SDSU Extension

iGrow Soybean

BEST MANAGEMENT PRACTICES

Chapter 16: Using Field Scouting or Remote Sensing Technique to Assess Soybean Yield Limiting Factors

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Obtaining real-time remote sensing information can be used to improve management by targeting scouting activities and identifying yield-limiting factors in areas that cannot be seen from the road. In addition, an improved understanding of the yield-limiting factors can be used to select appropriate genetic trait packages for next year. This chapter provides an overview of remote sensing and how it can be used to improve management (Chapter 29).

Scouting, identifying problems, and sensors

Soybean yields can be reduced by nutrient deficiencies, water stress, and weed, insect, and disease infestations. Information about the extent of problems can be identified by scouting the field from the air, the ground, or by obtaining satellite images (Fig. 16.1).

The traditional crop scouting method is to walk or drive a 4-wheeler on a random course, selected in advance, through a field with stops at a number of locations to look for damaged leaves, collect insects, or count weeds (Chapter 29). When using this approach, an attempt should be made to identify the cause and extent of a problem (Table 16.1). A disadvantage of this approach is that it is time-consuming and in many situations, a large percentage of the time can be spent in evaluating healthy plants. In addition, random observations can miss areas of the field requiring corrective treatments. Remote sensing can be used to increase the efficiency of the ground scouting program (Table 16.1).

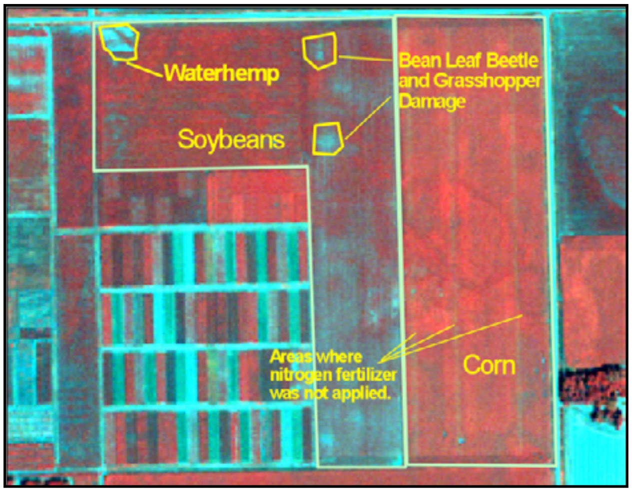

Figure 16.1. False color IKONOS image (green, red, and near infrared) of corn and soybeans collected on July 17, 2002. In these images problem areas were identified by ground scouting. Available at http://www.umac.org/agriculture/ss/RemoteSensingtoDetectWeedsandDiseasesinaSoybeanField/detail.html

Table 16.1. Symptoms and possible causes that should be identified during scouting. In this table, NIR is reflectance in the near infrared band (700 to 1200 nm) and NDVI is a ratio of reflectance in the red (600 to 700 nm) and near infrared bands [NDVI = (NIR-red)/(NIR+red)]. Additional information about reflectance is available at http://earthobservatory.nasa.gov/Features/MeasuringVegetation/measuring_vegetation_2.php.

Symptoms	Possible Causes	Impact in Remote Sensing
Poor seedling emergence or young seedlings die	Low quality seed, soil crusting, incorrect planting depth, root rots, chemical carryover	Low NDVI values and low density of red color is false color image due to low density of green plants (Ahmadi and Mollazade, 2009).
	High pest pressure, root rots, chemical injury from metribuzin or atrazine	
	Damping off, Stems may show reddish-brown decay or appear water soaked	
Yellow/brown leaves	Fe deficiencies, poor nodulation, nematodes	Low NDVI values and light/no red color in false color image due to low NIR reflectance from unhealthy plant leaves.
	K deficiency	
	Brown spot	
	Root rots, on older plants tissue between the leaf veins turn yelow and dies, roots may be rotted	
Mottling or distorted leaves	Pod and stem blight	
	Bean pod mottle	
	Soybean mosaic virus	
Poor plant growth	Chemical injury or insect damage	
	Nematodes, drainage problems, drought, pests, chemical damage	
	Low pH, nutrient deficiencies, lack of effective seed treatment	
Holes in leaves	Hail damage or foliage-feeding insects	
Stunded roots	Soil compaction, nematodes, chemical damage	

