SELECTION INDICES FOR RESISTANCE AGAINST CORN BORER (*OSTRINIA FURNACALIS*, GUENEE) IN MAIZE

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R I N G K A S A N

Pengamatan besarnya kerusakan pada daun, kerusakan keseluruhan tanaman dan panjang alur dalam batang, jumlah lobang pada batang yang diakibatkan oleh serangan penggerek batang jagung (*Ostrinia furnacalis*, Guenee) serta pengamatan data produksi, dilakukan terhadap 560 "full-sib families" dan/atau 140 "half-sib families" tanaman jagung varietas CBWR Composite # 2. Rancangan genetik I dari Comstock dan Robinson (1948) digunakan dalam penelitian ini untuk menduga besarnya varian-varian genetik dan selanjutnya dipakai untuk menghitung indek seleksi.

Semua macam kombinasi dari kelima sifat yang diamati tersebut dihitung indeks seleksinya. Hasil perhitungan indeks seleksi yang terdiri dari sifat produksi dan kombinasinya dengan sifat-sifat yang lain menunjukkan bahwa perbaikan sifat tahan terhadap penggerek batang tidak selalu sebanding dengan perbaikan produksinya. Perbaikan sifat tahan menunjukkan variasi baik untuk macam maupun jumlah kombinasi sifat-sifatnya. Indeks seleksi yang terdiri dari kelima sifat di atas memberikan harapan perbaikan sifat tahan yang terbesar.

I N T R O D U C T I O N

Breeding objectives primarily concerned with improvement of characters that are directly or indirectly related to yield. Choosing the most efficient selection procedures to be used has always been difficult especially when multiple selection criteria are involved.

Corn borer is one of the widely distributed and serious corn pest in most of corn growing areas in the world. Resistance against this pest is manifested by several indices of damage such as leaf feeding injury, overall plant damage, length of tunnel in the stalk and number of holes on the stalk or else. In breeding works, higher levels of resistance may often be obtained by combining components of resistance from several sources or by combining genetic factors for each of the components.

The purposes of this paper are to illustrate the construction of selection indices and to estimate the expected genetic advance resulted from the index in improving resistant variety.

The computation based on the data obtained from the author's experiment for his masteral thesis.

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MATERIALS AND METHODS

The base population used in this study is known as CBWR Composite # 2 and was derived from crossing together several varieties and advanced generation varietal hybrids which were previously screened for resistance and tolerance to corn borer, weevil and downy mildew.

To estimate of genetic parameters, a genetic Design I of Comstock and Robinson (1948) was used. The production of progenies as experimental materials representing 560 full-sib and/or 140 half-sib families was carried out in the early 1977. The progenies were evaluated at USM (The University of Southern Mindanao) Experiment Station during the 1977 wet season. A nested randomized complete block design was employed in the evaluation. The progenies were divided into 20 sets with two replications for each set. A set contained 28 full-sib families which represented 7 half-sib families. The full-sib families were randomized within each set. Three seeds per hill were planted in 5 meter rows with 50 centimeters space between hills and 75 centimeters between rows. One entry was planted in one row. In order to get a uniform stand, thinning to two plants per hill was done during the seedling stage. To evaluate their corn borer resistance, all plants were not protected against the corn borer attacked. The evaluation was based on natural field infestation which had been considered having enough eggmasses.

Data of first concern taken which thoroughly described by Mangoendidjojo (1978) were yield, leaf feeding injury, overall plant damage, length of tunnels and number of holes. Considering the five characters studied as individual criterion for evaluating resistance to corn borer, the problem would be how to utilize such data to evaluate and improve the overall resistance of a variety or population.

Index selection as developed by Smith (1936) provides a very efficient method of utilizing data from different characters in improving the overall characters of a population (Hazel, 1943; Aday, 1973).

