Vol.2 Issue-9, May 2022 (e-ISSN: 2582-8223)

# Role of Lectins in Insect Pest Management

**Anam Khan**
Ph.D Research Scholar, Department of Entomology, College of Agriculture, SVPUA&T, Meerut

**ARTICLE ID: 46**

## Introduction

Pests and diseases cause an estimated loss of 37% of total agricultural production worldwide, with 13% due to insect pests (Gatehouse, 1998). Indiscriminate uses of harmful insecticides cause deleterious effect on non-target organisms and environment. There is necessity for research and development of alternative approach to balance agricultural, environmental and health issues, in crop protection. New approaches including the use of entomotoxicproteins has been proposed for the insect pest control (Aronson, 1994; Ferre and Rie, 2002; Janmaat and Myers, 2003).

Lectins, ribosome-inactivating proteins, protease inhibitors, α-amylase inhibitors, arcelin,canatoxin-like protein, ureases and chitinases are the various entomotoxic plant proteins that have been recently identified. Among these some insecticidal proteins like lectins, ribosome-inactivatingproteins, α-amylase inhibitors and protease inhibitors, show greater potential effects onbiological parameters to a wide range of important insect pests and for exploitation intransgenic-based pest control strategies (Carlini et al., 2002; Vasconcelos et al., 2004).The new efficient strategy to control insect pest has been based on toxic proteinssuch as lectins.

## Role of Lectins

Used as a defensive tool against plant pathogens. According to Peumans & Van Damme (1995) definition "Lectins are a class of proteins of non-immune origin that possess at leastone non-catalytic domain that specifically and reversibly bind to mono-or oligosaccharides"."Based on the overall domain architecture of plant lectins, four major groups can be distinguished : merolectins, hololectins, chimerolectins and superlectins" (Van Damme et al., 1998).

The principal function of lectins are to act as recognition molecules within the immune system, storage proteins, cell surface adhesion and they have been implicated in defence mechanisms of plants against invading pathogens and pests (Peumans & Van Damme, 1995; Van Dam et al., 1998;Rudiger&Gabius, 2001; Trigueros et al., 2003).

**Principle of Entomotoxic Lectins**

The harmful effects of lectins on biological parameters of insects are larval weight decrease, mortality, feeding inhibition, delays in total developmental duration, adult emergence and fecundity on the first and second generation (Powell et al., 1993; Habibi *et al*., 1993). Also insecticidal activity of some lectins against many important pest insects has been well documented showing their ability to be used as bio-pesticides (Gatehouse et al., 1995; Powell, 2001; Carlini & Grossi-de-Sa´, 2002). Lectins from diverse sources are found to be toxic to members of insect orders such as Lepidoptera, Coleoptera and Homoptera.

**Plant Lectins**

Plants lectins are found in Fabaceae, Poaceae and Solanaceae; especially some of leguminous seeds have aremarkable amount of lectin.Plant lectins function as storage proteins and theyhave been implicated in defence mechanisms against phytophagus insects (Powell *et al.*,1993; Peumans& Van Damme, 1995; Van Damme *et al.*, 1998; Rudiger & Gabius, 2001;Gatehouse *et al.*, 1995; Powell, 2001; Carlini & Grossi-de-Sa´, 2002; karimi *et al.*, 2010).

The first lectin to bepurified on a large scale and was available on a commercial basis was Concanavalin A;which is now the most well- known lectin to control of some pest insects.

**Fig. 1 *Canavalia ensiformis*, or Jack-Bean (Common Name), is the Source of Concanavalin A lectin.**

An assay was performed to evaluate the efficiency of Con A in pea aphid,*Acyrthosiphonpisum*. Results showed that Con A has highly significant toxic effects on *A.pisum*. It also induced remarkable effects on the structure of midgut epithelial cells of thisaphid (Sauvion et al., 2004). These results clearly show that plants lectins play a crucial rolein plant resistance against insect pests.

**Insecticidal Lectin Gene Expression in Transgenic Plants**

GNA, WGA, PSA, PHA and Con A were more successfully expressed in a range of crops such as Tomato, Rice, Sugarcane, Tobacco, Maize, Mustard and Arabidopsis and they have been shown to exert deleterious effects on a range of important pest insects. Lectins have been introduced into crops genomes and are now being tested in field conditions. Transgenic plants technology or genetically modified (GM) crops can be a useful tool to produce resistant crops; by introducing novel resistance genes into plants thus it provides a sustainable alternative to the control of pest insects and pathogens by pesticides (Gatehouse et al., 1997; 1999; Gray et al., 2003).

**Insecticidal Activity of Fungal Lectins**

Insecticidal properties of *Sclerotinia sclerotiorum*agglutinin (SSA) and its interaction with pea aphid, *Acyrthosiphonpisum*tissues and cells showed that this fungallectin has high mortality on *A. pisum* with a median insect toxicity value (IC50) of 66 µg/ml. Also these results revealed that SSA has significant cell toxicity on *A. pisum*midgut tract and its brush border cells (Hamshou et al., 2010) (Fig. 2). A purified lectin from *Rhizoctonia solani*agglutinin (RSA), which exhibits specificity towards N-acetylgalactosamine, was shown to exert deleterious effects on the growth, developmental time, survival and the larval weight of the cotton leaf worm, *Spodoptera littoralis* (Hamshou et al., 2010). Hence, fungal lectins are able to confer enhanced level of resistance to phytophagous insects in plants.

**Action Mechanism of Lectin at the Tissue Level of Insects**

Binding of the lectin to the midgut tract causing disruption of the epithelial cells including elongation of the striated border microvillus, swelling of the epithelial cells into the lumen of the gut lead to complete closure of the lumen, permeability of cell membrane to allow the harmful substances penetrations from lumen towards haemolymph and impaired nutrient assimilation by cells, allowing absorption of potentially harmful substances from lumen into circulatory system, fat bodies, ovarioles and throughout the haemolymph

(Gatehouse *et al.,* 1984; Powell *et al.,* 1998; Habibi *et al.,* 1998; 2000; Fitches *et al.,* 1998; 2001b; Sauvion *et al.,* 2004; Majumder *et al.,* 2005). This information gave further support to previous suggestions that the XCL lectins disrupt midgut cells (Francis et al., 2003; Karimi et al., 2008, 2009).

**Fig.2. *Xercomuschrysenteron* fungus naturally growth in forest. It is a small, edible wildmushroom in the Boletaceae family and has a cosmopolitan distribution, concentrated incool-temperate to subtropical regions.**

**Indirect Effects of Lectins on Pests Control**

In some case lectin have an indirect remarkable effects such as interaction with virus transmission and synergistic effects on the other proteins.

**Conclusion**

Due to increasing harmful effects of chemical compounds on non-target organisms and our environment in recent years, lectins could be safe alternatives to chemical compounds for the pests control. Results from different investigations were shown that plant lectins as well as fungal lectins could be good candidates to be applied in the agriculture by biotechnologists in order to manage insect pests in an effective manner without depending solely on chemicals.