Prebreeding and Genetic Enhancement of Cultivated Sunflower (*Helianthus annuus* L.)

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Abstract

The production and productivity of a sunflower crop is adversely affected by different biotic and abiotic stresses, and reliable genetic sources with high levels of resistance or tolerance to biotic (SND, Leaf curl virus, Alternaria and powdery mildew) and abiotic stresses (drought and salinity) are not available in the cultivated sunflower. In contrast, wild *Helianthus* species having potential to thrive well under climatic extremes and harbour many useful genes for exploitation in breeding programmes. Pre-breeding activities using promising wild sunflowers and popular cultivars have been initiated at the ICAR-Indian Institute of Oilseeds Research, Rajendranagar, Hyderabad, to increase the frequency of useful genes, wider adaptability, and to provide a broad genetic base. Towards this goal, we have used six accessions of *Helianthus annuus* (wild) (ANN-232, ANN-243, ANN-1270, ANN-1272, ANN-1486 and ANN-1624) for improvement in seed yield and oil content; four accessions of silver leaf sunflower *H. argophyllus* (ARG-153, ARG-1317, ARG-1575 and ARG-2126) for incorporation of tolerance to powdery mildew, downy mildew, drought and leaf hopper; two accessions of *H. praecox* (PRA-1823 and PRA-1154) for powdery mildew tolerance; two accessions of *H. debilis* (DEB-369 and DEB-691) for powdery mildew resistance and high seed yield, and one accession of *H. petiolaris* (PET-1910) for seed yield and oil content. Wider variability was observed for cytomorphological traits besides disease reactions within species and between species in interspecific hybrids (F_1s), BC_1F_1, BC_2F_1, and BC_2F_2 generations. Interspecific cross combinations with *H. praecox* (PRA-

1823) and *H. debilis* (DEB-369) were found to be resistant to powdery mildew in F_1 as well as in the advanced generations. Seed yield was reported high in combinations with *H. annuus* (wild) (91.0 g/plant), *H. petiolaris* (64.2 g/plant), *H. debilis* (73.0 g/plant) and *H. argophyllus* (65.2 g/plant). The highest oil content (38.9%) was reported in combination with *H. praecox* (PRA-1154). Generation advancement and introgression of resistance to biotic and abiotic stresses is under way. Evaluation of a few populations for biotic stresses and yield related traits resulted in the identification of desirable introgression lines that have been shared with the All India Coordinated Research Project (AICRP) centres for use in breeding programs. Overall, prebreeding ensures a continuous supply of novel and diverse genetic variability derived from wild species in readily usable form into the breeding pipeline to develop new climate-resilient cultivars with a broad genetic base.

Key words: diploid annuals, interspecific derivatives, meiotic configurations, prebreeding, wild sunflowers

栽培向日葵(*Helianthus annuus* L.) 的前育种和遗传改良

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摘要

向日葵作物的生产和生产力受到不同生物和非植物胁迫的不利影响, 稳定的遗传来源对生物胁迫(叶卷曲病毒、斑点和白粉病)和非生物胁迫(干旱和盐度) 具有较高水平的抗性或耐受性，但栽培向日葵不具此特点。相反，野生向日葵在极端的气候条件下具有良好的生长潜力并具体很多有用基因可以用于育种中。在ICAR海得拉巴印度油籽研究所,已经启动了研究项目用一些有潜力的野生向日葵和常规品系去提高有效基因的频率，拓宽它的适应性，提供一个广泛的遗传基础。基于这一目标，我们使用6个编号分别为(ANN-232, ANN-243, ANN-1270, ANN-1272, ANN-1486 和ANN-1624)的野生向日葵，提高种子产量和含油量；4个编号为 (ARG-153, ARG-1317, ARG-1575 和 ARG-2126)的银叶向日葵用于白粉病抗性、霜霉病、抗性和叶蝉的研究；编号为(PRA-1823和PRA-1154)的向日葵用于白粉病抗性研究；编号为(DEB-369和DEB-691)的品系用于向日葵高产抗白粉病研究；编号为(PET-1910)的品系用于种子产量和含油量研究。

在种内和种间杂交种中，除病害反应外，(F_1s), BC_1F_1, BC_2F_1, 和 BC_2F_2代的细胞形态特征表现广泛变异。种间杂交组合*H. praecox* (PRA-1823) 和*H. debilis* (DEB-369) 的F_1代及后续的几代中发现抗白粉病品系。在野生品系*H. annuus* (wild) (91.0 g/plant), *H. petiolaris* (64.2 g/plant), *H. debilis* (73.0 g/plant) 和*H. argophyllus* (65.2 g/plant)的杂交中发现高产特性。报道称在与 *H. praecox* (PRA-1154)的杂交中含油量最高(38.9%)。目前正在进行加代繁殖并导入生物和非生物胁迫抗性基因。对生物胁迫和与产量相关的性状进行评估并与印度协调研究项目(AICRP)中心共享这些资源。总之，前育种项目确保了充分利用野生种中存在的新的广泛的遗传多样性，以培育适应气候变化的栽培新品种。

关键词： 二倍体一年生植物、种间杂交衍生、减数分裂构型、前育种、野生向日葵