PROGRESS REPORT

ON COLLECTION, EVALUATION AND CONSERVATION OF WILD SPECIES AND THEIR USE IN SUNFLOWER BREEDING PROGRAMMES * (1984—1986)

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I. Collecting wild sunflower species

In October 1985, dr. Dragan Škorić took part in a collecting trip to the northeastern parts of the United States. The trip was organized by ARS-USDA and dr. Škorić's part was sponsored by IBPGR. The total number of the collected accessions was 90. All of them except one are perennial.

All accessions collected with seeds are at the moment multiplied at the Institute of Field and Vegetable Crops in Novi Sad to be made available to the participants in the subnetwork in 1987. The accessions of which rhizomes were collected are being multiplied at Plant Introduction Station, Iowa State University, Ames, Iowa, USA. After the multiplication, seed samples will be distributed among the participants in the subnetwork.

II. Maintenance and multiplication of wild species

Generally, the maintenance and multiplication of wild sunflower species are fairly complicated. In our case, the seed of several accessions was immature and tended to lose viability very quickly. If not reproduced on time, these accessions are practically lost from a collection.

Most accessions, especially the parennial ones, featured a protracted period of seed dormancy. This trait in its turn lowers the viability of seeds. Several participants in the subnetwork tried different methods of increasing the viability. The results obtained in Fargo and Novi Sad in 1984 and 1985 indicated that the highest viability was achieved when seeds were soaked in water to swell, then the husk and the seed coat were removed, and the naked seed put in a medium to germinate.

The members of the subnetwork used different methods of multiplication of the wild species. The most frequent one was the pollination with a bulked mixture of pollen of a particular population or species. It was demonstrated that perennial species may be multiplied vegetatively from rhizomes and tubers.

It was found that some wild species cannot be maintained in certain European countries due to ecological inadaptability. This finding hints at the need of specialization among the participants regarding the maintenance of certain wild species. The ARS-USDA programme in Fargo includes a study of possibilities to overwinter the perennial wild species in a greenhouse. This produced very interesting results.

III. Data base for wild sunflowers

The participants in the subnetwork, in cooperation with IBPGR/ECP, prepared a list of wild species, with the basic descriptors, which is ready for printing.

IV. Determination of morphological and botanical characters in order to complete basic data on wild sunflower species

Since the 1984 meeting in Novi Sad, all participating institutions have gained considerable knowledge of the morphological and botanical traits of the available wild sunflower species. The following traits were studied : time from emergence to the flowering of the first head, flowering period, head diameter (including ray and disk flowers), disk diameter, ray number, ray length, ray width, ray color, bract number, bract length, bract width, plant height, number of leaves per plant, color of leaves, leaf length and width, seed characters, fertility of the plants, oil and protein content in seed, fatty acid composition of oil, weight of 1,000 seeds, etc. These data will contribute to the general knowledge of the wild species and it would be advantageous if they were compiled and published.

* Presented at the working meeting held in Sindos-Thessaloniki, Greece, 22—25 July 1986.

V. Interspecific hybridization between wild species and the cultivated sunflower

The largest progress between the last meeting and the Sindos one was made in the field of interspecific hybridization between wild species and the cultivated sunflower. The crossing went both ways. Each participant produced a large number of crosses. Many F_1 hybrids were found to be partially or completely sterile. The researchers in Fargo, USA, developed a method of chromosome doubling to increase the fertility of interspecific hybrids and further backcrosses with the cultivated sunflower.

Besides producing interspecific hybrids by the conventional methods, embryo culture was used when embryo abortiveness occurred in F_1 hybrids. The latter technique was used in Fargo (USA), Fundulea (Romania) and Novi Sad (Yugoslavia).

The participants in the subnetwork produced a large number of backcrosses with the cultivated sunflower and started several cycles of inbreeding to produce inbred lines possessing good combining ability. This part of the programme has the largest practical significance. It will shortly bring significant increases in the genetic variability of the cultivated sunflower which will in turn make room for the development of more productive hybrids.

VI. Identification and evaluation of new male sterile cytoplasms and restorer genes

An important contribution made by the subnetwork is the discovery of new sources of *cms*. Dr. H. Serieys (Montpellier, France) found a new *cms* source in a cross between *H. petiolaris* ssp. *fallax* and the cultivated sunflower. He also found that the restoration of fertility in F_1 for that *cms* source was controlled by two complementary dominant genes.

In Fundulea, Romania, a new source of *cms* was found in a cross *H. annuus* ssp. *texanus* × cultivated sunflower.

In Novi Sad, two different sources of *cms* were found in crosses between *H. annuus* and the cultivated sunflower.

Five restorer genes for *cms* were found in various wild species.

A study currently in course in Pisa, Italy, may produce new *cms* sources from crosses between *H. argophyllus, H. bolanderi* and *H. debilis* on one side and the cultivated sunflower on the other.

VII. Use of wild species in breeding for drought resistance

Several participants in the subnetwork conducted extensive studies aimed at the discovery of sources of resistance to drought in wild sunflower species (Montpellier, France ; Fundulea, Romania ; Pisa, Italy ; Bushland, TX, USA ; Córdoba, Spain ; General Toshevo, Bulgaria).

