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COLLECTING WILD SUNFLOWER GERMPLASM FROM THE CENTRAL GREAT PLAINS OF U.S.A.

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One hundred forty-four accessions representing eight wild species of sunflower were collected from 124 sites in diverse habitats of the Central Great Plains of United States of America during September, 1991. A wide range of in-situ *variability was observed for various morphological and economic characters including stress tolerance. The populations of* H. annuus *were observed to be highly variable and widely distributed in different habitats in the seven states surveyed.* Helianthus pumilus *which has low variability and limited distribution, was represented by only one sample in Colorado.* Helianthus petiolaris *ssp.* petiolaris, *the only source species of cytoplasmic male sterility was found, widely distributed and along sandy roadsides of highways.* Helianthus pauciflorus *ssp.* subrhomboideus, H. nuttallii, H. grosseserratus *and* H. tuberosus *were sparsely distributed in some specific habitats. Other species such as* H. hirsutus, H. salicifolius *and* H. pauciflorus *ssp.* pauciflorus *occur in this area but were not collected due to immature stage of seed growth.*

The sunflower (*Helianthus annuus* L.) was first domesticated in the central parts of United States (Sindagi and Virupakashappa, 1986). The Central Great Plains of USA are still the centre of diversification of several wild species of sunflower (Rogers *et al.*, 1982). The wild species are important sources of genes for resistance to various abiotic and biotic stresses including major pests and

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diseases, the main causes of instability in crop production. Some wild species are also donors for other useful characters like dwarfness and male sterility, the essential prerequisites for heterosis breeding which is now emphasized for further increase in productivity. Many wild species are either not available or are under-represented in the National Germplasm System to reasonably match the potential genetic diversity available. Therefore, these valuable raw materials for plant breeders deserved to be collected and conserved before their erosion due to the destruction of habitat by men and animals. Accordingly, a joint exploration, sponsored by INDO-US PGR Project was undertaken by a team consisting of scientists from National Bureau of Plant Genetic Resources, India, United States Department of Agriculture, Agricultural Research Service and Institute of Field and Vegetable Crops, Yugoslavia to increase genetic diversity of the wild sunflower species from 7 states in Central Great Plains of USA. The results of the exploration are reported in this paper.

MATERIALS AND METHODS

The states of Montana, Wyoming, Nebraska, Colorado, Kansas, North and South Dakota, comprising the Central Great Plains of USA, were explored from 4 to 18 September, 1991, covering a distance of about 7400 km. The area explored lies between 38° to 49° North latitude and 94° to 144° West longitude (Fig. 1). The sandy, sandy-loam, clay, clay loam, stony and gravelly soils of black, grey, brownish to yellowish colours were observed in this region. The seed samples of 144 randomly selected populations representing various species were collected from 124 sites in different habitats ranging from dry sand dunes, marshy lands, roadside ditches, cultivated fields, waste/pasture lands, river beds, sandy and stony hills. Depending on the population size, 25 to 65 randomly selected plants were sampled in each population to record *in-situ* variability for plant height, number of branches, branching pattern, number of heads per plant, head size, head-clipper damage and incidence of rust alongwith other distinct morphological characters. One head each was collected to obtain additional seeds from the sampled population for further *ex-situ* studies. Common collector's numbers were assigned to each sample to facilitate easy retrieval and independent assignment of plant introduction (PI) (USA), Exotic Collection (EC) (India) and Introduction (I) (Yugoslavia) numbers for conservation and utilization in respective countries.

