Weed Biotechnology Services Section Home

Introduction to Weed Biotechnology

Biotechnology has provided further dimensions to herbicide technology. Transgene technology has generated herbicide resistant crops (HRCs), which have received a profound impact on the herbicide market. This similar technology possesses the potential to produce crops better competitors with weeds through improving competitive traits or making the crop more allelopathic. Living biocontrol agents can sometimes be applied to weeds, much like an herbicide. However, biocontrol has been widely unapplied in agronomic and horticultural crops for weed management because of a number of failings when compared with chemical herbicides. However, biotechnological advances may transform the equation, favoring biocontrol in some situations. This article deals with these biotechnology based methods of weed management.

Biotechnology has been practiced for millennia, including the fermentation of alcoholic beverages and derivation of medicines from the natural pharmacopeia. A particular subset of biotechnology is a genetic modification (GM), which we have in addition been doing for centuries with an artificial selection of bacteria, plant, and animals, including trans-species hybrids. A recent general review of the potential applications of molecular biology in weed management was commissioned by the Weeds CRC and published by Partridge.

Pioneers of Weed Biotechnology:

Biotech derived herbicide-tolerant crops have been genetically engineered through the use of recombinant DNA (rDNA) techniques. Genetic engineering alters the genetic constitution of isolated cells by selectively removing, inserting, or modifying individual genes or gene sets using rDNA technology. The soil-borne bacterium, Agrobacterium tumefactions, is able to utilize genetic engineering processes to transfer parts of its DNA into plant cells. The advantage for the bacterium is that the genetic material it inserts into plant cells causes the plants to produce complex nutrients (opines) which only this bacterium can use as a food source. The inserted DNA, in addition, contains plant hormone genes that cause the cancer cells to proliferate, resulting in a tumor called crown gall. Research into this phenomenon eventually led to the first published transgenic plant (tobacco) that expressed foreign genes. Since then there have remain many other crops and other plants (maize, tomato, potato, banana, alfalfa, canola, rice, soybean, sugarcane, wheat, etc.) that have been genetically transformed through rDNA technology. Agrobacterium-mediated transformation of plant tissue is preferred over microparticle bombardment because it results in higher transformation efficiency, fewer rearrangements and a low copy number of the transgenes (newly inserted genes).

History of Weed Biotechnology:

Many crops are efficient to withstand one or more of the herbicides on the market today, and this has provide the basis of selective weed control over the last 60 years. However, these selective herbicides do not provide broad-spectrum weed control. Since the introduction of modern herbicides, plant breeders have endeavored to create, by a number of alternative approaches, crop varieties that has been tolerant to broad-spectrum herbicides. The first introduction of a

conventionally bred, the herbicide-tolerant crop obtain triazine tolerant canola in 1981. In 1996 the first biotech-derived herbicide-tolerant crop (glyphosate-tolerant soybean) was introduced commercially and was rapidly adopted in the USA Argentina and other soybean-producing countries. In 2010 herbicide tolerance remained the dominant trait in biotech-derived crops and herbicide tolerant soybean the dominant biotech-derived crop in world agriculture, grown in 11 countries. Glyphosate-tolerant soybean accounted for 50% of the global biotech-derived crop area, followed by maize (31%), cotton (14%), and canola (5%) (James, 2010). Since 1996, the acreage of biotech-derived crops has grown beyond over 10% per year and is projected to continue to grow at this rate. In 2010 there were 148 million hectares of biotechnology-derived traits, with an estimated market value for the biotech-derived seed of US$ 11.2 billion.

Developments of Weed Biotechnology:

Diversified weed management programs are necessary and over-reliance on a particular herbicide as the sole means of weed control should be avoided. With biotechnology, genes for resistance to diverse types of herbicides can be inserted into one crop variety. Not merely does this capability increase the number of weed control options available to farmers, but it also can delay the development of resistance to a particular herbicide and allows growers more flexibility. Biotech crop varieties allow growers to restrain weeds with isolated, broad-spectrum compounds that are more benign and receive a lessened impact on the environment.

Scope of Weed Biotechnology:

Currently, the potential of plant tissue culture is widely utilized for the rapid and economic clonal multiplication of fruit and forest trees, for the production of virus-free genetic stock and planting material, as well as in the creation of novel genetic variations through somaclonal variation. With the aid of rDNA technology, it has now become possible to produce transgenic plants with desirable genes like herbicide resistance, disease resistance, increased shelf life, etc. Techniques such as molecular breeding have been employed to accelerate the process of crop improvement. For instance, molecular markers, like restriction fragment length polymorphism (RFLP), and simple sequence repeats (SSRs) provide potential tools for the indirect selection of both qualitative and quantitative traits, and also for studying genotypic diversity.