

RESULTADOS Y EVOLUCION DE TRES ANOS DE SELECCION EN GIRASOL
EN CONDICIONES DE CLIMA MEDITERRANEO

By

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Resumen

Se expone la evolucion y resultados obtenidos en los tres ultimos años en un programa de mejora iniciado en 1.973, para obtener variedades e hibridos adaptados a las condiciones climaticas del sur de Espana con deficit hidrico y altas temperaturas en la epoca floracion-maduracion.

Los objetivos del programa han sido: Ciclo corto, baja estatura, alto contenido en aceite, maximo rendimiento y resistencia a enfermedades. Partiendo de un material heterogeneo en el que el germoplasma de ciclo corto era de bajo contenido en aceite y mediante un metodo de seleccion familiar, se han obtenido lineas puras, actualmente convertidas en androesteriles citoplasmicas y restauradoras de la fertilidad. La longitud del ciclo de estas lineas es de una a tres semanas mas corta que la variedad Peredovik y su contenido en aceite igual o mayor. En los ensayos de ACG llevados a cabo con estas lineas, un porcentaje bastante significativo de sus descendencias fueron superiores en rendimiento en semilla y contenido en aceite a las variedades e hibridos comerciales utilizados como testigos. Una gran parte de estas lineas son de corta estatura y cierto numero de ellas tienen incorporados genes de resistencia al mildiu del girasol. Actualmente se estan ensayando combinaciones especificas entre lineas androesteriles y restauradoras con buena ACG.

Introduccion

El girasol, como planta oleaginosa, es un cultivo relativamente nuevo en Espana. Hasta hace poco tiempo solo se producia girasol para consumo directo y alimento para pajaros. En el año 1.963 la superficie era de 500 Has., habiendo evolucionado de una forma espectacular en una decada, acercandose a 700.000 Has., en la campana de 1.975. Una de las principales causas de esta fuerte expansion, que tuvo su mayor incidencia hacia el año 1.970 (155.000 Has.), fue la introducción de germoplasma ruso con alto contenido en aceite.

Aunque actualmente el area de cultivo de girasol se ha extendido a otras regiones, cuando se inicio nuestro programa de mejora en 1.973 la mayor parte estaba localizada en el surceste de Espana (Andalucia Occidental) con usas condiciones climaticas de tipo mediterraneo caracterizadas por altas temperaturas y bajo contenido de agua en el suelo en la epoca floracion-maduracion. Estos factores ambientales son probablemente las principales causas de los bajos rendi-

mientos de este cultivo en Espana (700 kg/ha), en relacion con otros paises de diferente tipo de clima, al actuar durante el periodo de floracion-maduracion de una forma adversa sobre la produccion de semilla y el contenido de aceite en esta, (Downes y Connor, 1.973), Downes, 1.974), Downes y Davidson no publicado, Muriel y Downes, 1.974, Gimeno 1.977 no publicado).

Los objetivos fundamentales de nuestro programa de mejora fueron el incremento del rendimiento de semilla por Ha., y el rendimiento de aceite.

Teniendo en cuenta estos objetivos, junto con los factores limitantes ya mencionados, habia dos caminos logicos para la consecucion de las metas expuestas:
1) Obtener una variedad o hibrido con resistencia a estas condiciones adversas
2) Obtener un cultivar con un ciclo suficientemente corto que permitiera, con un adelantamiento de la siembra, una floracion y maduracion en condiciones mas favorables; en definitiva, eludir las condiciones adversas. La segunda alternativa, que llevaba como consecuencia la utilizacion de germoplasma tolerante a temperaturas bajas, fue la elegida. Paralelamente, una seleccion para baja estatura permitiria, al existir unas condiciones ambientales adecuadas, un aumento de la densidad de plantas por Ha., lo cual se traduciria en un mayor rendimiento de semilla (Downs 1.974). Asi pues nuestros objetivos quedan resumidos en lo siguiente: Ciclo corto, alto contenido en aceite, estatura moderada, tolerancia a heladas y alto rendimiento; ademas y simultaneamente se pretende conseguir resistencia a enfermedades de entre las que destaca por su importancia el mildiu del girasol.

