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WEED MANAGEMENT UPDATE FOR THE NEXT MILLENNIUM

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Introduction

In general, the 1999 growing season was excellent with regard to weed management. Weather patterns provided frequent rain thus enhancing soil-applied herbicide performance. While these rains also made timely postemergence applications a challenge, the efficacy of herbicides was quite good and larger weeds were consistently controlled. On the down side, these same weather conditions also reduced crop tolerance to herbicides, favored multiple and delayed weed emergence, and caused difficulties for mechanical weed management strategies. Regardless, 1999 was a successful cropping season.

Unfortunately, record poor prices for crops, a record dry fall resulting in unfavorable soil conditions, and concerns about genetically modified organisms has created major concerns in the agricultural economy. It is feared that weed management decisions for 2000 may be decided for reasons other than weed management. While these issues and concerns should not be overlooked, because of the unfavorable economy, it becomes more critical to make sound weed management decisions considering all implications of those decisions.

This paper will review the major issues of 1999, detail many of the changes scheduled for 2000 and attempt to provide some guidance for weed management decisions in the 2000 growing season.

New Products

While there will not be a great number of “new” active ingredients for 2000, there are a number of “new” products. These represent new formulations of existing product, new premixes, and new contracts between companies. An incomplete list of these products follows. There will likely be new products labeled as the New Year develops so it would be prudent to check the ICM Newsletter and the ISU Weed Science web page for the most current information.

Encapsulation of herbicides is not a new concept. Currently there are a number of herbicides and premixes that are an encapsulated formulation. The encapsulation technology is designed to extend the period of weed control by allowing the timed release of the herbicide. Other benefits the manufacturers have touted are better weed control in conservation tillage production systems and protection from herbicide leaching in the soil.
Typically the release of the herbicide is a function of soil moisture. While an excellent concept, in practice the benefits of this technology have been difficult to quantify. For example, if conditions are dry, there is little herbicide released and weed efficacy is poor. The requirement of moisture to “break” the encapsulation has been greater than the amount of soil moisture needed for weed seed germination. Monsanto has developed a different, and presumably better, encapsulation technology based on soil temperature.

Monsanto will introduce a new product line based on existing herbicides in 2000. The products will be **Degree** (acetochlor) and **Degree Xtra** (acetochlor plus atrazine). Both products will include a safener, however the atrazine included in Degree Xtra will not be encapsulated. The encapsulation “shell” will begin to break down and release the acetochlor and safener when the soil reaches 50° F. Benefits claimed for the new technology include better crop safety and extended herbicide activity.

Monsanto will also introduce several premixes including glyphosate. The first that will be introduced will be **ReadyMaster ATZ** (glyphosate plus atrazine). Other premixes that will likely be introduced include combinations of glyphosate with acetochlor and acetochlor plus atrazine. These products will be labeled for glyphosate resistant corn hybrids and will be positioned as “one pass” weed control options. The glyphosate formulation used in the ReadyMaster products is the same as the Roundup Ultra product.

Another potentially important change for 2000 is that glyphosate goes off patent in October. Currently there are a number of licensing agreements between Monsanto and other companies who will begin marketing their glyphosate products, either glyphosate alone or in premixes. Companies that will be marketing glyphosate products include American Cyanamid, Cheminova, DowAgro Sciences, EnTek, New Farm, and Novartis.

BASF will drop the Celebrity co-packaged product and introduce **Celebrity Plus**. Celebrity Plus is a premix of Distinct, Clarity, and Accent. BASF claims broad spectrum, one pass weed control on corn with excellent crop safety. Celebrity Plus is labeled to control weeds from 2 to 6 inches tall and can be applied to corn between 4 and 24 inches tall.

Bayer will market **Domain** in 2000. Domain is a premix of flufenacet and metribuzin that are also the components of **Axiom**. The difference is the ratio of the components. Axiom is 4:1 while Domain is 2:3 for flufenacet:metribuzin, respectively. Other differences are that Domain is only registered for soybeans and is intended for use as a “foundation” herbicide prior to postemergence applications of glyphosate to resistant soybeans. Domain has a use rate range of 9 to 16 ounces per acre which is the equivalent to 0.26 to 0.46 lb/A of Sencor 75DF. Domain is intended to provide greater application timing flexibility for the postemergence glyphosate and is suggested to provide weed control only for a limited period (3 to 6 weeks). It is important to recognize the potential for soybean injury from metribuzin and observe the cautionary statements included in the label.
Balance in 2000

