Kasetsart J. (Nat. Sci.) 37 : 1 - 4 (2003)

Screening Methods for High Yield Corn Inbreds in Honeycomb Design and Performances of Their Hybrid Combinations

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ABSTRACT

Plant selection method is changing accordingly with emerging new concepts of selections. One of the most widely discussed concept is plant selection under nil competition environment in honeycomb designs to avoid plant to plant competition, minimize soil heterogeneity, promote highest expression of genetic potential, enhance differentiation among lines and facilitate line selection. This study designed to compare moving circle selection and prediction criterion, PC = $\overline{X}\ (\overline{X}s - \overline{X}) / S_p^2$ with conventional visual grid selection (selection 1 plant out of each 19 plants in the same row) in honeycomb design. Grouped replicated R-49 honeycomb design and 40 replicated plants was used to screen 49 S_7 inbreds under nil competition environment. As a results, moving circle selection identified highest number of diverse and good combine lines followed by PC and visual grid selection when tested in conventional plant spacing, 0.75 ¥ 0.25 m. Top-7 hybrids were derived from top–5 inbreds of moving circle selection while only 3 and 1 hybrids in the top-7 were derived from top-5 inbreds of PC and visual selection, respectively. The results suggested that moving circle selection was the most effective method of selection under this experimental conditions. However, considering time and cost efficiency, visual grid selection is more practical for the identification of potential inbreds.

Key words: honeycomb, prediction criterion, moving circle

INTRODUCTION

Genetic and environmental interaction (GxE) is one of the most decisive factors for the success or failure of plant selection. There are two kinds of environment, the one that can be controlled and the one that can not be controlled. Eventhough, plant densities are controllable environment but there are different views for the optimum plant densities for the effective line screening. It is a commonsense that plant screening should be done under the conditions that plants will be grown. However, conditions in farmers' fields are varied widely and the optimum conditions are impossible to ascertain. To solve the problem, multilocation yield trials are needed but it is very costly and practically will carry out only for the most promising lines on the final screening. In addition, yield per unit area can be improved by increasing plant densities or increasing yield per plant with the same densities. Troyer and Rosenbrook (1983) and Russell (1991) suggested that selection should be done under higher plant densities as means to improve grain yield of maize. Selection under high plant densities also increase heritabilities and gains for many traits (Eagles and Lothrop, 1994). Indirectly, selection under higher plant densities should verify progenies that can tolerate more limited moisture supplies, effectively use available nutrients, effective in partitioning of available

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Received date : 20/01/03 Accepted date : 26/03/03

photosynthates and survive greater pressures for susceptibility to diseases and pests (Hallauer, 1990). On different poin of views, Fasoula and Fasoula (2000) suggested a selection under nil competion environment in honeycomb designs by moving circle selection for effective control of soil heterogeneity and full expression of genotypes. Moreover, potential yield per plant ($\overline{X}$), tolerance to stress (predicted by standardized entry mean, $\overline{X}/S_p$) and response to input (predicted by the standardized selection differential, $(\overline{X}s - \overline{X}) / S_p$), were proposed for analysis of yield components or prediction criterion (PC) = $\overline{X}\ (\overline{X}s - \overline{X}) / S_p^2$. This study was conducted to evaluate the effectiveness of each selection method; moving circle, PC and visual selections in honeycomb design in order to identify useful inbreds and hybrid combinations.

MATERIALS AND METHODS

Forty-nine S_7 inbreds from different sources of germplasm; Pioneer3012, Pioneer3013, Pacific328, Pacific700, CPDK888, CPDK999, G5445A, SW3853, Cargill919, Pop28 (HS), Ki32 and Ki42 were planted in grouped replicated R-49 honeycomb design with 40 replications. Plant spacing was equilateral triangle of side 0.86 m., three seeds per hill and thined to 1 plant per hill at 14th day after planting. Three selection methods; visual grid selection (1 out of 19 plants in the same row), moving circle selection (1 out of 19 plants in the circle) and prediction criterion, PC = $\overline{X}\ (\overline{X}s - \overline{X}) / S_p^2$ as proposed by Fasoula and Fasoula (1997b) were applied in the same experimental plot. Selections were based on prediction criterion values and selection frequencies of each inbred by the other two selection methods. Top-5 inbred lines from each selection method were selected.

The remnant seeds of selected inbreds were separately planted in non-replicated honeycomb design, 0.86 m. spacing among plants and 3 plants from each line were selected and bulked, separately. They were crossed in diallel series and the derived hybrids and 4 checks were planted in randomized complete block design with conventional spacing (0.75 ¥ 0.25 m.), 4 row plot of 5 meter rows and 2 replications. Yields and desired agronomic traits were recorded.

RESULTS AND DISCUSSION

Nil competition environment of each crop is depended upon plant types and root systems of each crop. For maize, Onenanyoli and Fasoulas (1989) used plant to plant space of 1.25 m. to avoid competition among plants. As a matter of convenience, the present study used plant to plant space of 0.86 m. which fitted to the conventional 0.75 m. row spacing being used at Suwam Farm. Under the present study plant to plant space of 0.86 m. seemed to be adequate for corn inbreds because wide gap among plants and full expression of plants were observed.