El material vegetal de partida fue variable en cuantia, orígenes, ciclo y caracteristicas agronomicas, utilizandose cultivares de ciclo corto (variedades de polinizacion, abierta, Karlik, Chernianka, Morden, Issanka) de bajo rendimiento y contenido en aceite; variedades de ciclo semitardio y tardio (Arnavirski, series Vniimink, Smena, Perekovik, etc.) con un mayor rendimiento y contenido en aceite; lineas androesteriles de origen norteamericano (CMS HA 89, 234, 119, etc.) y restauradoras de la fertilidad (RHA 265, RHA 266), algunas con resistencia al mildiu incorporada (RHA 271, RHA 274).

Con el germoplasma citado se llevaron a cabo cinco ciclos de recombinacion tras los cuales el material se separo en poblaciones A androesteriles, B mantenadoras y R restauradoras siguiendose un esquema de seleccion familiar modificado que permite completar un ciclo de seleccion recurrente por año (Downes, 1.974 (a)).

De acuerdo con este metodo de seleccion se aplico un diferencial de seleccion moderado en los indices antes mencionados: ciclo corto, baja estatura y contenido en aceite con objeto de mantener una variabilidad adecuada en las poblaciones.

Al permitir nuestras condiciones climaticas, normalmente, cultivar bajo condiciones de riego una segunda cosecha verano-otono, se pudieron conseguir dos cosechas por año. La segunda cosecha de otono se utilizo para incrementar la semilla y obtencion de aquella que sirve para las evaluaciones al año siguiente.

Resultados Y Conclusiones

En el cuadro No. 1 puede apreciarse la evolucion del contenido en aceite de las familias A, B y R durante los anos 1.975, 1.976 y 1.977.

CUADRO 1. Evolucion de la media de la poblacion (% aceite) en los tres ultimos ciclos de seleccion.

Ano	Familias A		Familias B		Familias R	
	Media (\bar{x})	Desv. tipica	Media (\bar{x})	Desv. tipica	Media (\bar{x})	Desv. tipica
1.975	41,89	3,7	42,28	3,9	43,32	4,0
1.976	43,91	1,7	43,21	2,06	44,32	2,2
1.977	51,21	4,3	47,93	4,0	48,50	5,7

Es necesario hacer notar que inicialmente nuestras poblaciones estaban compuestas de familias con bajo indice de consanguinidad debido el metodo de seleccion utilizado. Aunque la idea original fue obtener hibridos poblacion, y la seleccion en poblaciones con bajo indice de consanguinidad aun es continua, se opto por la extraccion de lineas puras de las poblaciones con el objeto de facilitar incorporacion de genes de resistencia al mildiu.

Actualmente muchas de nuestras lineas tienen cuatro autofecundaciones debido a los dos ciclos por ano que han realizado.

Al comienzo de nuestros ciclos de seleccion el remdimiento no fue considerado como primer criterio de seleccion seleccionandose fundamentalmente para alto contenido en aceite. Sin embargo, a partir de 1.976 en todas las lineas seleccionadas con alto contenido en aceite, baja estatura y ciclo corto se obtuvo una generacion de policruzamiento para hacer una estimacion de la Aptitud Combinatoria General (ACG). Los resultados de esta estimacion se exponen en el cuadro no. 2 y cuadro no. 3.

CUADRO 2. Estimacion de la ACG de las lineas A y B (1.976).

No. Lineas	Media General Poblacion	Intervalo Poblacion	Media Testig.	Intervalo Testigos ¹	No. lineas superiores a media testigos
Kg./Ha.	124	1818	1108-2600	1838	1481-2203
% Aceite	124	48,4	44-52,3	48,7	47-50

¹Los testigos utilizados fueron: Peredovik, Morden, HP-102, INRA 7702, SH-25, SH-75, SH-265.

