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HONEYCOMB MASS SELECTION EFFICIENCY FOR SUNFLOWER YIELD UNDER DIFFERENT SPACING CONDITIONS

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SUMMARY

An open pollinated variety of oilseed sunflower (*Helianthus annuus L.*) was selected under conditions of absence of competition and under competitive conditions also. Selection was based on seed yields of individual plants established in a honeycomb design. Seeds of the selected plants, separately for each case, were bulked and sown next year in comparison to the check. Under conditions of absence of competition a seed yield increase of 26,0% compared to the check was obtained. Under competitive conditions seed yield increased only by 8,2%. It is concluded that honeycomb selection at wide spacings was more effective in improving seed yield.

INTRODUCTION

In plant breeding, efficiency is mainly estimated by the genetic gain obtained in each generation of selection. Falconer (1981) formed the fundamental equation $R=\sigma_p \cdot h^2 \cdot i$, in which, in qualitative sense, response to direct selection depends on the phenotypic standard deviation (σ_p), heritability (h^2) and selection pressure (i). Phenotypic standard deviation and heritability are qualities of selected population, whereas selection pressure depends on breeder's decision. In selection experiments for yield, where genotypic expression is affected a great deal by growth conditions and a low portion of phenotypic variance is heritable, the proportion of the population selected to be parents is up to 10-20%. Usually no progress was ever made in improving yield, probably because the environmental variation was so large relative to the genotypic variation that yield heritability was near zero (Frey, 1983). Selected phenotypes will inherit their superiority when environment affects their expression a little. According to Fasoulas (1988) genotypes are evaluated from their phenotypic values and conditions that ensure maximum phenotypic expression and differentiation will also maximize genotypic expression and differentiation. The phenotypic variance (σ_p^2) could be subdivided in genetic variance (σ_g^2), environmental variance (σ_e^2) and genotype-environment interaction σ_{ge}^2. The ratio $h^2=\sigma_g^2/\sigma_g^2 + \sigma_e^2 + \sigma_{ge}^2$ (Simmonds, 1981), that approximates heritability, depends merely on the relation between σ_g^2, σ_e^2 and σ_{ge}^2. At widely spaced plants all these factors increase but the question is if participation of genotypic variance σ_g^2 in the total phenotypic variance σ_p^2 increases also.

The aim of this research was to evaluate the response to honeycomb selection for seed yield of widely-spaced and dense-spaced plants of an open pollinated variety of sunflower.

MATERIALS AND METHODS

An open pollinated variety of sunflower, Cavissos, (abbreviated Co), was chosen to be the selection material. Investigation was carried out in three experiments at the Cotton and Industrial Plants Institute Farm in two growing seasons.

In the first growing season two selection experiments were established side by side. In order to represent competitive conditions 1050 positions spaced at 45 cm were sown with Co. Other 1050 positions, spaced 125 cm in order to represent conditions of absence of competition, were also sown with Co. The honeycomb field design NR-O as described by Fasoulas (1988) was used in the above mentioned experiments. Seed yield of all individual plants was recorded in a selection form with the same arrangement as the actual layout of plants. A coloured and transparent sheet of plastic was cut into the shape of a hexagonal grid. The size of the grid was determined by the magnitude of selection pressure. Selection pressure was 0,7% and the hexagonal grid covered the yield of 127 plants. A hole in the center of the grid marked the position of the middle plant. A plant was selected only when it outyielded the other 126 plants within the grid (Fasoulas, 1988). Seven plants (half-sib families) were selected in each experiment with this method. Equal amounts of seeds of the selected plants from each experiment were bulked into balanced composites, (C_1SynO,I and C_1SynO,II).

The next growing season these mixtures were compared with the source population of Co in a randomized complete block design with four replications. Response to selection was expressed as percentage of the check. The objective of this experiment was to find out how different spacing conditions affect honeycomb selection efficiency for seed yield after one cycle in an oilseed sunflower variety.

RESULTS AND DISCUSSION

Figure 1 shows two seed yield histograms of individual plants of Co sunflower o.p. variety, one from the experiment in presence of competition and the other from the experiment in absence of competition. Measurement of the (σ_p^2) parameter in the two experiments showed that absolute value was threefold under conditions without competition as compared with competitive conditions. Comparison of coefficients of variability (CV) showed that there is large phenotypic standard deviation under competitive conditions. The two experiments were sown with the same o.p. variety (Co) and were established in identical conditions, except plant spacing. Large phenotypic standard deviation at 45 cm spacing compared to 125 cm spacing, as statistic quantity (CV) shown, was due to either a better genotypic differentiation which reflects the phenotypic variation or a new source of environmental variation which did not exist under 125 cm spacing conditions.

