REVIEW ARTICLE

REVIEW ON WEED CONTROL IN GLYPHOSATE TOLERANT MAIZE

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ABSTRACT

Weeds are a constant nuisance for farmers, which steal space and nutrients from the crops. Weed management is the botanical component which attempts to stop noxious weeds from competing with desired flora and fauna including domesticated plants. It is preventing of non-native species competing with native species. Growth of various weeds has been major problem in the yield of many plants. It has also affected the growth and development of maize as it competes with the space and nutrients. Different weed management techniques have been introduced till date to increase the yield and to control the weeds, also, aiming less effect of the techniques on the main plant. Generally, preventive, biological, cultural, mechanical and chemical weed control methods are used. Advancements in plant biotechnology have allowed the development of a number of herbicide resistant crops which is a success in chemical weed management of the crops. They have provided the requisite tools to transform the plants to contain the foreign genes. Genetically engineered herbicide resistant crops have been widely planted globally since their introduction in 1995. These developments offer new approaches to managing weeds in cropping systems. This technology offers some advantages over currently used systems.

KEYWORDS

Maize, Weed, yield, Glyphosate tolerant, Herbicide resistant.

1. INTRODUCTION

Maize (Zea Mays) is the second most important cereal crops in the world in terms of production. Because of having high genetic yield potential, it is known as queen of cereals. The maize is cultivated for grain, fodder, green cobs, sweet corn, baby corn and popcorn in peri urban areas. Being a rainy season crop, maize is heavily infested with weeds from time it is sown till harvesting. This is because of frequent rains encourages several flushes of weed, hot and humid climate congenial for the growth of weeds especially grasses, wider row spacing and increased use of fertilizers (Rana, 2017). However, the most critical period for crop weed competition are first six weeks after planting of crop because of initial slow growth and wider row spacing of maize, coupled with congenial weather conditions allow luxuriant weed growth which may reduce yield by 28-100% (Dass et al., 2012, Pandey et al., 1999). The presence of weeds reduces the photosynthetic efficiency, dry matter production and distribution to economical parts and thereby reduces sink capacity of crop resulting in poor grain yield. Breeders have introduced maize hybrids with higher yielding potential than before, which are adapted to the local climatic conditions. Some growers use glyphosate as a pre-sowing or pre-emergence clean-up herbicide, but genetically modified herbicide-tolerant (GMHT) varieties offer the opportunity to apply this broad-spectrum herbicide over the growing crop itself (Dewar, 2009).

1.1 Glyphosate Tolerant Maize

Glyphosate is the active herbicidal ingredient in Roundup and many other herbicide brands which controls a broad spectrum of plant species. Among

all the GR crops grown, glyphosate tolerant maize occupies the second highest area (Dill et al., 2008). The action mechanism of this herbicide is that it targets an enzyme found only in plants and certain bacteria. Due to this, it has an excellent toxicological and environmental profile (Dill, 2005). The introduction of Glyphosate tolerant maize took place in 1998. Transformation of maize plants with CP4 (an Agrobacterium species strain) EPSPS and e35S promoter produced plants with vegetative resistance to glyphosate but this reduced male fertility in the plant. To improve maize tolerance to glyphosate at both vegetative and reproductive stages, a new event NK603, with two copies of a slightly modified EPSPS CP4 gene, was developed and was commercially released in 2001 in a breeding stack (Nandula, 2019). Glyphosate is quickly becoming the remarkable means of weed control in field, especially when glyphosate-tolerant maize is grown in rotation with glyphosate-tolerant varieties of soybean (Glycine max) (Nurse et al., 2006).

2. WEED CONTROL IN MAIZE

Maize is very susceptible to weeds competition in the early stages of growth. Common weeds of maize are:

Grassy weeds:

Echinochloa colona, *Eleusine indica*, *Cynodon dactylon*, *Digitaria sanguinalis*

Panicum colonum

Broad leaf weeds:

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Ageratum conyzoides, *Galinsoga parviflora*, *Phyllanthus niruri*, *Commelina benghalensis*, *Polygonum dichotomiflorum*, *Aeschynomene indica*

Up to 55% yield loss have been recorded in maize where no weed control was applied (Dewar, 2009). Best economic return from control of weeds is achieved by spraying herbicides at around the four-leaf stage of maize. The shallow root structure of plants and relatively wider spacing allows space for more weed development in maize field. The presence of weeds in maize field reduces the photosynthetic efficiency, dry matter production and distribution to economical parts and also reduces sink capacity of maize resulting in poor grain yield (Rana, 2017). Therefore, suppression of weed in early stage of growth is essential to improve crop yield in maize (Dewar, 2009).