CUADRO 3. Estimacion de la ACG de las lineas R (1.977)

	No. lineas	Media General Poblacion	Intervalo Poblacion	Media Testigo.	Intervalo Testigos ¹	No. lineas superiores a media testigos
Kg/Ha.	136	1347	702-2113	1547	1416-1830	32
% aceite	136	50,9	43-56	50,3	48-53	114

¹ Los testigos utilizados fueron: Peredovik, Morden, SH-75 cms HA 89 x RHA 274, cms HA 89 x RHA 273, cms HA 290 x RHA 278 y cms HA 234 x RHA 274.

Es importante hacer notar que las medias fueron relativamente altas en comparacion con los rendimientos normales obtenidos en el Sur de Espana, lo que pudiera ser debido a que las condiciones climaticas de estos anos no fueron excesivamente adversas para estos ensayos y a la calidad de las labores culturales dadas.

Se debe señalar tambien, que en los ensayos de las lineas R la media general es mas baja que la media de los testigos. Esto es fundamentalmente debido a la polifloria de muchas de estas lineas R, que al ser policruzadas con lineas que tambien son poliflorias dan una descendencia portadora asimismo de este caracter. Al recolectarse solamente la cabeza principal de cada planta esto lleva consigo una disminucion del rendimiento real.

En el cuadro no. 4 se expone una clasificacion de las lineas seleccionadas en cuanto a su longitud de ciclo y se comparan con la variedad Peredovik.

CUADRO 4. Clasificacion por longitud de ciclo de 554 lineas puras.

No. lineas Ensayadas	Dias a 50% floracion	No. lineas 3 semanas mas tempr. que testigo		No. lineas igual floracion testigo	
		Idem. 2	Idem. 1	Idem. 2	Idem. 1
Lineas A	184	76,54	89	60	27
Lineas B	166	79,55	64	52	35
Lineas R	204	76,99	76	75	40
Testigo	Peredovik	95,00			13

Se puede apreciar que el ciclo medio de nuestras poblaciones es aproximadamente tres semanas mas corto que Peredovik.

Un punto importante a hacer notar es el de la ruptura del posible ligamiento existente entre la longitud de ciclo y el contenido de aceite mediante la recombinacion y seleccion llevada a cabo. Este ligamiento, inferido de los resultados expuestos por Russel en 1.953 y Fick et al en 1.974 y por los obtenidos por Diaz de la Guardia y col. (no publicados) en nuestras condiciones, se desprende del coeficiente de correlacion positivo y significativo entre el contenido de aceite del aquenio y el numero de dias desde siembra al 50% de floracion.

En el cuadro no. 5 se dan los coeficientes de correlacion simple entre el contenido de aceite y numero de dias desde siembra al 50% de floracion de nuestras lineas puras seleccionadas y de variedades comerciales. Puede apreciarse que dichos coeficientes de correlacion son muy bajos para las lineas puras, mientras que para los cultivares comerciales es apreciable y altamente significativo.

CUADRO 5. Coeficientes de correlacion entre contenido de aceite del aquenio y dias a 50% de floracion en lineas puras y cultivares comerciales.

	Lineas A	Lineas B	Lineas R	Cultivares Comerciales
No. lineas o CV.	184	166	204	30
r	0,14	0,13	0,18	0,56**

**Significativos al P 0.01.

En cuanto a altura, la media de todas las lineas es de 83.5 cm., mientras que la variedad Peredovik cultivada en las mismas condiciones dio una altura media de 165 cm.

En conclusion podemos decir que se partio de una poblacion heterogenea formada con introducciones con distinto ciclo y contenido en aceite, siendo de bajo contenido los cultivares de ciclo corto. A partir de 1.973 se iniciaron ciclos de seleccion y recombinacion habiendo desarrollado poblaciones A, B y R con un ciclo suficientemente corto y con un contenido en aceite mayor o igual que los cultivares comerciales, y habiendo extraido de estas poblaciones lineas puras con el objeto de que sirvan como parentales en la confeccion de hibridos. La frecuencia de polifloria recesiva en nuestras lineas R es muy elevada siendo mas baja en jenes P1 de resistencia al mildiu aunque dicha resistencia se esta incorporando a las lineas mas interesantes.

