Breeding Strategies for Incorporation of Resistance to Major Diseases on Sunflower (*Helianthus annuus* L.) in India

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Abstract

Sunflower had become one of the most important oilseed crops in the Indian economy following its introduction in the country during the late seventies. The area under cultivation had increased steeply from 0.2 m. ha in 1981-82 to 2.6 m ha in 1993-94, followed by a drastic decline since 2010 reaching 0.5 m. ha in 2014-15. While one of the prime reasons for the decline is competition from other remunerative crops like cotton, maize, soybean, and pulses, the other reason is the vulnerability of the crop to a wide range of diseases. The disease situation in India is rather dynamic and there has always been a constant threat of new diseases limiting sunflower production and productivity. In the initial years and till 1990, the major disease was leaf spot caused by *Alternariaster helianthi.* From 1997, the crop suffered from sunflower necrosis disease (SND) caused by tobacco streak virus (TSV), and from 2006 onwards, powdery mildew incited by *Golovinomyces orontii* has assumed importance. Downy mildew, which is a major disease in the tropics, is localized to a single pocket in Central India. Thus, it has been a constant challenge for the breeders to identify durable sources of resistance in cultivated and wild *Helianthus* species. Sources of resistance to *A. helianthi* were identified in diploid perennial *Helianthus* species with limited crossability success (Sujatha et al. 1997). Hence, 16 stable interspecific derivatives involving perennial species such as *H. hirsutus, H. tuberosus,* and *H. strumosus* were obtained from USDA for assessing their reaction to the pathogen and utilization in the breeding programmes.

Owing to the lack of reliable sources of resistance to TSV, transgenic events harbouring the coat protein gene of TSV were developed for conferring resistance to SND (Vasavi et al. 2018). Sources of resistance to powdery mildew were identified in diploid annual species like *H. argophyllus* and *H. praecox*, and prebreeding programmes for transfer of resistance to the cultivar background is under way (Reddy et al., 2013). The donors for powdery mildew resistance, including *H. praecox* (PRA 1823), were subjected to proteome and transcriptome profiling for identification of candidate gene(s) and key regulatory pathways governing resistance to the pathogen (Reddy et al., 2018).

Key words: biotechnological tools, biotic stresses, interspecific hybridization, wild sunflowers

印度针对主要病害的向日葵抗性育种策略

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摘要

自从 17 世纪晚期向日葵被引入印度起，向日葵就已成为印度经济中最重要的油料作物之一。1982-1982 年，印度向日葵栽培面积仅 20 万公顷；到 1993-1994 年，栽培面积已急升至 260 万公顷。自 2010 年起，向日葵在印度的栽培面积开始下降；至 2015 年，栽培面积已降至 50 万公顷。其原因，一方面是由于来自棉花、玉米、大豆等经济作物的竞争，另一方面，是由于向日葵对一系列病菌的高感。印度的向日葵病害非常严重，一直以来，它是限制向日葵产量和丰产性的重要影响因素。直至 1990 年，主要为由 *Alternariaster helianthi* 导致的叶斑病。从 1997 年起，向日葵受由烟草条纹病毒引起的坏死病变得非常严重。从 2006 年起，由 *Golovinomyces orontii* 导致的白粉病变得非常严重。霜霉病是热带地区的主要病害，它在印度中部的部分地区较为常见。因此，如何从向日葵属栽培种及野生种中鉴定长久可用的抗性资源，是育种家长久以来面临的持续的挑战。我们从多年生的向日葵属二倍体材料中鉴定得到了抗 *A. helianthi* 的资源， 但可杂交性比较低(Sujatha et al. 1997)。我们从美国农业部引进了 16 份稳定的来源于野生种 *H. hirsutus, H. tuberosus,* 和 *H. strumosus* 的种间杂种材料用来评价它们对病原的反应，并试图将它们应用于育种实践中。鉴于缺少可靠的抗烟草条纹病毒的遗传资源，我们创建了含烟草条纹病毒外壳蛋白的转基因向日葵材料，从而使其具有抗坏死病的抗性(Vasavi et al. 2018)。从一年生二倍体材料（如 *H. argophyllus* 和 *H. praecox*）中，我们鉴定得到了抗白粉病的材料，目前我们正开展将抗性引入栽培材料中(Reddy et al.,

2013)。此外，我们对抗白粉病的供体材料，如 *H. praecox* (PRA 1823)，开展了蛋白质组和转录组分析，以期鉴定控制该病害的候选基因和关键调控通路(Reddy et al., 2018)。

关键词：生物技术工具，生物胁迫，种间杂交，野生向日葵