Site-Specific Management Guidelines

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SSMG-15

Scouting for Weeds

Summary

The concept behind scouting for weeds is to provide accurate and timely information needed to make intelligent, cost effective decisions. Moreover, scouting is a key component in the design of effective weed management strategies that help to manage risks by providing information needed to optimize the correct timing of herbicides and accurately monitor weed management successes and failures (Wallace, 1994). This requires one to think about dynamic and flexible weed management systems to meet challenging demands. Adaptive sampling strategies (rather than fixed strategies such as grid sampling) are flexible and build on previous information and experience. Adaptive approaches also result in more dynamic data gathering systems that can be used to determine if the current weed management system is or is not meeting your goals. We can also assess if given weed species are increasing or decreasing in density and area. Being able to adjust sampling strategies based on previous observations is critical and must be taken into account each year. Experience coupled with flexibility is the key to obtaining reliable data needed to make intelligent site-specific weed management decisions. However, we must recognize that here is no single scouting strategy that is best in all situations and that each strategy has advantages and disadvantages.

Introduction

In the past, weed information has been collected in a casual way, with little attention given to weed densities or distributions. This is due to time and labor constraints for rigorous scouting, the complexity of the scouting information when sampled, the assumption that weeds are constant and uniform throughout a field, and the lack of equipment to easily manage weed variability even if it was noticed. Generally, a single recommendation (whether a single herbicide, tank-mix combination, or pre/post split) for weed management was given for a field based on the previous year's weed problems, scouting field edges, or driving a W or Z pattern across the field in the spring. These approaches have been successful in controlling weeds and improving profits. The questions are: 1) Do weeds vary enough in a field to manage them with precision techniques using different methods or herbicides? and 2) can we take advantage of technology (GPS, variable rate sprayers, direct injection controllers, etc.) to further improve weed management and profitability? This guideline discusses different approaches and concepts for obtaining information about weed diversity in the field.

In most cases, weeds are highly aggregated in a field (Johnson et al., 1995; Cardina et al., 1996 and SSMG # 7). For example, in a 160 acre field, densities of Canada thistle and foxtails (mixture of green and yellow foxtail species) were not uniform and occurred in different areas of the field (**Figure 1**).

Drainage, topography, soil type, and microclimate play important roles in what weeds will be found and how successful and competitive they will be at a specific site. The first step in developing effective site-specific weed management strategies is to obtain accurate and reliable data on the location of weed species and populations. The next step is to match the weed management solution to the problem in a site-specific manner. Spray equipment has been developed that allows for different chemical treatments and rates to be targeted to different areas of the field (see SSMG #7). Using information about weed variability and equipment that matches the correct chemical with the weeds present has been shown to result in better weed control, lower herbicide costs, and increased net return.

With these concepts in mind, you can then formulate your own detailed, step-by-step plan that works best for your scouting needs. Clearly, the most effective data collection strategy depends on how the data are to be used and in what time frame.

Sampling Scale

It is impossible to determine the level of weed infestation on every square foot in a field. Therefore, cost-effective strategies are needed that provide fairly precise information at a scale that a farmer can manage. This requires a great deal of thought about the level at which information is collected and interpreted. In order to optimize your time, both in scouting and application, you will want to consider equipment size and speed and the time it takes to change an operation on-the-go.