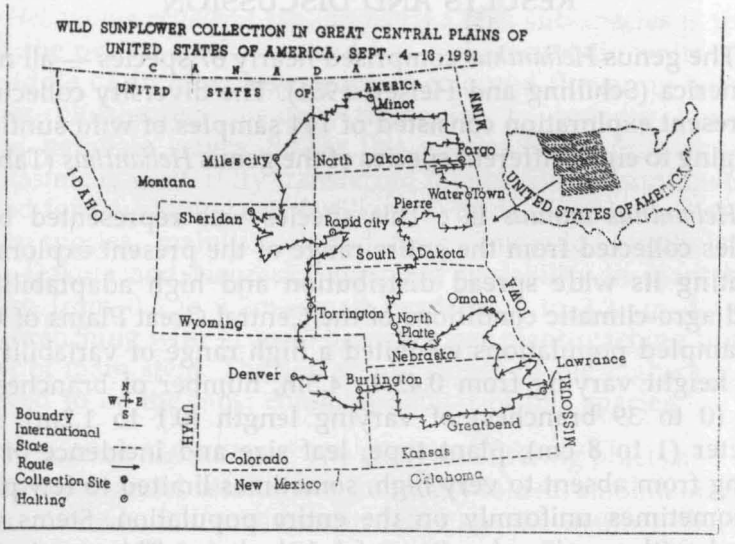

Fig. 1. Route followed and area explored for collection of wild sunflower germplasm.

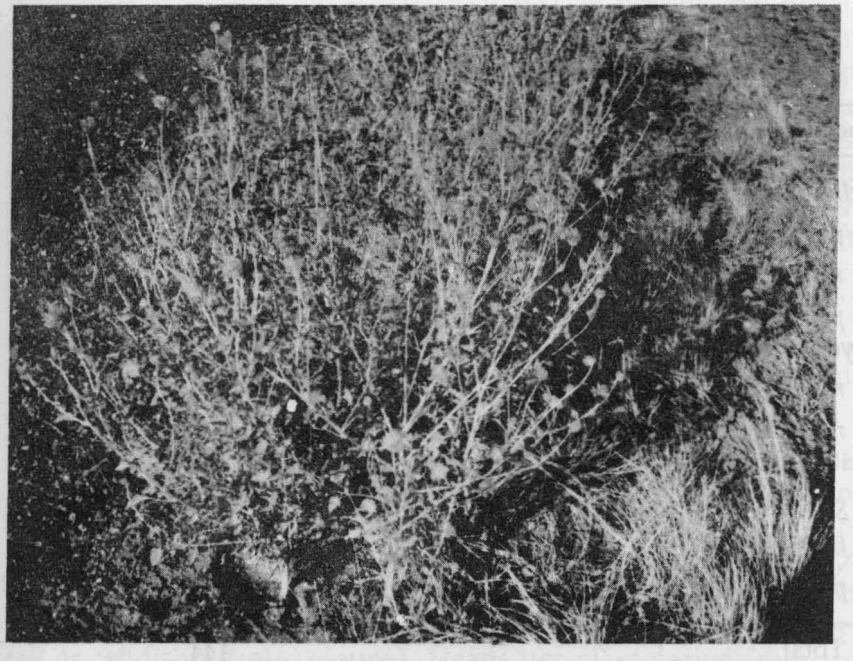

Fig. 2. *Helianthus petiolaris* ssp. *petiolaris* — growing in wild habitat near turtle lake, North Dakota.

RESULTS AND DISCUSSION

The genus *Helianthus* comprised nearly 67 species — all native to America (Schilling and Heiser, 1981). The diversity collected in the present exploration consisted of 144 samples of wild sunflower belonging to eight different species of the genus *Helianthus* (Table 1).

Helianthus annuus L. : This species was represented by 83 samples collected from the entire range of the present exploration, indicating its wide spread distribution and high adaptability to varied agro-climatic conditions of the Central Great Plains of USA. The sampled populations exhibited a high range of variability for plant height varying from 0.45 to 4.5m, number of branches per plant (0 to 39 branches) of varying length (0.1 to 1.2m), head diameter (1 to 8 cm), plant type, leaf size and incidence of rust varying from absent to very high, sometimes limited to few plants and sometimes uniformly on the entire population. Stems were covered with varying densities of bristly hairs. This species was observed to be the most diverse geographically, morphologically and habitat wise.