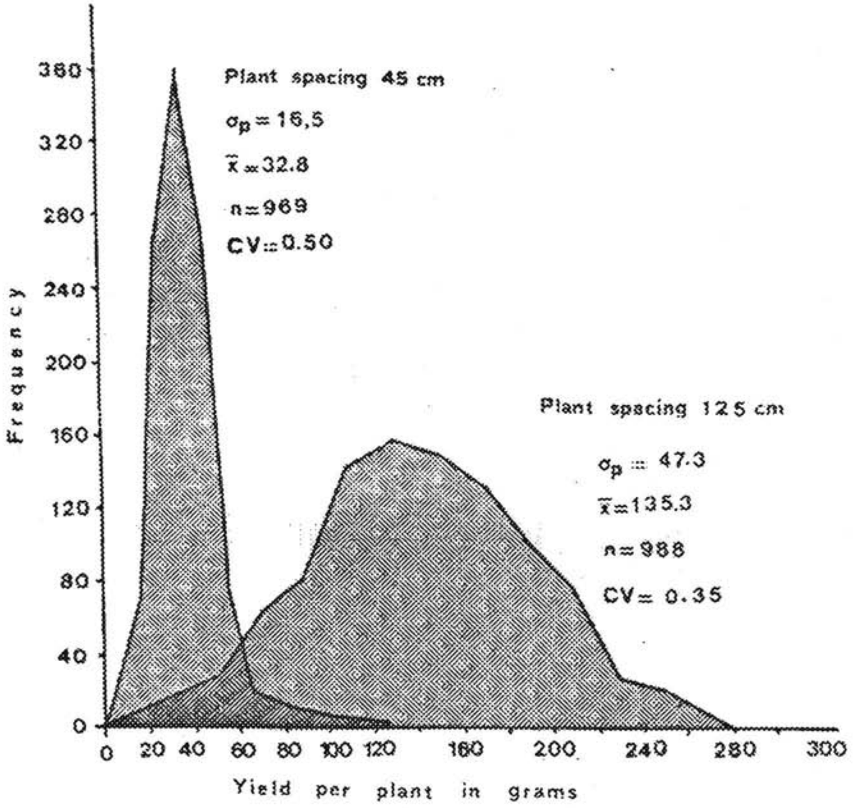

Fig.1. Single plant seed yield frequency distributions under different spacing conditions of a sunflower o.p. variety

Table 1. Mean and relative seed yield after one cycle of selection in different spacing conditions

Material tested	Seed yield kg/ha	Relative yield % of check
Co	2434	100.0
C_1Syn0,I	2634	108.2
C_1Syn0,II	3067	126.0
LSD 5%	392	

Table 1 provides the results of the comparison of selected plants, mixtures C_1SynO,I and C_1SynO,II, with Co o.p. variety. The data showed that honeycomb selection was effective in both cases. Howerer, selection response of widely-spaced plants increased more than 3 times as compared with densely-spaced. Selected plants inherited better their superiority under 125 cm spacing conditions in which the absolute value of phenotypic standard deviation was maximized. The equation $h^2 = \sigma_g^2/\sigma_g^2 + \sigma_e^2 + \sigma_{ge}^2$ that estimates approximate heritability, depends merely on the relation between its factors. When the magnitude of (σ_g^2) is small and its participation in the denominator is also small, heritability is small too. Direct measurements of the factors mentioned above, except (σ_p^2), did not take place but from selection results (better response to selection of widely-spaced plants) it seems that participation of genotypic variance in the total pnenotypic variance was higher at wider spacings, because the selected plants had a better inheritance. These results indicate that heritability of yield of selected sunflower plants increase when the absolute value of factor (σ_p^2) is maximized. In this case, the maximization of phenotypic differentiation was the reason that better phenotypes reflected in better genotypes. So, in the 125 cm spacing grid size there was an increase of eight times as compared with 45 cm spacing, response to selection increased more than three times, although soil heterogeneity increased too. The greater phenotypic variance in 45 cm spacing, as shown by the coefficient of variability (CV), was not heritable. It seems that strong competition under dense planting conditions may additionally increase environmental variance. In absence of competition, lower coefficient of variability (CV) also means lower phenotypic variance. The results, however, indicated that under conditions of absence of competition the phenotypes reflect more precisely the genotypes.

REFERENCES

1. Falconer, D.S., 1981. Introduction to quantitative genetics.2nd ed. Longman. Inc. New York, NY.
2. Fasoulas, A.C., 1988. The honeycomb methodology of plant breeding. Dept. Gen. Plant Breeding. Aristotelian Univ. of Thessaloniki. Greece.
3. Frey, K.I., 1983. Plant population management and breeding. In D.R. Wood (ed) Crop Breeding.p.p.72. Am. Soc. of Agron., Madison, Wis.
4. Simmonds, N.W., 1981. Principles of crop improvement. Longman. London and New York.

SELECTION MASSALE SELON LE SCHEMA DE HONEYCOMB APPLIQUEE A L'AMELIORATION DU RENDEMENT CHEZ LE TOURNESOL CONDUIT SOUS DIFFERENTS ECARTEMENTS DE SEMIS

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Une variété a pollinisation libre de tournesol de consommation (Helianthus annuus L.) à été sélectionnée selon deux modalités: en l'abscence et en présence de conditions de compétitivité. La sélection etait fondée sur le rendement de plantes individuelles établies dans un dispositif expérimental de honeycomb. Les graines des plantes sélectionnées ont été récoltées séparement et semées l'année suivante pour être comparées au controlE. Sous les conditions de non compétititvité le rendement en graines augmente de 26,0% par rapport au control alors qu'en présence des conditions de compétitivité il n'a augmenté que de 8,2%. Nous en concluons que la sélection selon le schema honeycomb à large espaces etait plus efficace pour l'amélioration du rendement en graines.

EFICIENCIA DE LA SELECCION MASAL EN PANAL PARA RENDIMIENTO EN GIRASOL VITILIZANDO DIFERENTES ESPACIAMIENTOS ENTRE PLANTAS

Xanthopoulos, F.P.

Una variedad de polinizacion abierta de girasol oleaginoso *(Helianthus annuus)* fue selecionada bajo condiciones de ausencia de competicion y tambien bajo condiciones de peticion. La seleccion se baso en los rendimientos de plantas individuales establecidas en un diseno en panal.

Las semillas de las plantas seleccionadas, separadamente para cada fue mezclada y sembrada el ano siguiente comparandola con el testigo. Bajo condiciones de ausencia de competicion se obutvo un rendimiento de semilla del 26.0% en comparacion con el testigo. En condiciones normales el rendimiento aumento solamente 8.2%. Se concluye que la seleccion con diseno en penal con mayores espaciamientos entre plantas fue mas efectiva en la mejora del rendimiento.