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REPORT ON THE STATUS OF SUNFLOWER GERMPLASM IN THE U.S.

Sunflower is one of the four most important annual oilseed crops grown for edible oil. It is also the second largest hybrid crop grown in the world. U.S. production in 2003 was estimated at 2.4 million acres with an estimated total economic impact of $1.8 billion. The ultimate goal of the entire sunflower germplasm effort is the enhancement and development of superior germplasm for the producer to ensure a continued and viable industry.

PRESENT GERMPLASM ACTIVITIES

The North Central Regional Plant Introduction Station, Ames, Iowa has the responsibility for the maintenance and distribution of the sunflower germplasm collection. Evaluation of the collection is being conducted by the Plant Introduction Station, the Agricultural Research Service (ARS), State Universities/Experiment Stations, and various cooperators around the world depending on the expertise and environments needed to evaluate for various characteristics.

STATUS OF CROP VULNERABILITY

Sunflower hybrids grown in the U.S. are based on a single male-sterile cytoplasm derived from wild *Helianthus petiolaris,* which makes them extremely vulnerable to many insect and disease pests. One of the potential threats to the sunflower crop could be the introduction of new races of pathogens. Rust (*Puccinia helianthi*), and downy mildew (*Plasmopara halstedii*) are pathogens that have evolved with the crop in the US. New races are continually evolving in the US and other countries, so the impact of the introduction of new races from outside of the US is unknown, but would be expected to be just as destructive and to have similar infection mechanisms resulting in the destruction of plants. Broomrape [*Orobanche cumana (cernua*)] is a parasitic weed that attacks sunflower in parts of Europe and Asia. This would probably be one of the greatest potential threats to the US sunflower crop. The parasite has been present in other parts of the world for a number of decades, but has not been found in the US. Its impact on the US sunflower industry is unknown. The parasite is of concern, but at the present time we do not understand the infection mechanism and why it is not present in the US. There have not been any extraordinary precautions taken to prevent the spread of this parasite from being introduced into the US. The seeds are very small (almost like dust) and could easily be transported with many different types of seeds traded in commerce. Other species of *Orobanche* exist in the US, but do not attack sunflower. Albugo rust (white rust) is another pathogen which has existed in sunflower production areas, especially in South America, Australia, and South Africa, but has not been a problem in the US. It occurs on wild *Helianthus* species in the US. These could be a potential source of genes for resistance.

The possibility exists that Genetically Modified Organisms (GMOs) with negative human health effects could be released that could potentially contaminate sunflower production fields. This would most likely be in the area of allergens, which generally have an effect on a selected portion of the human population. GMOs with various traits from other species could also be a potential threat to the sunflower crop.

In a more general sense, weedy species of plants could be introduced as invasive weeds which could overcome native species in agricultural systems. On a global basis, there are probably herbicides that would control most weeds.

As with the pathogens, insects evolved with the wild and cultivated sunflower crop in the US. This has resulted in large pest complex for the cultivated sunflower crop in the US. There are very few countries outside of the US that have severe insect problems. The likelihood that insects could be introduced in to the US exists, but it is unlikely they would have a significant impact since we already have the major sunflower insect pests.

The diversity of the wild species is an invaluable resource for genes to protect the cultivated crop. Since most of the wild species are native to US, destruction of the many populations spread all over the US is highly unlikely. The present gene bank contains a good representation of the available genetic diversity. However, many of the accessions have not been evaluated for specific traits, but could be mobilized with a substantial effort. Several interspecific and elite germplasms are available from USDA-ARS sunflower projects as the need arises. The use of biotechnology to move genes from other species into sunflower could be another source of germplasm to protect the crop against various pests. Use of the OX-OX gene from cereals to improve *Sclerotinia* tolerance, incorporation of antifungal proteins for resistance to the major diseases, and the use of BT or similar genes for insect protection are a few examples.

STATUS OF CROP SECURITY

The sunflower germplasm collections, both cultivated and wild species, represent a wealth of genetic diversity for improving and protecting the cultivated sunflower. With heightened awareness of security threats, the germplasm in the gene banks and at other locations is restricted in access and protected.