En cuanto a la tolerancia al frio, se lleva a cabo un subprograma, el cual ha permitido encontrar una gran variabilidad entre lineas, haciendo posible una seleccion de las mas tolerantes lo cual permitira una siembra temprana sin riesgos de daños causados por las heladas (Gimeno, resultados no publicados).

En el presente año, se estan ensayando mas de 150 combinaciones hibridas especificas experimentales, obtenidas cruzando nuestras lineas mas prometedoras. Puesto que existe variabilidad con respecto a la longitud del ciclo, seria posible, si ello fuera necesario, la extraccion de lineas puras con ciclos mas largos, para poder ser usadas en combinaciones hibridas en areas del centro y norte de Espana, en donde quizas pudieran ser aconsejable material con un ciclo mas tardio.

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SELECTION FOR SELF-FERTILITY AND OIL PERCENTAGE
IN DEVELOPMENT OF SUNFLOWER HYBRIDS

By

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Slide 1

Sunflower hybrids produced by the cytoplasmic male sterility and fertility restorer system were first introduced for commercial production in the United States in 1972. This present season, six short years later, hybrids have been planted on nearly all of the near 3 million acres of sunflowers grown in the U.S.

Slide 2

The rapid transition to the hybrids has occurred primarily because of higher yield potential which has been estimated to be as high as 20 to 25% more than that of previously grown open-pollinated varieties.

Slides 3, 4 and 5

Other advantages of the hybrids and factors that contribute to the higher yields include resistance to the major diseases of sunflower, greater uniformity for plant height and maturity which has greatly facilitated harvesting, and improved self-fertility or self-pollination. It is this latter trait that I wish to discuss in some detail in this report.

Slide 6

Sunflowers have normally been considered a highly cross-pollinated crop relying heavily on bees for pollination and good seed set. However, as more and more acres of sunflower are planted there are fewer bees per unit of area to affect cross-pollination, and it has been estimated that nearly 75 percent of the fields in our area have fewer bees than are needed to obtain maximum yields.

Slide 7

An obvious solution is to introduce bees into sunflower fields although in many cases it is questionable whether the increased returns would be enough to offset the costs.

Slide 8

To alleviate the dependency on bees and to improve pollination most breeders in the United States, including the speaker, have selected strongly for self-fertility in developing inbred lines for production of hybrids. This selection has been highly effective.

Slide 9

Estimates of self-fertility for certain hybrids, such as the widely grown 894, are as high as 80 to 90 percent, which compares with less than 10 percent for most previously grown open-pollinated varieties.

Slide 10

Although it is generally believed that estimates of self-fertility are directly related to yield performance, at least when bee populations are limiting, very few test results are actually available. The objectives of this study were to obtain information on the associations of self-fertility with yield and other characteristics, and also to identify source populations having a high frequency of self-fertile genotypes that might be useful in future breeding efforts. Because high oil percentage is also an important selection criterion, information was also obtained on the variability for this trait that occurs among and within selected populations.

Slide 11

Information on the associations of self-fertility with yield and other plant and seed characteristics was obtained from F_3 and F_4 lines from two crosses grown at Casselton, ND in 1976. Sixth-three F_3 lines from corss no. 1 and 50 F_4 lines from cross no. 2 were evaluated in replicated trials.

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The lines from each cross were arbitrarily classified for self-fertility as high, intermediate, or low on the basis of the amount of seed produced on individual self-pollinated plants. Those classified as high produced more than 50 grams of seed per plant from selfing, those classified as intermediate 30 to 50 grams, and those as low less than 30 grams. As can be seen, the highest yields in cross no. 1 were obtained from lines with high self-fertility and the lowest yields from those with low self-fertility.

Slide 13

Similar results were obtained for cross no. 2 with the highly self-fertile lines producing about 100 and 400 lbs per acre more than those classified as intermediate and low, respectively. Although precise counts were not made, the number of bees in the field during pollination was generally observed to be relatively low with fewer than 25 bees per 100 flowering plants. Thus the data from these two crosses strongly support the assumption that higher seed yield may be obtained with self-fertile genotypes when insect pollinator populations are less than optimum. The results also indicate that the procedure of measuring the amount of seed that is produced on heads isolated with light cloth bags does in fact provide a useful guideline in selection of genotypes with high yield potential.