Two alternative methods to field based weed scouting include using a W-pattern with 60 points or grid sampling (Clay et al., 1999). The W-pattern has been effective in collecting useful information on whole field weed populations, while the grid sampling approach, along with GPS (Global Positioning System) measurements, can be used to develop site-specific application maps. Grid sampling is much more labor intensive than a random sampling. It may be possible to develop a site-specific application map by using remote sensing targeted sampling.

In many situations, symptoms or anomalous areas can be easily identified using aerial or satellite images. Most multispectral satellite sensors measure reflectance at specific visible (blue, green, red) and near-infrared (NIR, 700 to 1200 nm) bands. When using remotely sensed images, it is important to remember that:

- Different sensors have different pixel resolution:
  - ▹ Each band generates an image and resolution represents the amount of detail within an image. The smaller the pixel the more spatial detail in the resulting imagery.
  - ▹ In agriculture, high resolution images are generally desirable. http://www.ipni.net/publication/ssmg.nsf/0/095C22F8E6598FEA852579E50077EC0D/$FILE/SSMG-42.pdf
- Many problems have similar reflectance patterns (Table 16.1).
- Once problem areas are identified, causes should be confirmed.

Additional information on sensors is available at http://www.satimagingcorp.com/characterization-of-satellite-remote-sensing-systems.html.

Crop reflectance

Changes in plant health can be measured using crop reflectance (Fig. 16.2). Healthy plants generally have lower reflectance in the visible bands and higher reflectance in the NIR bands than do unhealthy plants. The visible and NIR bands are combined in false color images (band combinations of green, red, and NIR) and the Normalized Difference Vegetation Index (NDVI = (NIR-RED)/(NIR+RED)). NDVI is a simple indicator that can be used to analyze remote sensing measurements and assess whether the observed target (field) contains live healthy plants (high index values) and unhealthy plants (low index values). In the false color images, the healthy plants have a very red color and the unhealthy plants have light red color.

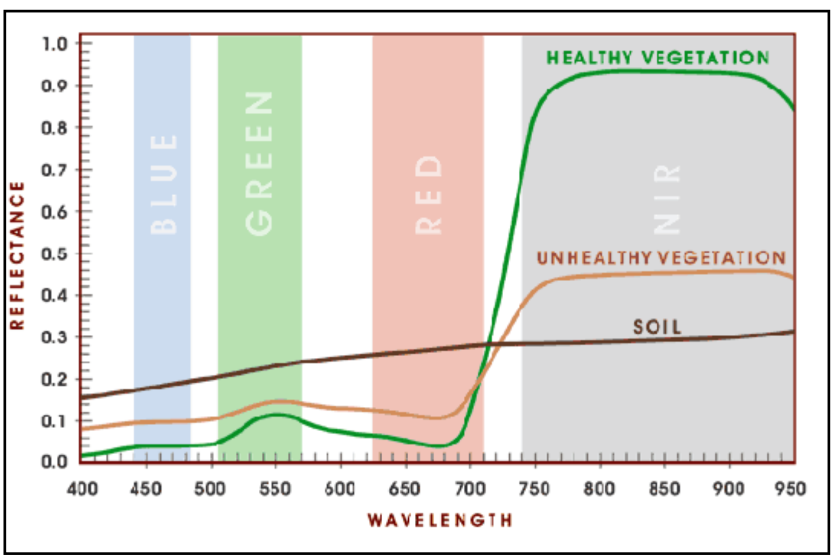

Figure 16.2. Spectral reflectance of healthy plant, unhealthy plant, and soil in visible and NIR wavelength.
(Source: http://extension.usu.edu/nasa/htm/on-target/near-infrared-tutorial/)

Remote sensing for crop management

A remote sensing program can be separated into four unique steps. These steps are discussed below.

