Editorial

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Interaction of a *Begomovirus* with the Opioid Biosynthetic Pathway of Opium Poppy

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Editorial

Opium poppy (*Papaver somniferum*) is a herbaceous plant of the family Papaveraceae grown for its medicinally important alkaloids. It was regarded as a magic plant in the classical period of ancient Greece. The major constituents of opium are phenanthrenes: morphine (about 12% w/w), codeine (about 0.5% w/w) and thebaine (about 0.2% w/w), and benzylisoquinoline: noscapine (about 6% w/w) and papaverine (about 1% w/w) [1]. Morphine is a narcotic analgesic medication used for the severe pain and has effects in the central nervous system and on smooth muscle. While the noscapine is a non-sedative, antitussive drug and recently its anti-mitotic activity was identified which may be used in cancer treatment [2]. Recently Prof. Graham and his team have decoded the whole genome of opium poppy which enabled the identification of a large cluster of 15 genes that encode enzymes for biosynthesis of essential opium alkaloids [3].

Viral diseases are a key constraint in the production of opium poppy crops in developing countries. Several viral diseases caused extensive damage to opium poppy. In India, opium poppy crops were found to be threatened by a severe mosaic disease, caused by Poppy mosaic virus (PMV-P) of family Potyviridae [4]. Srivastava et al. [5],Srivastava et al. [6] have reported a previously unknown disease of opium poppy which causes severe vein thickening and inward leaf curl in the plants. The whitefly-transmitted begomoviruses, Tomato leaf curl New Delhi virus (TLCNDV) and Ageratum Enation Virus (AEV) were found to be associated with the disease which may put opium poppy production in jeopardy in India and worldwide. The comprehensive histological, biochemical, and metabolomic investigations of virus-infected poppy plants and healthy plants by [5] revealed severe alteration at structural and metabolomic level. Virus-infection altered the biosynthesis of several important metabolites. The induced Programmed Cell Death (PCD) was also observed in virus-infected opium poppy plants by Comet assay and TUNEL and Hoechst dye staining assays.

The analysis of alkaloid contents in AEV infected plants in comparison to healthy plants exposed a surprising observation. The AEV infection tends to downregulate the biosynthesis of morphine, thebaine, codeine, and papaverine alkaloids while the biosynthesis of the PCD inducing anticancer alkaloid noscapine was marginally upregulated. The expressions of the genes of the biosynthetic pathway in AEV infected opium poppy were also corroborated with these findings. The reasons for the upregulation of noscapine biosynthesis is unknown, however, [7,8] compared three traits of poppy in HM1, HT1, and HN1 lines synthesizing morphine, thebaine, and noscapine, respectively, in large quantities, and showed that when noscapine is high in capsule, the morphine is low, presumably due to the substrate competition and showed the accumulation of noscapine pathway intermediates in transiently silenced HM1 plants. The overall research evidenced the existence of complicated defense and counter-defense strategies during opium poppy and AEV interaction. Further research is focused on the detailed transcriptomic expression studies will to understand the molecular basis of defense and counter-defense strategies of opium poppy and begomovirus.

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