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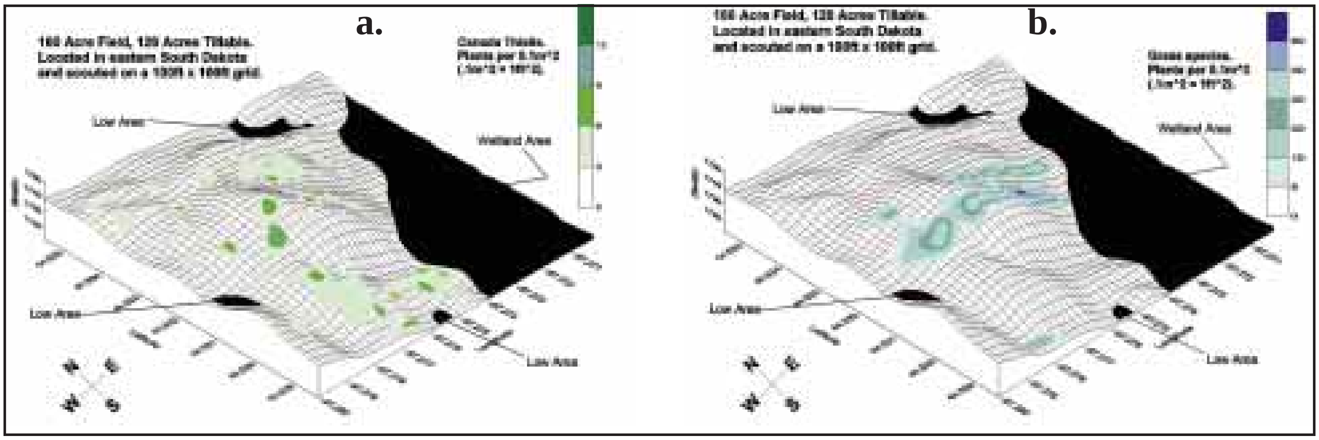

Figure 1. **Examples of weed populations and locations in a 160 acre field. Scouting was done on a 100 by 100 ft. grid, and data were kriged to obtain estimated densities between sampling points. Note the differences between Canada thistle (*Cirsium arvense*) distribution, (Figure 1a) and densities (0 to 12 per sq. ft.) compared with distribution and densities (0 to 50 per sq. ft.) of grass species [primarily green and yellow foxtail (*Setaria viridis* and *S. glauca*)], (Figure 1b).**

Equipment size. If the goal is site-specific herbicide application, then the width of the spray boom is a relevant sampling scale. For example, if the boom is 40 ft. wide, then you may consider a 40 by 40-ft. grid spacing. Grid sampling a 160 acre field at this scale results in about 4,400 individual data points. Sampling at this density would be time and cost prohibitive and would prove to be a data management nightmare. It would also be difficult to convert the information into useful decisions. How can we reduce the amount of time involved to sample and process data and still get useful site-specific information?

Speed and changing operations. In the above example, sprayer speed and the time it takes to change chemicals on-the-go can be included in the criteria for determining minimum grid size. At 5 mph, you travel 7.3 ft./sec. If it takes 10 seconds to switch herbicides coming from the boom, you've already traveled 73 ft. So perhaps a 40 by 100-ft. grid would be a more realistic grid size. Now in the 160 acre field, 1,750 samples would be taken; still too many, but an improvement over the previous example. If you are going faster, you've covered more distance and the grid could even be larger.

Sampling on a larger grid and using statistical techniques to interpolate values to the size that fits your management area is one solution. However, as grid spacing increases, weed patches or infestations may be completely missed because the area of the patch or infestation is less than the grid spacing used (**Figure 2**). There is obviously a trade-off between obtaining accurate information and doing so in a cost-effective manner.

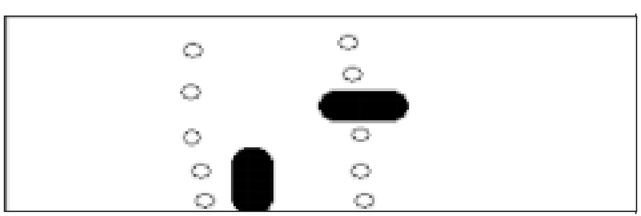

Figure 2. **Examples of weed patches that would not be sampled if a regular grid sampling technique is used.**

Sampling Schemes

Scouts must rely on their own judgement in designing a sampling plan that meets their objectives with respect to accuracy, time, and labor constraints. The following are suggested methods that can be adopted and adapted to your operation.