**Balance** (isoxaflutole) was introduced in 1999 and was marketed as a preemergence herbicide in corn that would provide broad-spectrum weed control. Balance demonstrates good activity on a number of small-seeded annual broadleaf weeds and velvetleaf. Balance also has better activity on woolly cupgrass than other soil-applied herbicides available in corn. However, Balance does provide consistent control of foxtails and has little activity on common cocklebur. Thus, Balance was often mixed with a herbicide to improve foxtail control (e.g. acetochlor, metolachlor, or flufenacet) or common cocklebur (atrazine). The premix Epic (flufenacet and isoxaflutole) was introduced to improve the weed control spectrum. While there introduction of Balance was extremely successful (estimates suggest isoxaflutole was applied to 3 million acres of corn), and weed control was generally excellent, there were significant problems with corn injury.

Corn injury from Balance in Iowa was most common in western Iowa, especially in the loess hills. Typically, small areas within a field were affected, but there were areas where the injury was throughout the field. Generally, the corn recovered from the injury, but there were areas where significant stand reduction occurred. There are a number of factors that contributed to the injury. Some of these factors were related to management and application accuracy, some were related to application rate relative to soil type, but the exact explanation for some situations has not been determined.

It is important to recognize that Balance has a relatively close tolerance between weed control and corn safety. The close tolerance is similar to many new herbicides and generally should not be a problem. The importance of the close tolerance is that other factors (e.g. management, and environment) may have an important role in the expression of crop safety or injury. When conditions stress the crop, there is a greater likelihood of herbicide injury.

Perhaps the most important factor that influenced the corn response to Balance was the weather conditions. Wet cloudy conditions negatively affected corn development thus reducing Balance metabolism, but also increased Balance availability. While these conditions favored weed control, they increased the potential for corn injury.

Management factors the influenced the injury included selection of hybrid, planting depth and application accuracy. Balance rate, relative to the soil characteristics was also a factor. Consider that the areas of Iowa that had the most injury also have a topography that does not allow for even and accurate herbicide applications. Sprayer overlaps, poor speed (and thus application rate) control, and boom position are a common problem. Further, fields in this area commonly contain areas with weathered soils and lower organic matter. All of these likely contributed to the occurrence of corn injury. Unfortunately there is little information about the influence of hybrid on the occurrence of Balance injury.
Rhone Poulenc has modified the Balance label in order to reduce the potential for corn injury. The label now addresses soil organic matter and texture with regard to Balance rate in a more precise manner. Restrictions and warnings are included for soils with coarse textures, organic matter below 1.5%, and a pH greater than 7.5. There are also restrictions for weathered soil areas within a field and Rhone Poulenc is working closely with applicators to improve application accuracy.

Another consideration is that there is cursory evidence to suggest that herbicide partners that include a safener may reduce the potential for injury. However, when the rate of the herbicide partner is reduced, the potential safening is also reduced. It is also important to consider that when herbicide rates are reduced, the control of more tolerant weeds such as wooly cupgrass and common waterhemp may be less. Given the excellent and extended weed control demonstrated by Balance in 1999, expectations for 2000 should reflect the changes in the label and recognize that control may not be at the level demonstrated in 1999.

Concerns for 2000

**GMO technologies** have provided a number of pest management alternatives for growers. The perception of the value GMOs deliver varies depending on the GMO trait, the management problem, and the severity or consistency of the pest infestation. In some cases, the value ascribed to the GMO is impossible to quantify. For example, anecdotal information from growers suggests that one of the important benefits to glyphosate resistance in soybeans is the simplicity of the system. Other growers indicate that they like “how the fields look” at the end of the season, suggesting that the benefits are due to “esthetic” weed control. Whether the GMO systems are indeed biologically simple (ISU would suggest not) or if “esthetic” weed control can be defended, the fact that growers see benefits to the technology is important.

Currently, a number of concerns have surfaced about the use of GMOs. Again, whether these concerns are scientifically valid matters not as the consumer public believes that the issues exist. This suggests that the value, or benefit, to the growers must be reviewed. Does the inclusion of GMO technologies in a crop production system represent a significant economic risk to the grower? This question is not easily answered, particularly when not all of the information needed to make an acceptable assessment of benefit and risk is available. It would be prudent, however, for growers to begin thinking about the tangible benefits of GMO technologies and consider the risks that may accompany their use.

