SUNFLOWER RESEARCH - A PROGRESS REPORT

By

Henry Enns, D. G. Dorrell,
J. A. Hoes, and W. O. Chubb
Canada Department of Agriculture
Research Station
Morden, Manitoba, Canada

Plot Competition

It is frequently necessary to yield test sunflower cultivars that differ markedly in maturity and size. Therefore, the question of competition between plots is quite important. In the Morden program preliminary yield trials have unusally been single row plots and the Co-operative Test which is grown in several provinces has consisted of two-row plots, both rows being harvested.

We, therefore, conducted a yield test with the cultivars Valley and Armavirec for two years. Valley is 9 to 10 days later and 8 to 12 inches taller than Armavirec. The plots used were one row, two rows - both harvested and three rows with only the center row harvested.

As expected the competition from Valley reduced the yield of Armavirec considerably in the one and two row plots. The yield of Armavirec in % of Valley was as follows: one row plot = 31.6; two row plot = 42.5; three row plot (center harvested) = 49.3. Or to put it another way, the yield advantage of Valley changed from a factor of 2 times to 3 times that of Armavirec.

Isolation Efficiency

In order to get some idea of the isolation distance necessary to prevent outcrossing in small sunflower plots, I conducted a small test using the French male sterile- anthocyanic linked strain. I selected a large field of Peredovic sunflowers far from neighboring fields and planted isolation plots at varying distances from the main field, each in a different direction. The red fertile plants were supposed to be rogued out but some recombination must have taken place so that two plots were discarded.

One usable plot at 1/2 mile from the main field contained 10 plants which showed no pollen staining. The estimated seed set on these uncovered heads averaged 13.75%.

Another field at 3/4 of a mile in a different direction contained 3 plants with no pollen staining. In this case the average seed set was 18.0% or slightly higher than the plot at 1/2 mile. Therefore, in dealing with small isolation plots a considerable amount of outcrossing can be expected at these distances. The two other plots which had one or two fertile plants in them, by mistake, showed a much higher seed set.

Induction of Seed Set by GA_3

You are aware that Gibberellic acid has many effects on plants, It has been used to induce sterility in a number of species. Recently, I came across a paper in which GA_3 was used to induce seed setting in genetically male sterile barley. With this in mind I tried 3 concentrations of GA_3 on the genetic male sterile sunflowers received from France. The solutions were sprayed onto the leaves at several stages starting prior to meiosis. However, on 47 treated plants (26,000 florets) not a single seed was obtained. The control consisted of nine plants and 4,250 florets and these also set no seed.

Therefore, the experiment was a failure with regard to seed set induction but it confirmed my belief that the French male sterile is reliable.

Breeding

The genetic male sterile with the anthocyanic linkage was received from Dr. Leclercq in June of 1967. A considerable amount of work has been done to incorporate this male sterile gene and the anthocyanic gene into prospective parents for F_1 hybrids. I have also yield tested many crosses of Morden inbred lines onto this genetic male sterile. Although some of these yielded fairly well and had reasonable oil content, we felt we could not use it directly. The French lines I received were not rust resistant and they are also highly susceptible to Verticillium Wilt.

In April, 1969, Dr. Leclercq kindly supplied his cytoplasmic male sterile and maintainer lines. Since we have now located pollen fertility restorers for this cytoplasmic male sterile my intention is to concentrate on the cytoplasmic-restorer method of producing hybrids rather than the genetic system with the marker gene linkage.

The data of Table 1 show that fertility restorers are present in wild and tame sources of sunflowers. Some collections yielded no restoration while others (from Blythe and Bower) produced only fertile progeny. Still others showed varying degrees of pollen fertility restoration. Gene pool I is a composite of cultivated sunflower lines which must be heterogeneous for fertility restoration. The collection from Tucumcari, New Mexico, (_Helianthus petiolaris_) produced only one progeny, which, however, was fertile. From these data it appears that pollen fertility restoration genes are quite common.

Some data of test crosses of the best fertility restorers is shown in Table 2. The Blythe restorer source produces a good fit to a 1:1 ratio of sterile to fertile plants indicating a single dominant gene for fertility restoration. Crosses involving the Bower source also produced a 1:1 ratio, but the probability of a fit is somewhat lower. Using the Armour source again indicates a single dominant gene for fertility restoration.

Although the progeny numbers involved in these crosses were low due to lack of space, the evidence appears to indicate single dominant gene fertility restoration from several sources. Tests of the similarity of these genes have not yet been made. Pollen fertility, however, was excellent in both the growth cabinet and greenhouse. It appears, therefore, that the restorers will be relatively easy to transfer to prospective

Table I

Percentage of pollen stainability of progeny from crosses of wild and cultivated sunflowers onto cytoplasmically male sterile lines (F_1).