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Calculation of the correlation coefficients showed that the association between self-fertility and seed yield was highly significant for both crosses.

Although several of the other correlations were also significant, generally there was a lack of consistency for the associations between self-fertility with other traits suggesting that a wide range of self-fertile types could be developed.

Slide 15

For selection of self-fertility and also high oil percentage to be most effective, it is necessary that the source population available to a breeder possess variability for these traits and that selection is practiced within populations having the highest frequency of desirable genotypes.

Slide 16

To identify populations of potential value more than 50 diverse germplasm sources were evaluated. These consisted primarily of cultivars from the USSR, Eastern Europe, South Africa, Argentina, recent USDA introductions and several synthetic populations formed from plants or inbred lines selected previously for other traits. Most of the germplasm sources are available from the USDA world sunflower collection maintained at Ames, Iowa.

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Each of the germplasm sources was planted at Breckenridge, MN in 1977 in small plots and hand thinned to populations of about 20,000 plants per acre.

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Heads of at least 20 plants of each entry were isolated with light cloth bags prior to flowering to insure self-pollination. Self-fertility was measured as the weight of seed that was produced on individual self-pollinated plants.

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Oil percentage of seeds was determined by nuclear magnetic resonance (NMR) for those plants that produced 10 grams or more of seed. Determinations were made on clean seed samples that had been dried and allowed to equilibrate to about 4 percent moisture.

Slide 20

Self-fertility of the different source populations ranged from an average of about 5 to near 70 grams of seed per plant. The majority of the populations produced an average of more than 10 but less than 30 grams of seed. Only 10 of 52 populations had averages of more than 30 grams of seed per plant from self-pollination.

Slide 21

The highest frequency of self-fertile plants occurred in two synthetic populations, both of which were formed by inter-crossing of plants or inbred lines that had undergone some selection previously for high self-fertility. Other sources that were relatively self-fertile included Perekovik selections 308,

437, and 428, all of which produced an average of more than 40 grams of seed. Most of the high oil Soviet cultivars, which have been used extensively by U.S. sunflower breeders in developing inbred lines of hybrids, were quite self-incompatible. Of 26 sources and 21 cultivars that were evaluated 19 sources produced an average of less than 20 grams of seed per plant. However, wide variation occurred within populations, and we have extracted from several populations lines that are essentially 100 percent self-pollinating producing more than 100 grams of seed per head from selfing during each of several generations of inbreeding.

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Mean oil percentage of seed from selfed plants ranged from near 50 to about 30 percent for the different populations. Thirteen of the 52 populations had oil percentages exceeding 46 percent and 36 of 52 exceeded 42 percent. Thus, mean oil percentages were relatively high and it is obvious that many of these populations could be very useful in breeding efforts to improve seed oil percentage.

Slide 23

The highest oil percentages occurred among plants of a branched restorer line synthetic with seed oil values of individual plants ranging as high as 63 percent. The seeds from branched plants are generally smaller in size, and previous investigations have shown that they contain significantly more oil than seeds from single headed types of similar genetic background. Generally the source populations or cultivars with the highest oil percentages were those introduced from the USSR since 1970. Wide variation occurred among individual plants within populations suggesting that lines with oil percentages exceeding the mean of the population could be selected from most sources.

Slide 24

Estimates of heritability for self-fertility and oil percentage were determined for two populations for which both S_1 and S_2 data were available. The estimates were obtained by the parent-progeny regression method. Heritability values for oil percentage were relatively high and of similar magnitude to those reported in a previous investigation. Estimates for self-fertility were lower although past experience suggests that considerable progress can be realized by selection for self-fertility in early generations.

Results of other researchers suggests that high self-fertility may be controlled primarily by recessive genes. Thus to produce hybrids with the highest degree of self-fertility it is likely that both parents must possess the high self-fertility trait. Additional studies on the inheritance of self-fertility are desirable.

