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Spike changes associated to six cycles of recurrent selection in bread wheat (*Triticum aestivum* L.)

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SUMMARY

Eighty four S-derived families (12 per cycle) and 12 wheat *(Triticum aestivum L.)* commercial varieties were evaluated to assess the effects of 6 cycles of recurrent selection (RS) on 11 spike characters. A random spike sample per family was divided into thirds for determination of seed number and weight per spikelet. Also spikelet and seed number per spike, seed weight and spike index were estimated. Significant differences between cycles of RS mean values were observed in 4 of the analyzed characters. The weight increased 11% at the 3rd cycle. With respect to the spikelet number per spike a 7.8% increase was noticed after 6 cycles of RS. The higher spikelet number per spike of the sixth cycle of RS did not generate more seeds per spike. As the fertile flower number per spikelet was observed to be invariable, the diminution of spikelet fertility could be related to the suboptimal environmental conditions of cultivation during the critical period of grain number determination.

Keywords: bread wheat, spike characters, recurrent selection

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RESUMEN

Se evaluaron 84 familias (12 por ciclo) y 12 variedades comerciales de trigo (*Triticum aestivum L.*) a fin de medir el efecto de 6 ciclos de selección recurrente (SR) sobre 11 caracteres de la espiga. Para la determinación del número y el peso de semillas por espiguilla, se dividieron en tercios 5-10 espigas por cada familia. Se estimaron: número de espiguillas y semillas por espiga, peso individual de las semillas e índice de espiga. Se observaron diferencias significativas entre las medias de los ciclos en 4 de las variables analizadas. El peso de la semilla

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aumentó un 11% hasta el tercer ciclo. Tras 6 ciclos de SR el número de espiguillas por espiga aumentó un 7,8%, no así el número de semillas por espiga. Ante la no variación del número de flores fértiles por espiguilla, esta disminución en la fertilidad podría deberse a que el período crítico en cuanto a la determinación del número de semillas transcurre bajo condiciones sub-óptimas de cultivo.

Palabras clave: trigo pan, caracteres de la espiga, selección recurrente

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Recurrent selection (RS), a cyclical scheme of selection, promotes the gradual increase of allele frequencies responsible for agronomically superior phenotypic expressions of quantitative and qualitative inherited characters. On the basis of the available information (Wiersma *et al*., 2001) there exist several short-term researchs (not longer than 4 cycles) in which the balance is largely positive. On the other hand, it is important to find out why there are few long time RS studies in autogamous species, particularly when the selection criteria is grain yield. From our results it is possible to affirm that up to the third cycle of RS, a significant grain yield improvement was attained (Maich *et al*., 2003); however, from the third cycle onward the genetic progress for the grain yield was inconsistent, but not for some of the grain yield components, which showed significant increases (Maich *et al*., 2002). This circumstance highlights the role of the environmental conditions on the primary and secondary character expression. In general, the former have lower heritability estimates. In this context, the perspective of advance toward higher grain yield potentials through a multi-character selection appears suitable. This study was designed to assess the effects of six cycles of recurrent selection on eleven bread wheat spike traits.

The original population was obtained by intercrossing sixteen Argentinean commercial cultivars of bread wheat (*Triticum aestivum L*.). Twelve S_1 – derived families from each one of the analyzed six cycles of recurrent selection were evaluated during two consecutive years (2001 and 2002), simultaneously twelve commercial varieties were evaluated. A completely randomized design in each of the two years was employed using the families of the same cycle as replications. The families used in the comparative study were sown in an experimental field in Ferreyra (Córdoba Argentina) at 31 29' S and 64 00' W. One row plots, 5m long, 0.2m between rows and 250 grains m^{-2} were utilized. From each experimental unit eleven variables were measured, determined as the mean value of five (2001) or ten (2002) randomly selected fertile culms. Each spike was split into lower, middle and upper third corresponding to the spikelets 4 – 5, spikelets 10 – 11 and the subterminal ones, respectively. The attributes measured were: seed number per spikelet and seed weight per spikelet. Also spikelet and seed number per spike, seed weight and spike index were estimated. An analysis of variance was performed considering the cycles of selection and the years as the principal sources of variation. Duncan's Multiple Range test was employed to test significance among mean values.