No. of plants and % stainable.						Origin of Male
0	1-25	26-50	51-75	76-95	96-100	
6	-	-	-	-	-	Yuma, Ariz.
2	-	-	-	-	1	Ellendale, N.D.
3	-	-	-	-	1	Armour, S. D.
-	-	-	-	-	6	Blythe, Cal.
-	-	-	-	-	8	Bower, Wy.
2	1	1	1	2	-	Gene pool I*
4	1	-	-	-	-	Gene pool I*
-	-	2	2	4	-	O'Neill, Neb.
-	-	-	-	1	-	Tucumcari, N. Mex.**
-	1	1	-	5	-	Cottonwood, Ariz.
-	-	6	-	1	-	Gallup, N. Mex.
5	-	-	-	-	-	OP
4	1	1	-	-	3	OP

* Cultivated sunflowers.
**Helianthus petiolaris.

Table II

Test crosses of the type cytoplasmic ms by (cytoplasmic ms x fertility restorer) using three restorer sources showing segregation of sterile to fertile progeny.

Restorer Source	Cross	Sterile	Fertile	Ratio	Ch-square	Probability
Blythe, Cal.	239	6	7			
" "	240	6	7			
" "	241	6	7			
Total		18	21	1:1	0.230	.50-.95
Bower, Wy.	242	3	7			
" "	244	8	4			
" "	245	9	6			
" "	249	10	5			
" "	250	9	3			
Total		39	25	1:1	3.062	.05-.10
Armour S. D.	246	7	4	1:1	0.818	.20-.50

males for the production of hybrid sunflowers using the French source of cytoplasmic male sterility.

Oil Quality

Sunflower seed is an untapped storehouse of variability for oil quality. Cultivars and inbred lines exhibit considerable variability for such quality parameters as oil content, neutral oil, fatty acid composition, tocopheral content, gumming potential, color, etc. Although the heritability of these parameters appears to be sufficiently high to allow modification of breeding, there is a very strong environmental effect.

In 1969, three cultivars were planted at six dates ranging from May 9 to June 12 based on an interval of 75 heat units. The vegetative period was shortened by up to two weeks at the later dates as more heat units were accumulated in a shorter period. There was an average increase in oil content from 39.9% - 44.2% from the first to last planting, and as expected the seed yield declined over the same period. The early cultivar Armavirec had the greatest increase, 34.6 - 42.9% probably because the period of oil synthesis and accumulation for the first planting fell during very hot weather, whereas the later plantings matured under more favourable conditions. The fatty acid composition also varied directly with planting date. Oleic acid declined from 23.1% to 14.5% with Armavirec again showing the greatest environmental interaction (28.8% - 17.0%) linoleic acid increased from 64.9% to 74.5% over the same period. This preliminary data indicates that a portion of the distinctive fatty acid composition of each cultivar is due in part to its maturity pattern and the environmental conditions when the plant is synthesizing and accumulating oil. The oleic acid content of Armavirec, Peredovik and Majak for the first date was 28.8, 20.3, and 20.2%, however, when the plantings were adjusted to syncronize flowering, the oleic acid levels were 17.8, 16.6 and 16.5% respectively. Therefore, when making statements about relative fatty acid composition of cultivars, the environmental effect must be considered. In addition, when undertaking inheritance studies attempts will have to be made to utilize material of similar maturity patterns or artificially syncronize flowering.

The fatty acids of sunflower oil have been identified in a wide range of cultivars. Earle et al, have reported the presence of 14 acids. We have noticed that the 10 minor acids range from less than 0.5% to more than 4% of the total oil. Some inbred lines contain only two minor acids. Extreme genotypes for the four main fatty acids have been selected and maintained. The following ranges in acids are on hand; saturated 5-40%, oleic 9 - 53%, and linoleic 34 - 83%.

A preliminary analysis for neutral oil content of adapted cultivars indicates an initial range of 0.8 - 6.0% non-neutral oil. No attempt has been made to partition genetic and environmental variance. We have also noted a considerable range in oil color, tendencies of the oil to gum upon heating and degree of viscosity and rate of crystalization at low temperatures. In effect given the proper criteria almost any quality could be tailor made.