**Weed shifts** are an inevitable consequence of weed control. There are a number of historically important examples of how weed communities change in response to crop production strategies. Giant foxtail became an important weed in the Midwest because of, in part, the use of 2,4-D. Large-seeded annual broadleaf weeds become less important when no tillage production systems are adopted. Winter annual weeds are not an important component of a weed community if small grains are not included in a crop rotation scheme.
Generally, these shifts in the weed community have occurred over a relatively long period of time. The reason for the longer period of time required for the weed shift to occur is, in part, due to the effectiveness of the selection pressure that favors one weed over another. While tillage dramatically changes the agroecosystem, the selection pressure on velvetleaf or common cocklebur is not that specific. Given the soil seed bank, it typically takes a number of years for no tillage systems to lessen the population of these weeds. However, there are selection pressures in agriculture that can rapidly cause weed shifts.

The introduction and wide spread use of ALS inhibitor herbicides rapidly caused a weed community shift resulting in common waterhemp as a major weed problem throughout the Midwest. This shift developed within a few years after the introduction of these herbicides. While reduced tillage systems contributed to the shift, the selection pressure from the herbicides was likely the greatest factor. ALS inhibitor herbicides demonstrated excellent activity on a broad spectrum of weeds, generally provided consistent control, and were used on a majority of the crop acres. Often, multiple applications of ALS inhibitor herbicides were used on a field in the same year. Finally, common waterhemp demonstrates variable response to these herbicides.

Thus, common waterhemp was “favored” in the ALS inhibitor herbicide programs. Certainly there are other factors involved such a germination habit, seed productivity, and others, but the major cause of the weed shift resulting in the common waterhemp problems widely spread throughout the Midwest was the use of specific herbicides. When a specific weed management strategy is employed widely in a crop production system and this system is used repeatedly, a weed shift will occur. Weed shifts are predicted for GMO crops unless alternative management strategies are included in the production system.

**Application timing** continues to be a concern. Generally, postemergence applications are made later that appropriate to protect the potential crop yield. Current GMO technologies favor this mis-management strategy, however late applications have been used with other herbicides such as PPO inhibitors for the control of common waterhemp or ALS inhibitor herbicides for later emerging annual grasses in corn. Regardless, late herbicide applications are typically not economically sound management. Importantly, many of the current herbicide labels allow late applications.

The problems with late applications are several. Perhaps the most important issue is whether or not the application has been made in time to eliminate the competition from the weeds. Predicting exactly when is timely and when is too late is impossible. When data are averaged across locations, crops and years, the appropriate application timing is suggested to be 3 to 5 weeks after crop emergence. However, weather patterns, weed populations, and other factors dramatically can influence this figure.

Another consideration is if the herbicide, when applied later, will effectively control the weeds without causing significant injury to the crop. Examples are when PPO inhibitor
herbicides are applied to soybeans in reproductive development. The injury that occurs can result in yield reductions. Similarly, when ALS inhibitor herbicides are applied over the top of corn beyond V6 to V8, particularly when a growth regulator herbicide is included in the application, significant injury can occur.

Finally, are late applications of herbicides justified even when injury is not a consideration? Can a grower justify controlling weeds when there is no risk of yield loss due to competition? While many rationalizations for this management strategy are known, none seem economically or environmentally acceptable.

**Drift** continues to be a problem in Iowa. Complaints received by the Iowa Department of Agriculture and Land Stewardship continue to increase. As the importance of postemergence application of herbicides increases and the number of applications on a crop within a season grows, the potential risk of off-target movement of herbicides will be considerably greater. GMO technologies contribute to the increases in postemergence applications, as do the currently available herbicides. Applicators must observe all herbicide label restrictions for applications. Further, they must use considerable judgement about when environmental conditions favor herbicide drift and refuse to make applications when there is a risk of drift.

**Conclusions**

There are many potential problems facing growers and agricultural professionals in 2000. While the environmental conditions will significantly influence how herbicide perform, the occurrence of crop injury, and the severity of drift, appropriate management strategies can be devised to minimize these problems. However, some of the issues are extremely difficult to understand thus making decisions difficult. The value of GMO technology, for example, must be reviewed objectively and benefits and risks assigned as deemed appropriate. Importantly, management strategies must be adaptable to changing situations.