SUNFLOWER RESEARCH : PROGRESS REPORT 1972

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Sunflower research in the Canada Department of Agriculture is centered at the Morden Research Station. Four of the professional staff have a total input into sunflowers of about 2.5 man years. Weed control, pathology, seed quality and breeding for improved yield are receiving attention.

BREEDING

The emphasis for improving yield is on material which matures as early as Krasnodarets. The southern part of the prairie provinces, Manitoba, Saskatchewan and Alberta, is the main region of potential production. Most of the Canadian production prior to the introduction of Krasnodarets was in the Red River Valley of Manitoba. This area has greater precipitation and higher temperatures than the remainder of the southern prairies and can mature varieties such as Peredovik. However, in relation to the remainder of the prairies it is a small area and it is felt that programs in the United States can provide improved varieties at the Peredovik range of maturity.

Development of hybrids is the main approach towards improvement of yield. Both to crosses and single crosses are being examined. The inbred lines are produced by conventional, self-pollination of selected plants in progenies originating from open-pollinated varieties, controlled crosses or synthetic pools of germ plasm. About five plants per progeny are selfed. When the progeny appears uniform for agronomic characters, the line is assigned a CM number and tests for general and specific combining ability follow. The lines of desirable combinations are being converted as rapidly as possible to forms which will permit use to the cytoplasmic sterile-fertility restorer mechanism to produce commercial hybrid seed. More information on sources of fertility restoration and related details will be presented to this conference in a separate paper by Dr. Enns.

Incidental to studies of spacings of rows and populations of plants, a variety x population interaction has been noticed. This observation suggests that potential new varieties should be tested at several levels of plant populations.

Coincident with the development of inbred lines from the cultivated type of sunflower, resistance to disease, particularly Verticillium wilt and rust, is being extracted from wild collections of Helianthus annuus L. The geographical range over which resistance has been found, plus the fact that fertility-restoring capability has been located in at least two widely separated locations indicates that the wild sunflower of the central plains of North America is a huge, valuable pool of germ plams. This

pool has existed in spite of cultural practices aimed at controlling the weed since the inception of commercial agriculture in the area, and the existence for about 25 years, of selective herbicides capable of destroying sunflowers. Seemingly undiminished masses of the weed remain. In contrast to cries from breeders in some other crops on the extinction of sources of wild germ plasm, the sunflower breeder is fortunate.

OILSEED QUALITY

Each oilseed crop has certain quality characteristics that makes it distinctive from other oilseed crops. However, there is enough variability within chemical constituents of each crop to make manipulation of quality possible.

Investigations are underway to determine what factors constitute sunflower seed quality and which of these can be modified or improved to expand the usefulness of this crop.

The fatty acid composition of sunflower oil is readily modified by inbreeding and selection. Sunflower genotypes with ranges in oleic acid of 8 to 68 % and linoleic acid of 17 to 88 % have been developed. Selections with high and others with low content of oleic acid are being grown under diverse environments to determine the genotype x environment interactions and to examine the economic potential of these distinctive oils.

Single plants selected in inbred material originating from the World Collection have been analysed for content of non-neutral oil. This assay gives a general indication of refining efficiency. The non-neutral or polar lipid fraction contains phosphatides, free fatty acids, waxes, etc... which are traditionally discarded or sold at a low price. The material tested contained from 0.3 to 9.0 % non-neutral oil. Under western Canadian conditions, commercial varieties normally contain 2 to 4 % non-neutral oil. Studies are underway to estimate the heritability of this character and analyse current breeding lines to anticipate the levels in potential varieties.

Discoloration of the meal during extraction of protein using alkali is thought to be caused by the oxidation of the natural phenolics in sunflower meal. Analysis of oil-free meal from whole seeds of the above World Collection revealed a range in chlorogenic acid of 0.75 to 3.25 mg/g. However, even the meal from the lines with the lowest level of chlorogenic acid discolored in the presence of alkali. Selection for lower levels will continue.

The tall and weak growth of sunflower plants in the greenhouse during winter was reduced by 40 % to 50 % by the application of the growth retardant succinic acid 2,2-dimethyl hydrazide (Alar). This chemical had little adverse effect on fertility or oil and seed quality. Its dwarfing effect is also useful in working with the crop in chambers with limited height.

Examination of additional quality components including, ultimately, the spectra of amino acids will be undertaken to anticipate changes in market potential and help to maintain the sunflower seed as a premium product.

DISEASES

Continuing surveys show that disease is one of the main limiting factors in Canadian sunflower production. The 1971 season produced the most serious outbreak of Sclerotinia root rot to date. Cropping history suggests that the increased incidence of this root rot is associated with the increasing prevalence of the rapeseed crop. Search for tolerance to this disease is being increased. The 1971 season also saw marked injury due to root rots by Rhizoctonia and Pythium spp. causing premature ripening.