An Undescribed Disease in Sunflower Inbred CM 144

Inbred CM 144 highly resistant to Verticillium wilt (V. dahliae Kleb.) growing in a disease nursery heavily infested with the pathogen, unexpectedly showed a high proportion of severly diseased plants in 1968. The abnormal condition was ascribed to excess water because diseased plants coincided with low, water collecting spots in the field. In 1969, the same abnormal condition was even more prevalent but water was not in excess. Isolations in 1969 from roots and stems of CM 144 showed high frequencies of Cephalosporium spp.and Cylindrocarpon spp., and a low frequency of V. dahliae. On the other hand, plants of other sunflower lines growing in the same field and appearing healthy were characterized by a high frequency of V. dahliae and absence of species of the other two genera.

In the one pathogenicity test carried out and still under progress, lots of 10 plants of CM 144 were inoculated by root immersion with each of 12 isolates of Cephalosporium. The isolates could be arranged in two groups on the basis of cultural appearance. None of 6 isolates of the one group caused disease, while 5 of 6 isolates of the other group caused a similar disease in all 50 plants. Diseased plants were either severely stunted (17/50 plants) or they showed very severe stunting accompanied by yellowing of leaves followed by limited necrosis (33/50 plants). The disease index on a 1-6 scale (1 = healthy; 6 = severely diseased) ranged from 4.6 - 5.6 with a mean of 5.3 for the 5 isolates; control plants scored 1.0. Koch's postulates have not been completed but re-isolations have yielded a Cephalosporium sp. It occurred in roots and throughout the hypocotyl in the vascular bundles. The evidence that Cephalosporium sp. is indeed the causal agent in the disease observed in Cm 144 is not yet conclusive, because of insufficient observations, presence of bacteria in diseases plants and because the experiments would have to be repeated. On the other hand, the symptoms observed are similar to those observed in the field. Two species of Cephalosporium are known incitants of systemic diseases in soybean causing "brown stem rot" and in winter wheat causing "stripe disease".

Bacterial Root Rot of Sunflower

In germination tests on wet filter paper in petri dishes, seeds of 3 varieties imported directly from Russia developed root necrosis. Tests were repeated twice and both times all seeds of all three varieties showed the disease; affected parts were heavily infected with bacteria only. It is not know whether the same disease occurs in the field. A number of isolations have been made but no inoculation tests have yet been performed. Experimental plots of the varieties will be closely observed for disease development. Similar necrosis has also developed in 60% of young seedlings of certain hybrid lines of sunflower, one parent of which is of wild origin. Only bacteria were present in affected parts. Bacterial isolates were obtained but it is not known whether they are similar or dissimilar to those obtained from Russian material.

Chemical Weed Control

Lack of dependable and economic weed control methods is a major factor in limiting profitable sunflower production in Manitoba. The most common weeds encountered in sunflower production include Setaria viridis, Avena fatua, Amaranthus retroflexus, Chenopodium album, Brassica kaber, *Thlaspi arvense*, *Polygonum persicarria*, and *P. convolvulus*. *Echinochloa crusgalli* is also now becoming a problem in some areas.

Until very recently no herbicide was available for effective use in sunflowers under Manitoba climatic conditions. Preemergence herbicide applications are generally unreliable in this area because of the lack of timely rainfall. Weather records for May in a central area of the province (30 years) for example, showed that 19 mm rainfall within 10 days after a dry day, suitable for spraying, occurred on the average only once in 3 years. Our program has therefore been directed towards the examination of preplant or post emergence herbicide application in combination with cultural methods of weed control.

Two preplant herbicides are now available for use in sunflowers. Applications of trifluralin at 1.12 kg or EPTC at 3.9 kg/ha, in 225 l/ha total spray volume, have proven effective in controlling *S. viridis*, *A. fatua* and some common broadleaved weeds but are ineffective in controlling cruciferaw such as *B. kaber* or *T. arvense*. However, herbicide usage is not widely accepted because of the high cost of these materials and the crop is still grown in widely spaced rows to permit inter-row cultivation. In experimental work lower rates for grass control (tricluralin at 0.56 kg or EPTC at 2.2 kg/ha) combined with postemergence harrowing for broadleaf control has given acceptable weed control. On plots treated with herbicide, cultivated with field scale equipment and given no special hand care yield increases of 20 percent or more have been obtained through control of weeds by this method.

Some preliminary testing has shown that sunflowers can tolerate post-emergence application of nitrogen at rates up to 3.4 kg/ha. Other herbicides of this group (diphenyl ethers) are being tested. This work is still in an early experimental stage.

Until dependable and economic weed control methods, which eliminate the need for inter-row cultivation, become available growing of sunflower in close row spacings, with its potential for higher yields, cannot become an accepted practice.

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