2.1 Current methods for weed control in maize

Weeds are being controlled with mechanical, biological, and cultural tools from over several years in the past. Chemical weed control with inorganic compounds was extensively practiced in the late-nineteenth to mid-twentieth century, with earliest evidence even pointing back to the Roman era (Nandula, 2019). Weeds control is mostly achieved by use of selective herbicides applied either pre-emergence and/or post emergence. In modern commercial crops, Very little cultural or mechanical control is applied although some have been suggested, particularly in continuous maize or organic systems (Hatcher and Melander, 2003). Different weed control methods have been used to manage the weeds but mechanical and chemical methods are more frequently used for the control of weeds than any other control methods. Mechanical methods including hand weeding are still useful but are getting expensive, laborious and time-consuming. In the less developed countries, the situation still exists where the peak labor requirement is often for hand weeding. Herbicides weed control is an important alternative to manual weeding because it is cheaper, faster and gives better weed control. Chemical control is a better alternative to manual weeding because it is cheaper, faster, and gives better control (Mohammed, 2014).

3. GM HERBICIDE-TOLERANT TECHNOLOGY AS AN ADDITIONAL ALTERNATIVE WEED CONTROL MANAGEMENT TOOL IN MAIZE

The introduction of GMHT technology that involves the usage of an approved broad-spectrum herbicide such as glyphosate or glufosinate-ammonium 13 will provide new alternatives for in crop weed control. Glyphosate is the most widely used across the world since it first became available in 1974. It is effective, economical and environmentally benign and has become the product of choice in other countries that grow GMHT maize as it is cost efficient and has a broader spectrum of systemic activity against perennial weeds. Glyphosate needs to be applied to the foliage of growing plants, because it has little or no effective residual activity when it is applied to the soil surface (Dewar, 2009). Glyphosate-tolerant crops is a powerful tool for managing herbicide-resistant weeds. It provides a broad-spectrum, non-selective herbicide in the crop rotation pattern. With the proper integration of glyphosate-tolerant crops into a total weed management program, the selection of herbicide-resistant weeds become efficient (Shaner, 2000).

3.1 Impacts of Glyphosate Tolerant Maize

The herbicide-tolerant varieties with their associated herbicides can provide benefits to the whole agricultural system. The introduction of glyphosate-tolerance trait in maize has provided the farmer with an additional option or tool to remove competing weeds from the crop, i.e. by employing a herbicide that has benign environmental characteristics (Molin, 1998). The use of glyphosate in herbicide-tolerant maize has facilitated the adoption of conservation tillage practices, with the consequent benefits of a reduction in the quantity of fuel required to plant the crops and a decrease in the carbon mobilisation that occurs when soil is tilled (Phipps and Park, 2002). Adoption of glyphosate-tolerant varieties give a substantial economic saving in the cost of the input package (herbicides + variety) when compared with conventional practices (Nandula, 2019). The glyphosate resistant maize helps in reduction in use of other herbicides, helps farmer to wipe out most of weeds from their field without damaging the crops, significant cost saving, reduces number of sprays in a season (Beckie, 2011).

3.2 Potential hazards of using herbicide-tolerant maize

The continuous use of any chemical (herbicide, insecticide or fungicide) over a wide cropping area has the chances of increasing the risk of development of resistance of the pest/weed to the chemical. (Dewar, 2009) The repeated use of glyphosate in no-tillage systems can greatly

increase the risk of resistance evolving, whether or not a GM glyphosate-tolerant crop (Fernando et al., 2016). However, it is likely that the increased adoption of glyphosate tolerant crops has increased the risk of resistance evolution by virtue of the greatly increased area (Shaner, 2000). The planting of maize itself and the use of any selective herbicide will lead to long-term changes in the weed spectrum if continuous cropping is adopted (Shaw et al., 2009).

4. CONCLUSION

The recommendation for glyphosate-resistant maize is to use a pre-emergence herbicide such as acetochlor or acetochlor plus atrazine along with glyphosate post emergence. The mixing of acetochlor and/or atrazine with glyphosate will help in delaying the selection of resistance to glyphosate, but this mixture will have limited activity on certain broadleaf weeds. GRCs represent one of the more rapidly adopted weed management technologies in recent history. Current use patterns would indicate that GRCs will likely continue to be a popular weed management choice that may also include the use of other herbicides to complement glyphosate. Stacking with other biotechnology traits will also give farmers the benefits and convenience of multiple pest control and quality trait technologies within a single seed.

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