Significant differences were observed between mean values in four of the eleven analyzed characters. With respect to the spikelet number per spike, excepting the C_1 derived families mean value, the remaining mean values differed significantly with regard to that of the C_0 (Table 1). The C_5 derived families mean value was higher than the other mean values, but not if compared to the control check one. Taking into account the seed number per spikelet, no significant differences were observed between cycles in the middle and upper thirds; however, in the lower third a progressive diminution after C_3 was noticed (Table 2). The number of spikelets per spike is one of the grain yield physical components on which the potential number of seeds per spike is

based. Not-withstanding the higher spikelet number per spike in the fifth and sixth cycle of RS, a counterbalance effect by means of the seed number per spikelet was observed. The lower spikelet fertility was not due to a lower number of fertile florets per spikelet, but to a diminished setting rate (unpublished data). Consequently, the higher grain yield potential evidenced through the increased spikelet number per spike, did not generate a higher seed number per spike. This invariableness can be attributed to a regional less than favorable early spring, both regarding rainfall and temperature.

When seed weight is considered, a statistically significant increase was observed at the third cycle of RS, in turn, not significantly different from the C_6 mean value (Table 1). With respect to the seed weight per spikelet, the most relevant differences were observed in the middle third between the C_3 and C_6 derived families mean values and that of the control check one (Table 2). The increase of the seed weight at the more evolved cycle of RS was not compensated by a diminution in the seed number per spikelet or spike. Our results did not correspond to those obtained by Wiersma *et al*. (2001), where seed weight and seed number were inversely related. However, in the future, it might be convenient to use a selection index constituted by physical and physiological grain yield components as selection criteria in order to prevent undesirable effects, even if it involves a decrease in the rate of genetic improvement for grain yield.

Table 1: Mean values of five variables in six cycles of recurrent selection in *Triticum aestivum* L.

Cycle	Spikelets/ spike (nº)	Seeds/spike (nº)	Seeds/spikelet (nº)	Seed weight (g)	Spike Index (%)
C_0	19.33 a	28.64 a	1.48 a	0.033 ab	65 a
C_1	19.83 ab	28.58 a	1.44 a	0.034 abc	63 a
C_2	20.50 bc	28.95 a	1.41 a	0.034 abc	63 a
C_3	20.55 bc	33.32 a	1.62 a	0.037 c	64 a
C_4	20.56 bc	31.08 a	1.51 a	0.033 ab	62 a
C_5	21.94 d	29.98 a	1.36 a	0.032 ab	61 a
C_6	20.84 bc	28.17 a	1.35 a	0.035 bc	64 a
Checks	20.93 cd	28.18 a	1.35 a	0.031 a	63 a

Means of columns with the same letter not significantly different (P ≤0.05) by Duncan's Multiple Range Test.

Table 2: Mean values of two variables analized by thirds in six cycles of recurrent selection in *Triticum aestivum* L

Cycle	Seeds / spikelet (nº)			seed weight / spikelet (g)		
	Lower Third	Middle Third	Upper Third	Lower Third	Middle Third	Upper Third
C_0	1.04 abc	2.19 a	1.38 a	0.032 a	0.035 abc	0.030 a
C_1	1.15 bc	2.05 a	1.41 a	0.032 a	0.036 abc	0.028 a
C_2	0.87 ab	2.05 a	1.37 a	0.031 a	0.036 abc	0.030 a
C_3	1.39 c	2.30 a	1.53 a	0.035 a	0.039 c	0.032 a
C_4	0.86 ab	2.21 a	1.54 a	0.031 a	0.034 ab	0.029 a
C_5	0.97 ab	1.96 a	1.34 a	0.030 a	0.034 ab	0.027 a
C_6	0.91 ab	1.94 a	1.23 a	0.032 a	0.037 bc	0.031 a
Checks	0.65 a	2.08 a	1.30 a	0.029 a	0.033 a	0.027 a

Means of columns with the same letter not significantly different (P ≤0.05) by Duncan's Multiple Range Test.

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