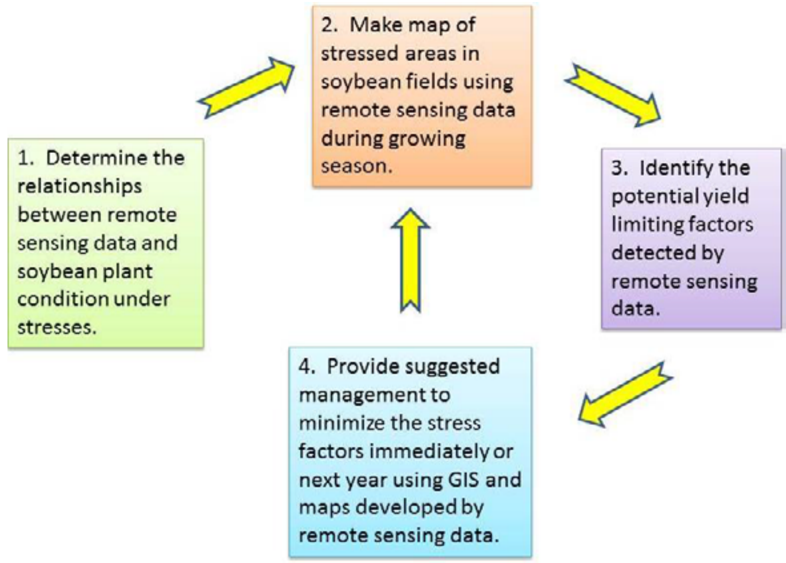

Figure 16.3. The concept of remote sensing technique for crop management. (Diagram: Jiyul Chang, SDSU)

Step 1. Determine if remote sensing can help.

The first step in integrating remote sensing into your decision process is to determine if the remote sensing images can detect the stressed areas. If differences cannot be detected, using the resolution available, remote sensing cannot be used. The inability to detect a stress may be related to:

- not having fine enough resolution,
- not using appropriate indexes or bands,
- not using the appropriate sampling date,
- having healthy and stressed plants with similar reflectance values, *and/or*
- collecting images under cloudy or hazy conditions.

Step 2. Develop a stress map.

Once an image is collected, the area producing differential reflectance must be identified. The factors causing differential reflectance can be identified by using targeted sampling (Table 16.1). If the spatial resolution is low (large pixel size), it is hard to identify the stressed areas. The commercial satellite images with high spatial resolution are IKONOS, RapidEye, GeoEye, QuickBird, and WorldView. The range of spatial resolution (pixel size of image) of these images is 1.5 to 5 meters.

Another important factor to consider is sampling dates. These images can be collected for the same field every 1 or 3.5 days. High spatial resolution images can show the exact locations under stress at different times.

Step 3. Identify the yield limiting factors.

During ground scouting, the causes for poor growth need to be identified. This may involve collecting plant, soil, weed, and insect samples (Fig.16.4). In Figure 16.4, soil samples revealed that areas with poor growth resulted from high soybean cyst nematode (SCN) populations. When soybean plants are severely infected by SCN, they become stunted, they appear chlorotic, and canopy closure may not occur. SCN areas typically are round or elliptical in shape and are elongated in the direction of tillage.

Many stresses have similar symptoms (Table 16.1) and may require additional information to make a diagnosis. Information that should be collected includes:

1. timing,
2. the location of stressed areas,
3. landscape position,
4. pattern in the field,
5. soil differences, *and*
6. plant symptoms.

Analysis of soil and plant samples can be used to help confirm a diagnosis.