Slide 25

In summary, self-fertility as measured by the weight of seeds of self-pollinated plants was positively and significantly correlated with seed yield in two crosses involving F_3 and F_4 lines. These results suggest the importance of selecting for high self-fertility when developing inbred lines for use in

production of high yielding hybrids. Self-fertility of more than 50 diverse sunflower populations varied widely ranging from an average of 5 to near 70 grams of seed per self-pollinated plant. Variability within populations was also high indicating that highly self-fertile types can be isolated from many different source populations. Mean oil percentage of seeds from selfed plants ranged from 32.6 to 48.4 percent with the highest oil percentage occurring most commonly among recently introduced cultivars from the USSR. Heritability estimates for self-fertility and oil percentage were of sufficient magnitude to encourage selection for those traits in early generations on an individual plant basis.

NEW SOURCES OF FERTILITY RESTORATION (Rf genes) AND
DOWNY MILDEW RESISTANCE (P1 genes) IN SUNFLOWERS

By

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Summary

Our study included the determination of new sources of Rf genes, for fertility restoration, and P1 genes, for resistance to downy mildew (Plasmopara helianthi). Rf genes were found in inbreds originating from local populations from the Netherlands, Czechoslovakia, Poland, and Morocco -- VIR-772, VIR-997, VIR-67, and VIR-2128, respectively. Rf genes were also found in the inbreds K-212, K-215, and K-216 developed from the Argentinian cultivar Klein, in the inbreds C-220 and C-222 developed from the Argentinian cultivar Ciro, and in the inbred M-13/4-3-1 developed from the cultivar Mayak.

The line NS-B-16, of unknown origin, which has recessive branching, possesses an Rf gene as well as P1 genes for the resistance to the European and American races of downy mildew. RHA-201 is a new restorer obtained by crossing H. tuberosus with the domesticated sunflower form. It is resistant to the American and European races of downy mildew. RHA-93 is a new restorer developed from the Argentinian cultivar Pehuen INTA. It has a P1 gene for the resistance to the European race of downy mildew. RHA-191-76 is the restorer developed from the French line HIR-34. The lines ODTA-5652 and ODTA-3722 possess Rf genes and are resistant to the European and American races of downy mildew.

Introduction

Practical utilization of heterosis based on cytoplasmic male sterility is possible providing that a parental line possesses restorer genes (Rf). Several sources of restorer genes have been recently determined. Anaschenko (1977) made a detailed review of the sources of fertility restoration.

Kinman (1970) determined the existence of an Rf gene in the line T6606-2. This source of fertility restoration was largely applied in the development of sunflower hybrids. Leclercq (1971) determined the existence of a dominant gene for fertility restoration in F_1 generation of H. petiolaris. Vranceanu and Stoenescu (1971) found the gene Rf_2 in the line MZ 1398 derived from the local cultivar Mezehedeshy. The line MZ1398 has good agronomic characters and high combining ability.

Fick and Zimmer (1974) developed restorers with recessive branching resistant to downy mildew (RHA-271, RHA-273, and RHA-274) which play a particularly important role in the development of sunflower hybrids based on cytoplasmic male sterility. The confectionery cultivar Sundak may also be used as a source of Rf genes. Fick and Zimmer (1974) selected the restorers RHA-280 and RHA-281

from this cultivar. Restorer lines have also been selected from the Argentinian cultivar Pehuen INTA. This source of fertility restoration in F_1 generation was found by Fernandez et al (1974). Fick, Zimmer et al (1974) determined the existence of restorer genes in a large number of wild sunflower forms. These forms are a solid basis for the development of restorers resistant to certain diseases (downy mildew, etc.).

Material and Method

For this study, we used inbreds from the breeding stock of the Institute of Field and Vegetable Crops in Novi Sad. The inbred used had been developed from local populations which in turn originate from the collection of VIR, Leningrad. Some Argentinian cultivars and local populations were also used as well as some lines originating from the Federal Institute of Genetics in Odessa. We also used the lines developed from the French line HIR-34.