Five selected inbreds out of 49 inbreds by each selection method were presented in Table 1. From total of 15 selected inbreds (3 selection methods), only 8 inbreds were different. The remaining 7 inbreds; 3 selected inbreds (Agron13, Argon26 and Agron27) from PC and 2 selected inbreds (Agron26, Nei9201) from visual selection were overlapped with selected inbreds from moving circle method. The other 2 selected inbreds (Agron4, Agron6) from visual selection were overlapped with selected inbreds from PC method. Considering the 5 selected inbreds of each selection method and their original sources presented in Table 1, selected inbreds from PC method comprised of 3 inbreds originated from Pioneer3013 (Agron4, 6 and 26) 1 inbred from G5445A (Agron27) and 1 inbred from SW3853 (Agron13). The visual selection method rendered 3 inbreds from Pioneer3013 (Agron4, 6 and 26) 1 inbred each from Cargill 919 (Agron21) and Pop28 (Nei9201). The moving circle method rendered a more diverse inbreds; 2 inbreds from SW3853 (Agron12 and 13) and 1 inbred each from Pioneer3013 (Agron26), G5445A (Agron27) and

Table 1 Selected top-5 of 49 S_7 inbreds by each of 3 selection methods planted in grouped replicated R-49 honeycomb design with equilateral triangular side of 0.86 m. and 40 replications.

Prediction criterion[1]		Moving circle selection		Visual grid selection	
Entry[2]	PC value	Entry[2]	Frequency	Entry[2]	Frequency
Agron27	3.11	Agron26	17	Agron6	11
Agron4	2.74	Agron12	14	Agron26	10
Agron13	2.64	Agron27	14	Agron4	6
Agron6	2.53	Nei9201	14	Agron21	6
Agron26	2.52	Agron13	11	Nei9201	6

1 $PC = \overline{X}(\overline{X}s - \overline{X}) / S_p^2$

2 Original sources of inbreds in Table 1:

Pioneer3013	=	Agron4, Agron6 and Agron26
G5445A	=	Agron27
SW3853	=	Agron12 and Agron13
Cargill 919	=	Agron21
Pop28(HS)	=	Nei9201

pop28 (Nei9201). Table 2 showed yields and other agronomic traits of top-10 hybrids out of 28 hybrids from diallel cross of 8 selected inbred lines from the 3 selection methods. The high effeciency of moving circle selection was obviously displayed. Top –7 hybrids were derived from selected inbreds of moving circle selection and there were only 3 and 1 hybrids in top-7 hybrids which had inbreds in common with inbreds from PC and visual selections, respectively. The Agron6 x Agron12 hybrid ranked 8th comprised of inbreds from visual and moving circle selection. The Agron6 x Nei9201 and Agron4 x Agron27 hybrids ranked 9 th and 10 th derived from crossing of inbreds from visual selection and PC, respectively. The top5 hybrids were comparable to checks (hybrids derived from early generation testing for combining ability program previously conducted) but statistically, better than the commercial hybrid, Pioneer3013. Therefore, selection for inbred per se under nil competition environment or for their combining abilities were equally effective for the identification of inbreds of which could render hybrids with similar yield levels, eventhough, they were different inbreds. However, high yield inbreds had advantages on seed production and maintaining of inbred lines. Using selection frequency of moving circle selection and visual grid selection to identify stable lines in replicated honeycomb designs should be an effective selection method for high yield and stable inbreds without any complicate calculation as compared to PC method. However, if more selected inbreds (10 inbreds) from each selection method were saved, all 3 methods were equally effective to identify potential inbred lines. Considering time and cost efficiency, visual grid selection with selection frequency of each line should be the most effective method for the identification of potential inbreds. For population improvement, selection for inbred per se under nil competition environment in honeycomb designs followed by hybrid yield trials under high densities should be a good combination to get high yield inbreds and hybrids which can be grown under wide ranges of plant densities (Tokatlidis *et a*l., 2001).

Table 2 Means of agronomic traits and grain yields of top-10 hybrids (S7x S7) from diallel cross of 8 selected inbreds from 3 selection methods planted at Suwan Farm in conventional row spacing 0.75 ¥ 0.25 m.

Hybrid	Grain yield at 15% moisture (kg/ha)	Days to tasseling -50%	Days to silking -50%	Ear height (cm)	Plant height (cm)	Shelling (%)	100 grain weight (g)
Agron12 X Agron27	6275a	52i	50j	133gh	195fg	85f-j	23d-f
Agron26 X Nei9201	6018a-c	51j	50k	155fg	211c	86c-f	25a
Agron13 X Agron26	5837b-d	52f	50j	117d-f	202d	86cd	24cd
Agron27 X Nei9201	5743b-e	50i	50k	118de	202d	84k-m	24bc
Agron26X Agron27	5712b-e	52i	51h	109jk	199de	83k-m	25ab
Agron12 X Agron26	5481d-g	53f	53f	117ef	194hi	88ab	22gh
Agron13X Agron27	5462e-g	51k	50j	111ij	186kl	83mm	21ik
Agron6X Agron12	5343f-h	53f	52g	119cd	197e-g	85f-j	23ef
Agron6X Nei9201	5331f-h	52i	52g	106lm	197e-g	82mm	23c-e
Agron4 X Agron27	5168g-i	53g	54d	109jk	173n	85c-g	18pq
Checks:							
Agron14 X Agron29*	6043ab	50i-m	51i	102op	188jk	84g-k	23f
Agron20 X Agron29*	5712b-e	52e-i	51i	92u	185kl	86c	20k-m
Agron30 X Agron32*	5656c-f	52e-i	48l	101p	174n	84h-l	17q-s
Pioneer 3013	5343f-h	48m	54d	97qr	179m	83k-n	20jk
Mean	4574	52	52	103	184	84	20
CV (%)	17	1.36	1.35	4.67	3.57	3.05	7.64

* Top hybrids of selected inbreds (S_7) from early generation testing (topcross) program previously conducted.

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