Table 1 : Diversity in wild species of sunflower from Central Great Plains of USA

Species	Number of collections
Helianthus annuus L.	83
H. petiolaris Nutt. ssp. *petiolaris*	25
H. maximuliani Schrad.	15
H. pauciflorus Nutt. ssp. *subrhomboideus* (Rydb) Spring & E. Schilling	8
H. nuttallii T. & G. ssp. *nuttallii*	4
H. nuttallii T. & G. ssp. *rydbergii* (Britt.) Liong	3
H. grosseserratus Martens	3
H. tuberosus L.	2
H. pumilus Nutt.	1
Total	144

Helianthus petiolaris ssp. *petiolaris* : This sub-species is usually called the prairie sunflower and has a characteristic white spot in the middle of an otherwise purplish coloured flowering head and shining bluish-green ovately triangular to broadly lanceolate shaped petiolate leaves. So far this species is the only source of cytoplasmic male sterility transferred into cultivated sunflower and utilized for developing self fertilized hybrids. Twenty five samples of this species, mainly collected from Colorado, North Dakota, South Dakota and Nebraska exhibited variability in plant height ranging from 0.3 to 1.2m, small heads of 1 to 2.3 cm diameter, basal branching with 11 to 15 branches per plant reaching upto the height of main stem. The soft sandy slopes of the highways were observed to be the most common habitat of this species.

Helianthus maximiliani : The elongate tapering bracts and slight green to grey green, sessile, longitudinally folded, smooth margined leaves covered with soft whitish hairs are the distinct characters of *H maximiliani*, fifteen samples of this species were collected from North and Sourth Dakota. Two distinct ecotypes were observed. The longitudinally folded leaves forming undulating furrows with occasional occurence of 1-2 okra-shaped leaves in the middle portion of plant, is the characteristic feature of this ecotype, endemic to North and South Dakota. The other type with leaves forming plain furrows is common in the rest of the distributional range of the species. Populations of *H. maximiliani* exhibited variability for plant height ranging from 0.6 to 1.4m, number of heads from 1 to 25 per plant with disks averaging from 1.5 to 2.5cm in diameter. Leaves were numerous mostly alternate, lanceolate with smooth to sometimes slightly serrated margins. Bracts were narrowly lance-shaped, loose and conspicuously protruding the disk. Generally few to several secondary branches were present on the upper half of the plant, but sometimes primary branches also occur on light green to light red coloured thin stiff stems.

Helianthus pauciflorus ssp. *subrhomboideus* : Eight samples of *H. pauciflorus* ssp. *subrhomboideus* were collected from North and South Dakota. The plants were erect with reduced height varying from 30 to 90cm., bearing 8 to 12 opposite, sessile to petiolate (1cm), lustrous green, rough and tough uprightly-oriented leaves. Bracts were narrowly ovate and 8 to 10mm long. Disk florets were deep red or reddish-purple coloured. Heads per plant varied from 1 to 4. The populations exhibited apparent resistance/tolerance to

drought, head clipper/stem borer and other sucking pests and rust coupled with a very good plant type to facilitate high plant density.

Helianthus nuttallii : Of the reported 3 sub-species of *H. nuttallii*, *H. nuttallii* ssp. *nuttallii* and *H. nuttallii* ssp. *rydbergii* were distributed in the area surveyed and represented by 4 and 3 population samples respectively (Table 1). The populations of *H. nuttillii* ssp. *nuttallii* generally grew in marshy lands, near ponds or lakes in association with cat tails (typha). Plant height varied from 1.3 to 1.5 m with hairless to bristly stem and occasional appressed branches on the upper half; mostly alternate lanceolate leaves with dorsal side moderately to densely covered with bristles; 2 to 25 small heads per plant with disks ranging from 1.5 to 2cm. in diameter. The sub-species *rydbergii* grows in dry to wet soils. The plants varied from 0.6 to 1.6m in height with mostly smooth stem. Leaves are mostly alternate to all opposite, pale green in colour, nearly smooth to slightly serrated margins. Bracts have fine hairs on margins, nearly hairless or with soft hairs on back.