The inbred line CM 144 has shown resistance to Verticillium in a field nursery heavily infested with the pathogen. A few years ago this resistance appeared to "break down" in this nursery. Study of the situation revealed another pathogen, initially ascribed to Cephalosporium sp. (Proc. Fourth Inter. Sunflower Conf. 1970 - p. 166) and now identified as Phialophora sp. In the investigations Koch's postulates were fulfilled. A similar disease of carnation is caused by P. cinerescens. The new disease, being termed

"yellows", is systemic. It has been found in disease nurseries and in commercial fields in Manitoba, but it is not widespread and is not a serious deterrent to sunflower production at present. Lines in the field nursery where the disease was first observed have shown resistance to it and this resistance has been confirmed under controlled conditions. The genetics of resistance is being studied.

Downy mildew (Plasmopara halstedii) was uniformly distributed in an experiment testing seven dates of seeding. The cultivars Krasnodarets and Peredovik were seeded at a rate to provide 120 plants per cultivar in each of 4 replicates. The two cultivars were equally susceptible and the combined data show that the number of systemically infected plants ranged from 0.3 % in the earliest to 30.2 % in the latest planting (Table 1). Earlier plantings exposed to more frequent attacks by the pathogen than later plantings, nevertheless showed fewer infections and were the more resistant. It is concluded that plants become resistant to infection when they pass the seedling stage. The amount of infection is positively associated with the amount of rainfall during the susceptible seedling stage (Table 1) assumed to extend from one day before seeding to three days after seeding. Temperature as judged by degree days above 5.5°C in the susceptible period is likely also an important factor because it will affect the speed of growth of plants, as well as the production of infective propagules by the pathogen and the infection process itself.

Plants were classified as "missing" when no trace of them could be found. The number of missing plants (Table 1) ranged from 2.1 % to 28.5 % depending on the seeding date. A highly significant ($P = 0.99$) positive correlation coefficient of 0.54 existed between the number of downy mildew plants and missing plants. Downy mildew was the only disease recognized in the test, and the data suggest that Plasmopara halstedii also caused damping-off and seedling blight. The pathogen was reported as an incitant of damping-off in sunflowers by Sackston (1). It could be that the prevalence of downy mildew is underestimated when only visible plants with systemic infection are counted.

Table 1 - Percent plants with downy mildew and missing plants in sunflowers seeded at different dates, and rain and degree days in the susceptible period from 1 day prior to 3 days after seeding.

Date of seeding	% Plants		During Susceptible Period	
	Downy mildew	Missing	Rain (mm)	Degree-days (C)
May 14	0.3	7.2	7.4	40.6
May 21	1.3	2.1	12.9	21.7
May 28	2.1	14.1	0.0	48.9
June 3	5.4	8.2	8.1	69.4
June 7	6.4	13.4	19.5	50.6
June 11	12.2	28.5	43.5	73.9
June 15	30.2	20.8	30.9	72.8

WEED CONTROL

Farmers in most of the Canadian prairies grow wheat, barley or oats as their sole crops. Those

(1) W.E. Sackston, Can. J. Bot. 46 : 5-10. 1968.

who have commenced growing sunflowers in Saskatchewan and Alberta in the past two or three years do not have machinery for producing the crop in the conventionally spaced rows. Instead they plant in "solid-seeding" which means the rows are spaced at 30 cm or less. Methods for controlling weeds in such plantings are required.

The herbicides now available effectively control Setaria viridis and Echinochloa crusgalli at low doses but higher rates, which make the costs high in relation to the value of the crop, are required for controlling common broadleaved weeds and checking the development of wild oats (Avena fatua). Further these herbicides do not control cruciferous weeds. Therefore, combinations of low doses of the herbicides with harrowing, which is a cheap tillage operation, were investigated.

In the tests populations of 53.800 plants per hectare in rows spaced 96 and 30 cm apart were treated with EPTC at 2.24 kg/ha and trifluralin at 0.56 kg/ha followed by one harrowing after emergence. The main weeds were Setaria viridis and annual Cruciferae. The herbicides reduced the grass and broadleaved weeds by 99 % and 80 % respectively. In another year trifluralin alone at 1.12 kg/ha or at 0.56 kg/ha in combination with one harrowing reduced the dry matter of weeds at harvest by 70 % to 80 %. S. viridis and E. crusgallii with annual Cruciferae were again the main weeds. In both years harrowing alone reduced the weeds by 50 %. Thus the combination of light applications of herbicides and harrowing after emergence holds promise of effectively controlling weeds in sunflowers in closely spaced rows.

In summary, the breeding program for improved yield is centered on earlier maturing types and use of the cytoplasmic sterile-fertility restorer mechanism to produce hybrids. Studies in quality show a wide range of genotypes with respect to oil quality. There is increasing evidence that the wild annual sunflower over North America is a huge persistent pool of germ plasm containing useful genes.

Disease and weeds remain two limiting factors in production. Improved understanding of the etiology of downy mildew and Sclerotinia wilt has been obtained and a new systemic vascular disease caused by Cephalosporium sp. has been identified. Combinations of light applications of herbicides and harrowing, in crops planted in narrowly spaced rows, promise effective and economical weed control.