ADVNACE RESEARCH JOURNAL OF CROP IMPROVEMENT
Volume 1 Issue 2 (December, 2010) Page : 201-205

Received : *November, 2010;* ***Accepted :*** *December, 2010*

Review Paper

RNA interference in fruit and vegetables for crop improvement

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ABSTRACT

RNA interference is a very efficient knockdown technology in plants as it is useful for genetic improvement, in plants with low transformation efficiencies. Down regulation of a particular gene can be achieved by mutation-based reverse genetics, but its use is more limited than that of RNAi. Although the basic concept of the application of transgene-based RNAi for genetic improvement of crop plants has been established, further feasibility studies are needed for its wider application. One of the major purposes of the present review article is to help policy makers in food deficient countries to understand how scientific breakthroughs such as RNAi technology may be helpful in tackling this gigantic problem of feeding an additional 2 billion people over the next 30 years from an increasingly fragile natural resource base. However, any new technology involving the gene manipulation may be opposed by anti-GM groups severely limiting its effectiveness or wider use. Since this technology offers a great potential in understanding gene functions and utilize them to improve crop quality and production, it is a matter of time before we see the products of this RNAi research in the farmers' fields around the world.

Jadhav, P.B., Jarande, S.D., Bhalerao, R.R. and Modi, P.K. (2010). RNA interference in fruit and vegetables for crop improvement, *Adv. Res. J. Crop Improv.,* **1** (2) : 201-205.

Key words : RNA, Interferences, Fruits, Vegetables

RNA interference (RNAi) is a post-transcriptional gene-silencing phenomenon induced by double-stranded RNA. It has been widely used as a knock down technology to analyze gene function in various organisms. Although RNAi was first discovered in worms, related phenomena such as posttranscriptional gene silencing and coat protein mediated protection from viral infection had been observed in plants prior to this. The technology became a powerful tool to understand the function of individual genes also proved useful for molecular breeders to produce improved crop varieties. Introduction of a piece of double stranded RNA (dsRNA) into the cytosol initiates the phenomenon of RNAi, in turn activating a pathway culminating in the degradation of the targeted gene transcript (Agrawal *et al.,* 2003). In addition to RNA degradation upon activation of the RNAi pathway, there are also cases where the promoter region of the gene is silenced through methylation (Mette *et al.,* 2000). In plants, RNAi is often achieved through transgenes that produce hairpin RNA. For genetic improvement of crop plants, RNAi has advantages over antisense-mediated gene silencing and co-suppression, in terms of its efficiency and stability. It also offers advantages over mutation-based reverse genetics in its ability to suppress transgene expression in multigene families in a regulated manner. More recently, research in this field has been directed to several other areas including microRNA's (Bartel, 2004; Pasquinelli, 2002), promoter methylation (Matzke *et al.,* 2004), and hairpin RNA (Wesley *et al.,* 2001). Simultaneously, results obtained in these areas have found practical applications in crop improvements such as in the production of potato virus Y (PVY) resistant potatoes (Smith *et al.*, 2000). Other important areas of RNAi will also be discussed with special reference to its applicability for production of improved varieties of cereal, fruit, cash and vegetable crops.

A surprising observation was made in petunias. While trying to deepen the purple color of these flowers, Rich Jorgensen and colleagues introduced a pigment-producing gene under the control of a powerful promoter. Instead of the expected deep purple color, many of the flowers appeared variegated or even white. Because of this observation the phenomenon was first named "co-suppression of gene expression" but the molecular