Helianthus grosseserratus: This species may be distinguished from other species by its smooth stem, flat serrated and petiolate leaves with lower surface covered with soft woolly hairs. The tough conopy with its dark green colour, lanceolate shape, medium size, upright orientation and balanced distribution on the stem, appears to be highly desirable for increased photosynthetic efficiency, high plant population and resistance to drought, diseases and particularly sucking pests, an essential features required in modern cultivars. The populations of this species exhibited variability for plant height ranging from 1 to 1.6m, branching mostly absent on the lower two-third of stem but with a few appressed secondary branches commonly on the top portion. The flowering disks averaging 1.5 to 2.5cm, in diameter, and narrowly lanceolate bracts exceeding the disks. The populations collected were free from all the major disease and pests including rust, *Phomopsis*, head clipper and sucking pests.

Helianthus tuberosus : The most common features of the Jerusalem artichoke or artichoke sunflower (*H. tuberosus*) is the production of slender rhizome terminally enlarging into tubers. The tubers are rich in sugars and starches. Though it was commonly distributed in Kansas and Nebraska, only 2 populations were sampled due to its late maturity. The plants varied in height from

1 to 1.7m, stems were bristly to gritty mostly branched above. Leaves were opposite below and alternate above to all opposite, oval to broadly lanceolate, ventral side gritty and dorsal softly pubescent, and serrated to entire margins. Usually several small head with disks measuring about 2 to 4cm, in diameter were present. Both populations sampled were free of diseases and pests especially rust and head clippers.

Helianthus pumilus: This species is found in dry, often rocky soils. Only one sample of this species was located and collected from a small rocky hillock in Colorado. The plants in the population varied from 30 to 40 cm in height and had single to branched rough stem, ovate to lanceolate, opposite, rough and scabrous leaves of ash-green colour with smooth to slightly serrated margins tapering towards petioles of varying length up to 1cm. The plants had very small heads with disks measuring about 1cm. in diameter. The bracts were lance shaped, pointed to sharp tipped, shorter than or equal to disk and slightly to densely covered with white hairs on back and margins. In mixed populations of *H. pumilus* and *H. petiolaris*, fully mature, diseases and pest free plants with intact lustrous foliage were seen under an extremely dry habitat in the *H. pumilus*, whereas the plants of *H. petiolaris* showed symptoms of damages by pest and diseases and drought. This indicated some built-in mechanism of resistance to biotic and abiotic stresses present in *H. pumilus*. Other species such as *H. hirsutus. H. salicifolius*, and *H. pauciflorus* ssp. *pauciflorus* were not collected due to their immature stage but were located in an area with high population concentrations near Lawrence, Kansas.

The germplasm, so collected, has been deposited at the USDA-ARS, National Plant Germplasm System, Regional Plant Introduction Station, Ames, Iowa, National Bureau of Plant Genetic Resources, New Delhi, India and Institute of Field and Vegetable crops, Novi Sad, Yugoslavia for evaluation, enhancement and conservation. Since hypothesized origin of wild and cultivated sunflower is from the Central Great Plains, wild populations from this area have potential for increasing genetic variability of cultivated sunflower. The addition of 144 wild population samples to the germplasm collections will greatly increase the available genetic diversity and preserve it for future improvement of cultivated sunflower before its natural habitat is destroyed.

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REFERENCES

Rogers C.E., T.E. Thompson and G.J. Seiler. 1982. Sunflower species of the United States. Nat. Sunflower Assoc. Bismarck., N. Dakota 58502

Schilling, E.E. and C.B. Heiser. 1981. Intrageneric classification of *Helianthus* (Compositae). *Taxon* 30: 393-403

Sindagi, S.S. and K. Virupakshappa. 1986. Sunflower, ICAR, New Delhi. 36p