

EXPERIMENTAL RESULTS WITH LINEAR SELECTION INDICES IN TRIBOLIUM

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SUMMARY

Proportion of realized versus expected response was evaluated in several experiments with *Tribolium*, which were designed to compare selection index methods. It is suggested that discrepancies between observed and expected selection response are mainly due to the action of genetic drift interfering on the selection effects, and do not seem to be produced by environmental effects. Discrepancy is greater when restricted and/or antagonistic indices are used. Sampling errors of parameter estimates, especially that of the genetic correlation, seem to affect the response of these indices more than that of conventional indices.

INTRODUCTION

When comparing alternative methods of selection, environmental trends are assumed to be eliminated by taking differences between the experimental lines (Muir, 1986). However, actual response might not equal predicted response, without maintaining a control population in order to separate environmental and genetical trends. In this situation, expected selection response will not correspond to realized phenotypic change if environmental effects on parental and progeny generations are not the same. There are also several factors able to cause disagreement between realized and predicted response (Falconer, 1981). These include changes from sampling or genetic drift, inbreeding depression, natural selection, errors of the parameter estimates and changes in the genetic properties of the population. The objective of this paper is to illustrate the agreement between predicted and realized selection response using experimental data obtained in our department with *Tribolium*, comparing several selection indices.

MATERIALS AND METHODS

The genetic material used was the Consejo or Andujar populations of *Tribolium castaneum*. The two traits selected were given equal weights in the aggregate genotype. Selection indices are given in Table 1. Restricted indices were used in experiments 5 and 6. Genetic correlation always was positive. The number of selected individuals ranged from 26 to 50, and the proportion of selection was 10% or 20%. Mean response obtained per generation was calculated as the regression coefficient of observed means on generation number.

RESULTS AND DISCUSSION

Expected and observed responses per generation are shown in Table 1 for the aggregate genotype (unrestricted indices) or each individual trait (restricted indices). In experiment 1, the expected response was greater than observed. The use of overestimated adult weight heritability (0.72) and underestimated genetic correlation (0.34) in the calculation of index coefficients did not explain the small relation between observed and predicted response (31%); expectations of response (Harris, 1964) using the generation 0 estimates (0.45 and 0.69, respectively) were similar to that showed in Table 1 (9.05 and 9.13). The magnitude of the estimates did not significantly change during the six generations of selection, suggesting that re-estimates of parameters are not necessary in short-term experiments. In an experiment with nine generations of selection for the same traits, Orozco et al. (1980) did not detect significant changes in the parameters. Realized heritability (0.17) differed appreciably from the estimated index heritability (0.75; Lin and Allaire, 1977; Nordskog, 1978), reflecting that the actual response is dependent upon realized heritability rather than upon estimated heritability. Neither natural selection nor nonnormal distribution for the index seem to explain the reduced observed response, since the standardized selection differentials (weighted or nonweighted) were similar to that based on the normality assumption (1.26, 1.27 and 1.39, respectively). Genetic drift might have interfered on the selection effects; effective population size (26.68) was small enough to produce effects from random changes. The relation between actual and effective population size was 1.8, not very different to the value estimated by the formula of Robertson (1961). The effect of reduced population size can be eliminated with highly replicated single generation experiments (Bohren, 1975); experiment 2 had ten replicates of a single generation selection, and gave response which could be considered as accurate estimate of theoretical response (observed versus expected ratio was 98.3%).

The relation between realized and predicted response was very high (98%) in experiment 3, which considered three generations of selection; realized heritability (0.24) was very close to the index heritability (0.26). Changes from genetic drift are accumulative, and disagreement between observed and expected response will be smaller in this experiment than in experiment 1 (with six generations). On the other hand, egg laying heritability is similar to those for pupal or adult weights, and differences caused by environment do not seem to explain the discrepancy between experiments 1 and 3. In both indices of experiment 4 (which included egg laying) there was a very close agreement between expected and observed response during the three (four) generations considered. Experiment 3 showed that a greatly incorrect genetic correlation estimate (0.95 or 0.25) had no significant effect on the response.

Indices from experiment 5 were antagonistic to the genetic correlation; proportions of realized versus predicted responses were high in the optimum index 5a, while expected changes for pupal: adult weights (3:1) in the desired gains index 5b did not agree with observed changes (6:1). The underestimation

(0.95 or 0.25) of the genetic correlation seems to effect the optimum index less than desired gains index. In the latter index there were partial restrictions in both traits and they were greater than the pupal weight partial restriction specified in the former index, suggesting that discrepancies between expected and observed response could be greater in restricted indices.

This fact is further verified by the results from experiment 6, in which two completely restricted indices were used, considering seven (five) replicates and a single generation of selection. Disagreements between expected and observed results are generally greater for the individual traits than for the aggregate value, especially if there is antagonism with the genetic correlation; in a restricted index the response for individual traits are of main interest. The number of replicates in experiment 6 b, in which there was less antagonism between index aims and genetic correlation, was small, and effects of random genetic drift were not minimized. The proportion of realized versus predicted response was very small during the five generations considered in the unrestricted antagonistic index from experiment 7. The error of the genetic correlation estimate (0.59 or 0.95) explained this discrepancy, especially in the line 7a in which selection was practiced for increasing index value; expected response using the formula of Harris (1964) was 3.83.

Table 1. Selection index, expected and observed response (in brackets) in each experiment.

Experiment	Traits	Selection index (sexes pooled)	Selection response			
			Agregate	x ₁	x ₂	x ₃
1	x ₂ ; x ₃	$2.3x_2 + \bar{x}_3$	8.9 (2.8)	-	-	-
2	x ₂ ; x ₃	$2.3x_2 + \bar{x}_3$	8.9 (8.8)	-	-	-
3	x ₁ ; x ₂	$30x_1 + x_2$	25.3(24.9)	-	-	-
4a	x ₁ ; x ₃	$x_1 + 1.5\bar{x}_3$	7.4 (6.5)	-	-	-
4b	x ₂ ; x ₃	$2x_2 + \bar{x}_3$	7.6 (7.4)	-	-	-
5a	x ₁ ; x ₂	$-x_1 + 5.9x_2$	-	13(11)	9 (8)	-
5b	x ₁ ; x ₂	$x_1 - 1.3x_2$	-	6.6(6)	2.2(1)	-
6a	x ₁ ; x ₂	$-x_1 + 2.5x_2$	-	0(5.5)	14.5(6)	-
6b	x ₂ ; x ₃	$-x_2 + 6.7x_3$	-	-	0 (5)	9.5(4)
7a	x ₁ ; x ₂	$x_1 - x_2$	16.5 (3.3)	-	-	-
7b	x ₁ ; x ₂	$-x_1 + x_2$	-16.5(-2.0)	-	-	-

x₁: pupal weight; x₂: adult weight; x₃: egg laying

The results of comparisons between the selection indices here considered and several alternative methods of selection have been described in detail by Campo and Rodríguez (1985, 1986), Campo and Velasco (1989 a,b), Campo and de la Fuente (1990 a, b), Campo and Villanueva (1987), and Campo and Raya (1986).

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