In 1975, a large number of inbreds was crossed with five cms-lines. The restoration of fertility was checked in 1976. Repeated crossings were performed in 1976 and the checks of fertility restoration in 1977. The ensuing F_1 combinations were comparatively tested, in three replications, to evaluate the combining ability of the tested inbreds.

All tested inbreds were inoculated in 1976 in Novi Sad to test their resistance to downy mildew. A part of the breeding material was tested for the resistance to downy mildew in 1976 by Dr. D.E. Zimmer, ARS, USDA, Fargo, North Dakota.

Results and Discussion

Besides the already known sources of fertility restoration in our breeding stock, we found several new sources of Rf genes. They were found in inbred lines originating from local sunflower populations from several countries -- a local population from the Netherlands (VIR-772), a local population from Czechoslovakia (VIR-997), a local population from Poland (VIR-67), and a local population from Morocco (VIR-2128). The newly-developed restorers have poor agronomic characters and thus cannot be directly used for the development of sunflower hybrids. The studies presently in course should determine whether the discovered Rf genes differ from those already known or not.

The inbreds K-212, K-215, and K-216 derived from the Argentinian cultivar Klein, were found to possess Rf genes, as well as the inbreds C-220 and C-222 derived from the Argentinian cultivar Ciro. These restorers have high combining ability and may be used for the development of early hybrids with stem height to 160 cm.

The inbred M-13/4-3-1 from the cultivar Mayak also possesses an Rf gene. This restorer has a high oil content in seed (higher than 50%) and combines well with certain cms-lines. Several experimental hybrids having this restorer as a parent brought high seed yields. They are early maturity.

A much more interesting breeding material are the lines which possess both Rf genes and the genes of resistance to downy mildew (Plasmopara helianthi).

The line NS-B-16, the origin of which is not quite known, which has recessive branching, possesses an Rf gene and is resistant to downy mildew. According to still unpublished results of Zimmer (1976) this line is also resistant to the American race of downy mildew. The seeds of NS-B-16 are small and whitish in color, therefore different from the seeds of American restorers with recessive branching and the French restorer HIR-34. It is most probable that this line originated from a free crossing of an inbred from the cultivar Armavirsky 3497 and some wild sunflower form. Besides its resistance to downy mildew, NS-B-16 is tolerant to the agents of leaf and stem spot, Alternaria helianthi and Phoma sp. NS-B-16 has a high GCA value and may successfully be used in sunflower breeding programs. The studies presently in course should determine which P1 genes are present in NS-B-16.

RHA-201 is a new restorer resistant to the European race of downy mildew and, according to the results of Zimmer (1976), also resistant to the American race of the disease. It was obtained by crossing H. tuberosus with the domesticated sunflower form. RHA-201 is short (about 90 cm), with short internodes. When crossed with the tested cms-lines, it yielded short and relatively early hybrids.

RHA-93 is a new restorer genetically resistant to the European race of Plasmopara helianthi and tolerant to Sclerotium bataticola. It was selected from the Argentinian cultivar Pehuen INTA and we do not know how different it is from the restorer developed by Fernandez et al (1974) from the same population. RHA-93 is medium late, with stem height of 180-190 cm. When crossed with the tested cms-lines, it brought high seed yields and late maturation. We have not determined yet whether RHA-93 possesses the P1 gene for the resistance to the American race of downy mildew.

RHA-191-76 is the restorer with recessive branching derived from the French line HIR-34. It is resistant to Plasmopara helianthi and tolerant to Sclerotinia sclerotiorum. Its hybrids are medium early; their stem heights are also medium (160-170 cm).

The lines ODTA-5652 and ODTA-3722 possess an Rf gene and are resistant to the European race of downy mildew. According to the results of Zimmer (1976) they are also resistant to the American race of downy mildew. These restorers also showed the resistance to Orobanche cumana.

The newly developed restorers which possess P1 genes for the resistance to downy mildew and other positive characters may be used for the development of sunflower hybrids.

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