The index selection which become the basis for selection of the different families is of the form,

$$I = b_1X_1 + b_2X_2 + \dots\dots\dots\dots + b_nX_n$$

or concisely,

$$I = b'X$$

where, X is a vector of observations equaled to the corresponding trait value of the individual or family on which the selection is based, and b is the vector of weights determined by solving the equation,

$$\begin{aligned}
b_1P_{11} + b_2P_{12} + \dots\dots + b_nP_{1n} &= a_1G_{11} + a_2G_{12} + \dots\dots + a_nG_{1n} \\
b_1P_{12} + b_2P_{22} + \dots\dots + b_nP_{2n} &= a_1G_{12} + a_2G_{22} + \dots\dots + a_nG_{2n} \\
\cdot \quad \cdot \quad\quad \cdot \quad &= \quad \cdot \quad \cdot \quad\quad \cdot \\
\cdot \quad \cdot \quad\quad \cdot \quad &= \quad \cdot \quad \cdot \quad\quad \cdot \\
\cdot \quad \cdot \quad\quad \cdot \quad &= \quad \cdot \quad \cdot \quad\quad \cdot \\
b_1P_{1n} + b_2P_{2n} + \dots\dots + b_nP_{nn} &= a_1G_{1n} + a_2G_{2n} + \dots\dots + a_nG_{nn}
\end{aligned}$$

or in the form of matrix,

$$b = P^{-1}Ga$$

where, P is the phenotypic variance-covariance matrix, G is the genotypic variance-covariance matrix and a is the vector of relative economic weights.

In the computation, mean grain was arbitrarily assigned an economic weight (a) of 1.0, while leaf feeding injury, overall plant damage, length of tunnels and number of holes were each assigned an economic weight of −1.0. That is all characters are considered equally important but since among the entomological characters the lower values are desired levels the negative sign is affixed.

Expected genetic advance resulted from index selection were estimated using full-sib family selection at 10 percent selection intensity. The expected total genetic response to index selection is,

$$\Delta_T = k \sqrt{\sum_i b_i G_i} \quad , \text{ for } i = 1, 2, \ldots\ldots\ldots, n.$$

where, $$G_i = \sum_j a_j G_{ij} \quad , \text{ for } j = 1, 2, \ldots\ldots\ldots, n.$$

The expected response for the i^{th} trait is,

$$\Delta_i = \frac{k \sum_j b_j G_{ij}}{\sqrt{\sum_i b_i G_i}}$$

The expected total genetic response is also equal to the weighted sum of the response for each of the separate traits (Brim et al., 1959) as follows,

$$\Delta_T = \sum_i a_i \Delta_i$$

RESULTS AND DISCUSSION

Table 1. presents the expected genetic advance resulted from index selection for the different combinations of characters.

Among the different combination of two characters, the index consisting of yield and length of tunnel gave the highest total genetic response of 0.277. An expected gain or expected response of 0.234 percent in yield and 8.288 percent shorter tunnels aid also obtained with this combination.

The expected total genetic response of 0.322 would be obtained when three characters combination of overall plant damage, length of tunnel and number of holes were incorporated in constructing the index.

Index selection consisting of four entomological characters gave the highest expected total genetic response of 0.331 among the others four combination of characters.

The highest expected total genetic response was obtained when all five characters were considered in the index. This combination would result in 0.441 percent gain in yield, 1.862 percent decrease in leaf feeding injury, 0.291 percent decrease in overall plant damage and 9.333 percent decrease in tunnel length eventhough number of holes would increase by 1.817 percent.

Based on the expected total genetic response obtained, the index consisting of yield and its combination with other character(s) indicated that improvement of resistance was not always proportionally followed by the improvement of yield. The improvement of resistance also varied depend on the characters involved in the construction of the index. This variation arose might be due to different in magnitude from genotypic and phenotypic correlation among the characters.

CONCLUSION

Improvement the degree of resistance varied depend on the characters involved and was not always proportionally followed by the improvement of yield.

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Table 1. Expected genetic advance resulted from Index Selection for resistance to corn borer.