Quick Assessment

Method: ***Random assessment.*** Use an ATV to quickly identify the location of weed patches by driving in a grid pattern or pseudo grid pattern across the field, stopping only where weeds are present. Once a patch is identified, the area of the patch can be determined by driving around the perimeter of the patch. It is also not a bad idea to record the visual severity of each patch based on a predetermined set of criteria. For example, a patch can be recorded as severe, moderate or light based on a quick density estimate or some other measure of severity. It is best if a GPS can be used to provide accurate position information.
However, a rough estimate of location (either by counting rows or by using a measuring device) will do.
Alternative assessment. This can be accomplished by visually splitting a large field into 4, 8, 16, etc. smaller fields or splitting the field into areas with similar topography (drainage area, hilltop, side slope etc). For each area, a herbicide recommendation is developed using techniques like those described above.

Outcome: Data obtained from this procedure can be used to make a map showing the location of individual weed patches as well as relative severity. Some GIS software will also allow you to determine percent field area occupied by all weed patches or individual weed patches. This information is important for monitoring patch size over time or deciding if a patch is large enough to warrant control.

Advantages: Very quick and easy to implement. Works best for perennial weeds.

Disadvantages: Annual weed patches may be difficult to identify, especially if sampling is done in the spring when weeds are small. Information is limited to patch location, but can include an estimate of visual severity. When using a visual severity assessment, you must be very clear as to what you mean when you classify a population as severe vs. moderately severe vs. light. Because of this, the value of information can be limited. Visual estimates of patch severity can be misleading if care is not taken to standardize the estimates.

Regular (Uniform) Grid Sampling

Method: Data are collected on a uniformly spaced grid coordinate system. At each grid node, weed density or presence/absence data are recorded in a quadrant. There are a number of ways to record weed density.

Quantitative. The first method is to record the actual weed density for each species. This method can be time consuming when weed density is high, but does provide valuable information.

Semiquantitative by species. The second method involves counting weeds up to a certain number (e.g. 50) for each species. The idea here is that the value of knowing there is 100 vs. 50 weeds per ft^2 is not relevant from a weed competition standpoint.

Semiquantitative by groups of species. You can also choose to count weeds by species groups (e.g., broadleaves vs. grasses or small seeded broadleaves vs. large seeded broadleaves vs. grass weeds). This method is less time consuming than the other methods, but does not provide detailed information on individual weed species. It is less time consuming than determining actual density by species, especially in heavily infested areas.

Qualitative. The least time-consuming method is to simply assess the presence or absence of a given weed or weed complex at the given sampling points. The information obtained in presence/absence sampling provides a quick assessment of weed species diversity, but does not provide information related to the severity of weed infestations.

Outcome: Interpolation techniques can be used to build a map showing the location, size and density of weed infestations across the field. If a GIS is used, other information collected at the time of sampling (e.g., stand counts or disease presence) can be integrated in this map.

Advantages: Easy to implement and understand. Does not require any prior information about weed populations in the field and can therefore be done by less-experienced people.

Disadvantages: Optimal grid spacing is unknown and depends on several factors. One can decide on a grid spacing that maximizes cost and labor efficiency (e.g., I only have time to sample 100 points across a field). This has shown to be an effective method for soil sampling, where soil properties change gradually across a field and usually occur in larger blocks. Because weeds are highly aggregated, this method may result in entire weed patches being missed because the size of the weed patch is smaller than the grid spacing. One alternative would be to use a predefined grid system which allows the scout to deviate from the grid if weeds are noted but otherwise missed. The allowable degree of deviation off the grid is dependent on time and cost considerations.

Sampling at Harvest

Method: Weed mapping at harvest is an easy method to generate maps of weed infestations in a field. Simple devices are connected to the GPS signal on the yield monitor to record weeds as a field is harvested. You simply push buttons on the device when you enter and exit a weed patch. If you have different "flags" for different weeds, you can determine the location and the weed problem.

Outcome: A map is produced that is matched to the yield map.

Advantages: This is a simple, easy method that is done with another operation so it does not require any extra time. The map can be used to see how well weed management operations worked for the past season and will give an indication of trouble spots for the next year. If the weeds are perennial, you may be able to treat problem areas after harvest.

