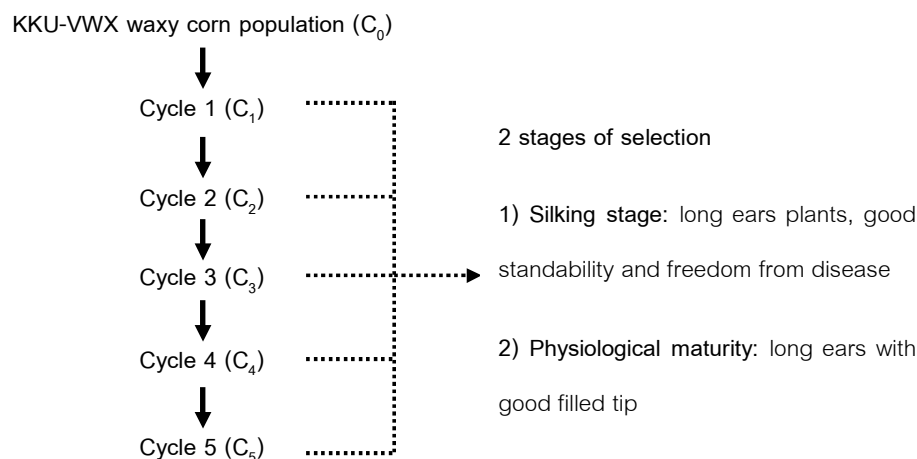


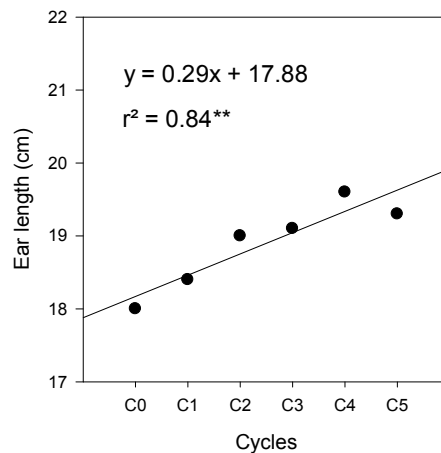
Figure 1. Schematic diagram for population development of KKU-VWX waxy corn population through modified mass selection for long ear length for five cycles in 2008 to 2010

Table 1. Mean squares for husked ear weight, unhusked ear weight ear length, ear diameter, days to tasseling, ear height and plant height of six cycles of modified mass selection in waxy corn in the rainy season 2011

| Cycles | Ear length (cm) | unhusked ear weight (kg/rai) | Husked ear weight (kg/rai) | Ear diameter (cm) | Day to tasseling | Ear height (cm) | Plant height (cm) |
|-----------------------|--------------------|---------------------------------|-------------------------------|----------------------|---------------------|--------------------|----------------------|
| C ₀ | 18.0c | 2,215c | 1,240c | 4.3b | 44.5ab | 79.1 | 164.8 |
| C ₁ | 18.4bc | 2,312bc | 1,432b | 4.6a | 43.5b | 76.4 | 167.2 |
| C ₂ | 19.0abc | 2,415ab | 1,561ab | 4.7a | 44.7ab | 79.4 | 164.9 |
| C ₃ | 19.1ab | 2,362bc | 1,536ab | 4.6a | 46a | 79.1 | 165.8 |
| C ₄ | 19.6a | 2,601a | 1,668a | 4.7a | 45.5a | 76.1 | 165.3 |
| C ₅ | 19.3ab | 2,315bc | 1,548ab | 4.6a | 45.2a | 84.9 | 172.8 |
| F-test | * | ** | ** | ** | * | ns | ns |
| b-value ^{1/} | 0.29* | 37.54ns | 63.51* | 0.04ns | 0.31 ns | 0.79 ns | 1.0 ns |
| C.V. (%) | 3.9 | 5.5 | 7.3 | 2.4 | 2.4 | 12.8 | 7.6 |

ns = non-significant *, ** significant at 0.05 and 0.01 probability levels, respectively

^{1/} b-values are significantly difference from zero

**Figure 2.** Response to five cycles of modified-mass selection forear length in KKV-VWX waxy corn population in the rainy season 2011.

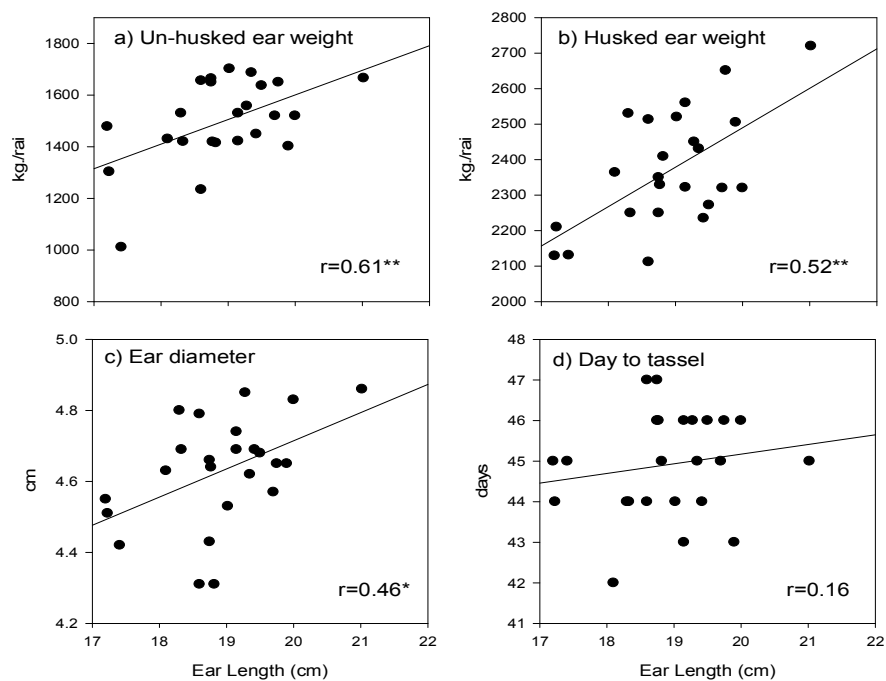


Figure 3. Correlations between ear length with unhusked ear yield, husked ear yield, ear diameter and days to tassel in six cycles of modified mass selection of KKU-VWX population; a) Un-husked ear weight; b) Husked ear weight; c) Ear diameter and d) Days to tassel.