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Modern Biotechnology Tools: A new paradigm for insect research field

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ABSTRACT

Biotechnology is a field of applied biology that includes the use of living organisms and bioprocesses in agriculture, engineering, medicine and many other fields demand novel bioproducts. The development of DNA-based techniques, generally known as biotechnology. In early of 1990 and in agriculture field, biotechnology is obviously fitting the broad definition of "using a biotechnological system to make newly and novel products. The genetic modified plant is one of the most renowned examples in agriculture field which created by transferring a desirable gene in plant genomic in order to produce desirable protein (s) that governors specific function in the plant system. For decades, scientists have used traditional breeding to improve the production and crop quality in order to use them for food consumption. In this type of breeding, organisms with desirable traits are mated to produce individuals carry the same traits. Many other applications of biotechnology have been reported in various fields *viz*, organisms and organism by-products that used to fertilize and restore nitrogen in soil. In insect research field, the biotechnological tools have been applied to study various issues such insect identification, insect control and insect genetic relationships. Bt Cry1Ac modified cotton plant (Bollgard I) was the primary example to control American bollworm; *Helicoverpa armigera* pest. Thus, exploiting such technology in the field of Entomology could help scientists in understanding various physiological mechanisms occurred in insect.

Keywords: Biotechnology, field

INTRODUCTION

Biotechnology as a tool has created from many disciplines like genetics, molecular biology, microbiology, bio-informatics, biochemistry etc. Biotechnology has been applied in agriculture as a breakthrough measure towards sustainable agriculture through genetic manipulations process. Genetic manipulations could be used to modify the genetic constitutions of plants, animals, and microorganisms. For the last two decades, enormous genes have been identified and isolated and are available for transformation process in order to improve specific traits in the targeted organisms. Currently, this technology is mainly used to modify crops, while a several applications are still in considerations. Similarly, genetically engineered materials endure a long time of research work before they enter into the market. Two decades ago, though biotechnology was considered as a novel technology that going to guide us in a new era of agricultural with negligible harm to the environment, the initial outcome of genetically manipulated products has proven to be save and modest. Some of the most important commercial applications of biotechnology in insect field are deliberated below. Bt toxins are highly effective for many pest organisms, like Lepidopterans, coleopterans, Dipterans and other related species, but not toxic to mammals and most other non-target organisms. A major concern among scientists and environmentalists is that extensive use of Bt crops lead to development of resistance

to the toxin (Moussa, 2009). In the early of 1990, the *Cry1Ac* gene has been isolated from the soil Gram positive bacteria; *Bacillus thuringiensis* and inserted into genomic DNA of cotton plant to produce Bt-cotton plant (Bollgard I); the first generation of Bt-cotton. This modified plant was cultivated to control American bollworm pest that causes severe damage to cotton crop. But due to insect resistance development; Bt*Cry2Ab* gene was inserted along with Bt*Cry1Ac* gene in the same cotton variety to overcome insect resistance development. This technology was called Bollgard II and considered as the second generation of Bt modified crop. During 1996; about 6000 h of Bt-cotton plant has been cultivated for the first time in USA. Later on, Australia, India, South Africa and Canada have been adopted biotech crop technology. Currently more than 5.5 billion hectares of biotech crops are cultivated across the globe.

DNA markers tightly linked to the gene(s) of interest can be used at any crop stage for testing the presence of the gene(s) rather waiting to observe its phenotypic manifestations. In addition, Simple Sequence Repeats (SSRs) markers are one of the most fundamental applications of the biotic tools. It was found to play a significant role in studying the mode of inheritance of a gene (i.e. whether the gene is homozygous/heterozygous) and thus is very valuable in self/backcross breeding programs for interpretation of recessive but agronomically important gene(s). Recently, the microsatellite marker linked to BtCry1Ac resistance trait in *Helicoverpa armigera* pest was identified by (Moussa, *et al.*, 2005). Also, Identification of mealybug pest species in Egypt and France has been investigated using a DNA barcoding approach (Abd-Rabou *et al.*, 2012)**.** Currently, monitoring of Bt resistance gene(s) in the Egyptian cotton leaf worm pest; *Spodoptera littoralis* is ongoing work (Project No. 375 funded by STDF, Egypt) in my laboratory. Therefore, adopting biotechnological tools in insect research field have become essential in agriculture sector in Egypt.

RESULTS

Three broad applications of biotechnology tools that are expected to contribute both directly and indirectly towards insect field in Egypt are:

1. DNA marker technology for insect taxonomy and identifications.

2. Genetic engineering for transferring agronomically useful traits across plant species that cannot be achieved by conventional means in order to reduce insect invasion and increase plant tolerance.

3. Application of genomic tools for identifying new and useful genes/alleles.

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ARABIC SUMMARY

التقنيات الحديثة لعلم البيوتكنولوجى: تقنية جديدة لعلم بحوث الحشرات

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يعرف علم البيوتكنولوجى بانه عبارة عن استغلال الكائنات الحية وأنظمتها الحيوية فى مجال الزراعة والهندسة والطب الخ لانتاج منتجات حيوية جديدة، واى تغير يطرا على المادة الوراثية كنتيجة لتطبيق تلك التكنولوجى يعرف على أنه علم التكنولوجيا الحيوية. ففى بداية التسعينات استخدم هذا العلم فى مجال الزراعة بصورة كبيرة لانتاج منتجات جديدة. ومن أهم وأشهر الأمثلة على ذلك هو انتاج نباتات معدلة وراثيا والتى تتم بنقل جين من كائن حى لكائن حى أخر لانتاج بروتين متخصص مسؤل عن صفة محددة فى النظام النباتى. ومنذ عشرات السنين اعتاد العلماء على استخدام نظم التربية التقليدية لتحسين الصفات النباتية لتحسين المنتج الغذائى. وفى هذا النوع من التربية كان يتم تزاوج الكائنات الحية ذات الصفات المرغوبة معا لانتاج افراد تحمل الصفة المرغوبة من الأباء والمراد نقلها للجيل التالى. والعديد من تطبيقات التكنولوجيا الحيوية تم العمل بها فى مجالات مختلفة منها استغلال الكائنات الدقيقة فى انتاج وتثبيت الازوت فى التربة. وفى علم الحشرات تم استغلال التكنولوجيا الحيوية فى مجال تعريف ومكافحة الحشرات الى جانب دراسة علاقة الحشرات ببعضها البعض. ومن أفضل استخدامات علم البيوتكنولوجى فى مجال الحشرات هو نقل جين Cry1Ac المعزول من بكتريا الـ Bacillus الى نبات القطن لمكافحة حشرة دودة اللوز الأمريكية التى تتسبب فى خسائر كبيرة لتلك المحصول. لذا استغلال تلك التكنولوجى فى مجال الحشرات من الممكن أيضا أن يساعد العلماء فى فهم العمليات الفسيولوجية التى تتم داخل الحشرة.