Disadvantages: This is an "after the fact" map; weeds have already caused harvest losses. Often the flagging device is left on (or off), especially if you get busy or start daydreaming, resulting in an erroneous maps. Too many flags for different species are confusing. One flag for annual broadleaf weeds, one flag for grasses, and one flag for perennials may be the easiest sampling scheme. Problems may occur at field edges and in end rows. Since this is usually where new infestations start, mapping these areas with care is recommended.

The above methods do not consider prior knowledge about the weed populations in the field in determining the design of sample number or location (grid spacing). We feel that experience has a lot to do with how accurately a weed population is characterized and should not be overlooked. Most farmers and scouts know what weed species are present and where they are located in the field. In fact, weeds tend to occur in the same general location over time, and it is possible to direct sampling efforts to areas where weeds are most likely to occur. Directed sampling allows you to accurately characterize weed populations in much less time because you are not sampling the entire field. Given this fact, it seems natural to use this information in designing an adaptive sampling strategy that stresses flexibility and recognizes experience.

Adaptive Sampling

Method: A grid system is used initially and then modified based on supporting information over time. Supporting information may come from a variety of sources and experiences. An example of supporting data is aerial imagery.

Adaptive Sampling Using Aerial Imagery

Method: Multispectral remote sensing offers the potential to identify, categorize, and determine differences and similarities in crop and field conditions over a wide geographic area. Images can be taken several times during a season or over years to give views of whole fields, farms, and watersheds.

Outcome: Spatial variables relate to both pixel size and minimum object/feature size. Understanding what pixel resolution means will help you determine what would be useful for your scouting program. A 1-m^2 pixel resolution will integrate reflectance to give one value for an area about the size of a tabletop. A pixel resolution of 30-m^2 integrates the reflectance in the area of six school buses parked together. Large, dense weed patches may show up in the 30-m^2 resolution images, whereas the finer resolution would give more detailed information.

Timing of the flight also needs to be considered. Images taken just prior to post-emergence applications using a combination of visible and near-infrared bands can give information on the location of field anomalies. Images taken in the fall after a light frost along with adaptive scouting techniques are also excellent sources of weed information since perennial weed patches may still be green, even after the crop has senesced (**Figure 3**). Overlaying the visible and near-IR georegistered bands gives an enhanced false color view of the field which can also be used to determine areas related to other stress factors such as water, insects, diseases, or fertility problems.

Advantages: Aerial imagery allows you to modify a sampling strategy by having access to weed information on a field scale in a timely fashion.

Disadvantages: This method requires post-processing which means that images need to be analyzed by trained professionals. Therefore, there may be considerable time between when the data were collected and when they became available. Timing is obviously critical for post-emergence herbicide application decisions. You must work closely with the company providing the aerial images to make sure it is delivered in a timely manner. ■

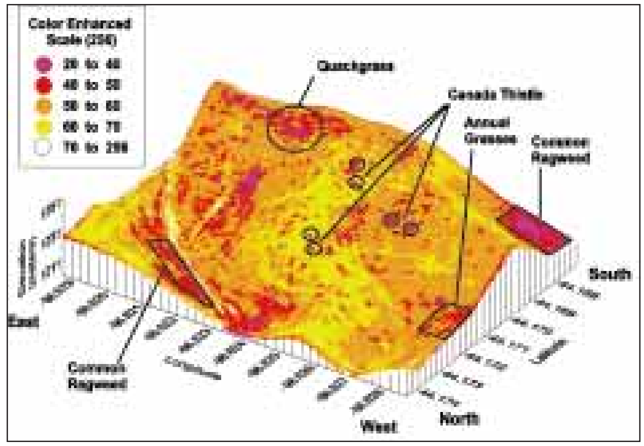

Figure 3. Aerial image of a 160 acre soybean field taken in early October with 1-m pixel resolution. Patches of Canada thistle are evident across the entire field as round, dark spots. Low areas of the field had high densities of common ragweed. Additional scouting using this image as a field map revealed the areas of quackgrass and annual grasses that had not been controlled. Since this image is georeferenced, it can be used as a spray guide for perennial weed control in the fall and as a scouting tool in the spring.

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Ref. # 99085/Item #10-0015