INTEGRATED PEST MANAGEMENT

Crop Rotation

Crop rotation is an essential part of agriculture. Without proper crop rotations, weeds, insects, and diseases are much harder to manage. Changing crop types removes the host or food source for pests and diseases causing populations to drop rather than to build up over time. Introducing a new crop also allows for changes in integrated pest management strategies including the pesticide class being used. Rotating through pesticide classes and using two or more effective ingredients is a very important step in reducing pesticide resistance.

Pesticide resistance builds when pest and diseases are not fully eliminated by a pesticide. The pests and diseases that have genetic attributes that afford some protection survive at a higher rate than those without leading to a resistant population. Changing the effective ingredient year after year and using more than one at a time decreases the likelihood of a pest or disease population simultaneously achieving pesticide resistance to all the applied pesticides. If they have developed resistance to one they will be eliminated by the other. A pesticide strategy that is intensively and carefully managed like this will result in less pesticide use in the long term, which benefits farmers and the environment.

Crop rotations have additional benefits especially if crops are chosen for complimentary soil improving properties. It is common practice to include a pulse crop to benefit from biological nitrogen fixation. Deep rooted graminoids like wheat are excellent at increasing belowground residue inputs as well as scavenging for nutrients that have leached below the rooting zone of more shallow rooted crops. Improved nutrient cycling and soil structure is thought to contribute to the higher yields seen with crops grown in rotation. Crop rotation improves overall farm level crop diversification. Crop diversification is beneficial as it promotes stability in production and markets as well as spreads out the timing of management practices.

SWAT MAPS can be used to take crop rotations and diversification further by targeting certain crops to their optimal locations within a field. For example, peas are prone to fungal root diseases and as such are not well suited to moist soil conditions found in many depressions. Conversely, canola is a high water use crop that can benefit from this increased moisture. Seeding peas in drier SWAT zones and canola in wetter SWAT zones optimizes the heterogeneity of the field. Pea and canola tend to also be a good mix as their vastly different seed sizes makes sorting post harvest far easier than more similarly sized grains (see Figure 1).

Figure 1. *"Peola" (Pea-Canola) intercrop applied with a VR prescription targeting dominantly peas in SWAT zones 1-3 (left photo) and mostly canola in SWAT zones 7-10 (right photo).*

Integrated Pest Management

Like nutrients, some pesticides are at risk of movement into aquifers or surface waters (Grover, 1973; Ritter et al., 1994). This risk is specific to individual chemicals and their solubility in water, adsorption characteristics and persistence (Congreve and Cameron, 2019). Relatively soluble pesticides (e.g. atrazine) can easily leach into subsoil water or surface waters. Others are bound tightly to soil particles (e.g. trifluralin) and are at negligible risk of movement unless there is soil erosion. Off-target movement of pesticides in this manner should be treated as seriously as spray drift from one field to another. Understanding the leaching potential of the soil, as well as organic matter and total WHC, can help reduce movement of pesticides off site (Futch and Singh, 1999). Well drained irrigated soils are a considerable risk, but precise management of irrigation schedules is one of the most impactful ways to minimize this risk. Variable rate irrigation (VRI), using soil moisture probes and SWAT WATER maps, is a valuable solution for this problem, much like managing nitrogen and phosphorus losses.

Any way pesticide rates can be reduced without resulting in a loss in weed control is an opportunity for reducing environmental impact and managing farm input costs. VR herbicide application has potential in some landscapes that are variable enough to justify different rates based on soil type or weed population (see Figure 2). Gaston et al. (2001) noted an example in cotton where a reduced soil-applied herbicide rate prior to cotton could be used in coarser textured soils with lower organic matter. This was both due to lower weed density in these areas, as well as varying herbicide effectiveness based on the soil properties.

Pesticides are valuable tools to produce healthy, high yielding crops, but it is imperative to use them according to label guidelines. Knowledge of soil and water variability across a landscape, which SWAT MAPS can provide, is the foundation for proper soil-applied pesticide application decisions. Pesticides should always be used in conjunction with other integrated pest management practices like crop rotations and general biosecurity including sanitizing equipment moving from field to field and especially farm to farm.

Metrics

Crop rotation metrics should be assessed during planning of the crop rotation. Metrics for good rotation planning include the incorporation of at least one legume, the inclusion of sufficient biomass yielding crops (e.g. wheat) to maintain SOM and be at minimum three years. Long term measurements of the efficacy of crop rotations include measuring SOM as mentioned previously. Additionally, pest monitoring can be useful in determining if the rotation has been effective and if the rotation needs to be modified. Furthermore, pest control measures need to be complimentary for pesticide carry over and ensuring that there is variability in the classes of pesticides being used.

Recommended Metrics:

- **Crop rotation: Inclusion of one legume, one biomass-yielding crop and minimum of 3-year crop rotation;**
- **Insect, weed, and disease monitoring**

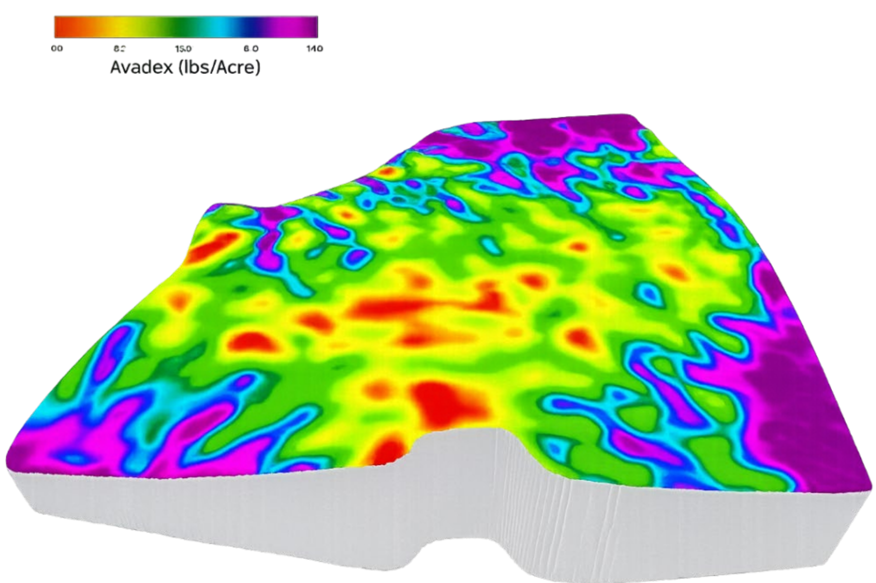

Figure 2. *Herbicide applied using variable rates based on SOM and texture.*

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Acronym & Abbreviation Guide

SOM — Soil Organic Matter
Decomposed biological material in soil essential for fertility, structure, water retention, and long-term soil health.

SWAT — Soil, Water, and Topography
A spatial soil landscape framework for mapping stable properties that drive yield potential and environmental interactions.

SWAT WATER
A modelled layer integrating SWAT MAPS with soil moisture probe data to estimate spatial plant-available water.

VR — Variable Rate
Varying seed, fertilizer, or pesticide applications within a field based on mapped variability.

VRI — Variable Rate Irrigation
Irrigation water applied at different rates across a field based on soil water holding capacity and moisture demand.

WHC — Water Holding Capacity
Volume of plant-available water stored between field capacity and wilting point across soil profiles.