H. argophyllus is the most frequently used wild species. Some important breakthroughs were made. A very important study was undertaken in France on the definition of most suitable parameters for the evaluation of drought resistance in interspecific hybrids (percent of dry leaves 3 weeks after flowering in dry conditions, foliar transpiration level, photosynthetic activity, etc.).

VIII. Tests of wild species to discover sources of genetic resistance to diseases and insects

All participants in the subnetwork have developed large programmes on the determination of sources of resistance to diseases and pests in wild sunflower species. Considerable progress was made and important results were obtained in the last three years.

Sclerotinia sclerotiorum. Sources of resistance to this pathogen were most extensively searched out.

In France, 25 ecotypes of wild *H. annuus* were used for that purpose. Increased tolerance to the attacks on floral buds, stems, roots and heads were achieved on the basis of interspecific hybrids.

At Fundulea, Romania, interspecific hybrids *H. argophyllus* × cultivated sunflower and *H. annuus* ssp. *annuus* × cultivated sunflower are used in the production of synthetic possessing an increased tolerance to *S. sclerotiorum.*

A notable progress on the discovery of tolerance to *S. sclerotiorum* was achieved in Pisa, Italy, by using interspecific hybrids between *H. debilis,* and *H. bolanderi* on one side and the cultivated sunflower on the other.

Studies conducted in General Toshevo, Bulgaria, showed that certain degree of tolerance to *S. sclerotiorum* was present in *H. eggerttii, H. strumosus, H. laevigatus, H. hirsutus, H. smithii, H. mollis,* etc.

Studies conducted in Novi Sad, Yugoslavia, indicated that the highest degree of tolerance to *S. sclerotiorum* existed in interspecific hybrids made on the basis of certain *H. tuberosus* ecotypes.

Regarding the determination of sources of resistance to other diseases, most extensive studies were conducted in Novi Sad. The following results were obtained :

— It is very probable that sources of resistance to *Diaporthe-Phomopsis helianthi* are present in *H. tuberosus, H. rigidus.* A large number of lines resistant to the pathogen was made.

— It appears that there exists a source of resistance to *Alternaria helianthi* in a *H. tuberosus* ecotype (NS-2) collected in the vicinity of Novi Sad.

— Resistance to *Verticillium dahliae* was in *H. tuberosus*.

— Highest degrees of resistance to *Phoma* sp. in field conditions were detected in *H. resinosus, H. hirsutus, H. occidentalis, H. eggerttii* and *H. decapetalus*.

— Resistance to *Puccinia helianthi* was observed in several wild species.

— In an inoculation test for resistance to *Plasmopara helianthi*, *H. tuberosus* and *H. rigidus* ecotypes displayed full resistance to the pathogen.

— The highest degree of resistance to *Erysiphe cichoracearum* was found in *H. divaricatus*.

At General Toshevo, Bulgaria, high degree of tolerance to *Orobanche cumana* was found in *H. debilis, H. petiolaris,* and *H. praecox*.

The testing of wild sunflower species for resistance to insects is conducted only in Bushland, TX, USA. Sunflower species were evaluated for resistance to a stem weevil, *Cylindrocopturus adspersus* (Le Conte). In greenhouse tests, foliar feeding by *C. adspersus* adults was significantly lower in 11 of 18 annual and in 13 of 34 perennial species than in the commercial hybrid 894.

IX. Cytogenetic studies on wild sunflower species

At Fundulea, meiosis was studied in the wild species *H. rigidus, H. mollis H. bolanderi, H. divaricatus, H. tuberosus,* and *H. strumosus* as well as in the hybrids *H. rigidus* × cultivated sunflower and *H. bolanderi* × cultivated sunflower.

In Novi Sad, meiosis was analysed in a large number of wild species and interspecific hybrids with the cultivated sunflower. In addition, pollen fertility was analysed in the majority of the wild species and their F_1 hybrids with the cultivated sunflower.

The ARS-USDA programme conducted in Fargo produced some interesting results. Interspecific hybrids obtained by pollinating collections of diploid perennial species of *H. gracilentus, H. pumilus, H. arizonensis, H. occidentalis* and *H. floridanus* with cultivar P21 were evaluated for meiotic irregularity, pollen stainability and backcross seed setting. Meiotic data suggested that these perennial species differed from P21 by 2 to 4 paracentric inversions and had 2 to 7 chromosomes involved in reciprocal translocations. These meiotic irregularities may have contributed greatly to the hybrid sterility and the low backcross seed set.

X. Salt tolerance

In Fargo, the wild species H. *paradoxus, H. debilis* and a race of *H. annuus* (= *H. jaegeri,* Heiser), native to salty desert areas were grown in Hoagland's solution supplemented with increasing amounts of NaCl. *H. paradoxus* was highly salt tolerant with some plants surviving at 1,300 mM. Salt tolerance was highly dominant in F_1 (*H. paradoxus* × cultivated H.a).

XI. Use of wild sunflower in breeding for increased oil and protein yield and quality

Most participants in the subnetwork studied the content of higher fatty acids in oil of wild species and their interspecific hybrids with the cultivated sunflower (Bushland, Fundulea, Pisa, Novi Sad). The studied wild species were found to differ largely regarding that trait. Important differences were observed in protein content in seed of the wild species. In Bushland, sunflower plant parts (stem, leaf, head), were analysed for the content of crude proteins. In the vegetative phase, *H. debilis* ssp. *cucumerifolius* had the highest content of crude proteins in leaves, 231 g/kg.