GERMPLASM NEEDS: COLLECTION

Sunflower is unique in that it is one of the four crop species which has its progenitor species native to the U.S. The genus *Helianthus* contains 51 species and 15 subspecies which offer genetic diversity for many agronomic characteristics for the improvement and expansion of cultivated sunflower. The present germplasm collection is representative of all extant species and subspecies, but does not come close to adequately representing the potentially available genetic diversity that needs to be conserved. Continued efforts are needed to strive toward collecting as many populations of all species as are feasible. Since Mexico has not been systematically collected, this area represents a wealth of genetic variation and should be collected as soon as possible. Due to the persistent *Sclerotinia* disease complex, emphasis will be put on collecting selected perennial species in the U.S. Herbicide resistance especially to the imidazolinone chemistry is more prevalent in the wild *H. annuus* populations that previously thought. Collection of wild *H. annuus* and screening to currently used herbicides (particularly Triazine chemistry) could have a major impact on the sunflower industry. In the future, collections will be based on species-specific needs, instead of collecting all species from a general area.

GERMPLASM NEEDS: MAINTENANCE

The seed multiplication program is the most valuable link of the *Helianthus* germplasm program. There is a critical need to regenerate and replenish wild *Helianthus* seed stocks. The number of accessions waiting to be regenerated is large. Until accessions are regenerated, this produces a bottleneck in the evaluation process. Due to the large number of wild perennial accessions waiting to be regenerated, and the difficulty in obtaining an adequate number of plants for regeneration, in situ conservation should be considered as a maintenance option.

GERMPLASM NEEDS: EVALUATION

An evaluation plan for disease and insect pests listing priorities for evaluation is in place. Evaluation information obtained to date has been a valuable addition to the GRIN system in characterizing the value of germplasm accessions. There is a continuing need to evaluate more accessions as pest races change and to evaluate additional species populations and accessions. Priority descriptors of the accessions of the wild species continue to be collected in an effort to make the information available in the GRIN system. There is a particular need for additional funds to evaluate the wild perennial species for *Sclerotinia* stem and stalk rots, and to screen wild species for *Rhizopus* head rot resistance, a persistent and increasing problem in the High Plains.

GERMPLASM NEEDS: ENHANCEMENT

Increasing genetic variability of cultivated sunflower is critical for ensuring survival of the crop. An enhancement plan is in place for the inclusion of wild *Helianthus* species into a domesticated background utilizing embryo rescue and other techniques. The plan includes interspecific gene transfer, germplasm pool development, and development of cytoplasmic male-sterility and fertility restoration programs. Based on current needs, crossing wild perennial species into the cultivated background is necessary since many of the perennial species have shown promise as potential sources of genes for resistance to some of the persistent pests. There is a critical need to utilize the molecular characterization techniques available to facilitate the difficult task of transferring genes from the wild perennial species into cultivated sunflower.

RECOMMENDATIONS

The priority needs and actions for the *Helianthus* germplasm collection are as follows:

1. Fund an exploration to explore the wealth of genetic variability in the wild species of the US and Mexico.

2. Provide funding to the Plant Introduction Station to build a greenhouse complex to increase the number of accession regenerations that require special conditions.

3. Provide $100,000 of permanent funding for evaluation of wild annual and perennial species, interspecific, and exotic germplasm for resistance to the *Sclerotinia* disease complex and for *Rhizopus* head rot resistance.

4. Provide funding for a Category I molecular biologist to facilitate the use of wild species for the improvement of cultivated sunflower.

5. The Committee strongly supports the activities of the NPGS site at Parlier, CA as an alternate grow-out site and encourages the continued cooperation utilizing it as an alternate site for difficult-to-regenerate sunflower accessions.

6. The Committee recommended exploring the opportunity and the possibilities of integrating existing databases into one “unified” database, Of particular interest are the bioinformatics databases and how and if they could be interfaced with the GRIN database.