Combination of characters		Expected gain (Percent of the respective population mean)					Expected total genetic response Δ_T
		Grain yield	Leaf feeding	Overall plant damage	Length of tunnel	Number of holes	
I.	Two characters combination						
1.	A + B	0.469	−6.374	-	-	-	0.17614
2.	A + C	0.116	-	−1.047	-	-	0.02035
3.	A + D	0.234	-	-	−8.288	-	0.27739
4.	A + E	0.107	-	-	-	−4.746	0.06811
5.	B + C	-	−6.416	−0.311	-	-	0.16058
6.	B + D	-	−2.241	-	−6.794	-	0.27329
7.	B + E	-	−5.902	-	-	−0.916	0.15581
8.	C + D	-	-	−0.293	−8.384	-	0.27423
9.	C + E	-	-	−0.580	-	−4.663	0.07060
10.	D + E	-	-	-	−5.893	−4.880	0.25488
II.	Three characters combination						
11.	A + B + C	0.465	−6.415	−0.329	-	-	0.18230
12.	A + B + D	0.408	−2.474	-	−6.846	-	0.29902
13.	A + B + E	0.520	−6.407	-	-	−0.701	0.18857
14.	A + C + D	0.282	-	−0.213	−8.523	-	0.29019
15.	A + C + E	0.134	-	−0.617	-	−4.614	0.07649
16.	A + D + E	0.178	-	-	−6.214	−4.442	0.26736
17.	B + C + D	-	−2.167	−0.357	−7.193	-	0.28950
18.	B + C + E	-	−5.606	−0.448	-	−1.124	0.15787
19.	B + D + E	-	−1.589	-	−9.256	1.834	0.31224
20.	C + D + E	-	-	−0.218	−10.679	1.913	0.32153
III.	Four characters combination						
21.	A + B + C + D	0.277	−0.104	−0.315	−8.228	-	0.28440
22.	A + B + C + E	0.494	−5.848	−0.478	-	−0.966	0.18424
23.	A + B + D + E	0.430	−2.325	-	−8.414	3.708	0.32171
24.	A + C + D + E	0.324	-	−0.238	−10.361	1.564	0.33043
25.	B + C + D + E	-	−1.529	−0.264	−9.881	2.149	0.33051
IV.	Five characters combination						
26.	A+B+C+D+E	0.441	−1.862	−0.291	−9.333	1.817	0.34531

Apendix Table 1. Estimates of the component of variance and covariance resulting from male differences containing ¼ σ^2_A for five characters (Components of variance in parentheses)

	Grain yield	Leaf feeding	Overall plant damage	Length of tunnel	Number of holes
Grain yield	(0.00103)	–0.00116	–0.00020	–0.00575	–0.00034
Leaf feeding		(0.00857)	0.00017	–0.00302	–0.00075
Overall plant damage			(0.00060)	0.00041	0.00031
Length of tunnel				(0.14883)	0.00866
Number of holes					(0.00472)

Appendix Table 2. Estimates of phenotypic variance and covariance among full-sib families for five characters (Estimates of phenotypic variance in parentheses).

	Grain yield	Leaf feeding	Overall plant damage	Length of tunnel	Number of holes
Grain yield	(1.26465)	–0.01519	–0.02063	–0.00053	0.00304
Leaf feeding		(0.03702)	0.00080	–0.00305	–0.00293
Overall plant damage			(0.01920)	–0.03695	0.00137
Length of tunnel				(3.87017)	0.43734
Number of holes					(0.06875)

Appendix Tabel 3. Equation of selection indices (I) against its corresponding combination of characters.

I. Two characters combination

1. I = 0.00284A – 0.51405B
2. I = 0.00060A – 0.08269C
3. I = 0.01069A – 0.07988D
4. I = 0.00252A – 0.14731E
5. I = –0.47087B – 0.06058C
6. I = –0.30569B – 0.07105D
7. I = –0.43308B – 0.13395E
8. I = –0.25838C – 0.07959D
9. I = –0.08447C – 0.14465D
10. I = –0.02176D – 0.05276E

II. Three characters combination

11. I = −0.00400A − 0.53469B − 0.08306C
12. I = 0.00259A − 0.56632B − 0.15009E
13. I = 0.00813A − 0.36575B − 0.07861D
14. I = 0.08275A − 0.15677C − 0.08275D
15. I = 0.00118A − 0.10344C − 0.15416E
16. I = 0.01003A − 0.02928D − 0.48743E
17. I = −0.30983B − 0.26069C − 0.07830D
18. I = −0.41626B − 0.08401C − 0.14163E
19. I = −0.23322B − 0.13291D + 0.46810E
20. I = −0.47445C − 0.15311D + 0.59275E

III. Four characters combination

21. I = 0.00386A − 0.03624B − 0.28090C − 0.08151D
22. I = −0.00309A − 0.50516B − 0.12082C − 0.15377E
23. I = 0.00862A − 0.35486B − 0.12082D + 0.33433E
24. I = 0.00233A − 0.48271C − 0.14974D + 0.54251E
25. I = −0.22317B − 0.48166C − 0.15214D + 0.59947E

IV. Five characters combination

26. I = 0.00058A − 0.28947B − 0.48874C − 0.14875D + 0.54535E