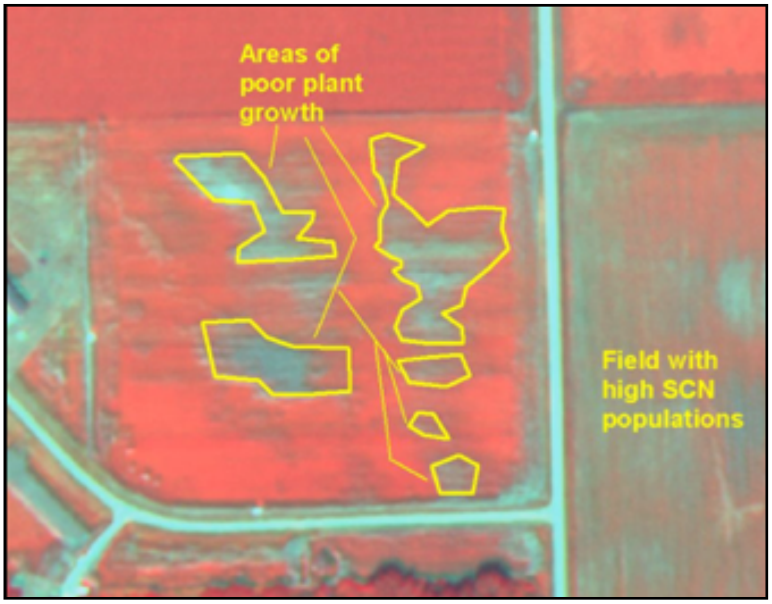

Figure 16.4. IKONOS false color image (Green, Red, NIR) (July 10, 2002) of a soybean field in southeastern South Dakota. Areas of very poor plant growth due to SCN and other factors are highlighted. The field across the road to the right was heavily infested with SCN; note poor reflectance in this field.
(Source: http://www.umac.org/agriculture/ss/DeterminingtheExtentofSCNInfestationinSoybeanFields/detail.html)

Weed patches can be detected in early season (before canopy closure) for row crops such as soybean and corn. Weeds can produce mixed impacts on crop reflectance. Depending on timing, weeds can reduce or increase the NDVI value (Fig. 16.4; Chang et al., 2004).

Potassium (K) deficiencies and diseases generally decrease the NDVI value. The symptoms of K deficiency usually appear relatively late in the season. K-deficient soybean plants may have yellow leaves. The soybean fungus diseases with similar symptoms are Sudden Death Syndrome (SDS), Brown Stem Rot (BSR), and White Mold. When symptoms of SDS first appear, they may be confined to a few small areas or strips. Over the following two or three weeks, affected areas may enlarge, and other areas in the field may show symptoms. Leaf symptom development of BSR is greatest when air temperatures are high during the R3-to-R4 growth stages. The foliar symptoms may peak at R7.

Symptoms of feeding damage of soybean aphids include plant stunting and leaves covered with honeydew (a sticky substance excreted by aphids) and black sooty mold. Ian MacRae, a University of Minnesota Extension Service entomologist based in Crookston, Minn., has found that the soybean plants which had stress with high aphid populations had lower reflectance of infrared and near-infrared light than the healthy soybean plants have. http://www.theprairiestar.com/news/agri-tech/remote-sensing-for-soybean-aphids%20-the-latest-in-crop-scouting/article_5fd849e2-d1ba-11e0-b269-001cc4c03286.html

The soybean aphids usually appear around the first week of June as small populations as well as isolated pockets during most of June. Aphid populations peak during the R1-to-R4 growth stages.

Step 4. Develop corrective management solution.
Once yield-limiting factors are identified, corrective solutions need to be developed. For some problems, corrective solutions are only available for future years. If current solutions are possible, this information needs to be forwarded to the decision-maker as quickly as possible. Processing information for precision treatments requires the ability to identify the problem locations. To identify the problem boundaries, Differentially corrected Global Positioning System (DGPS) and Geographic Information Systems (GIS) may be needed. The GIS formats are point, line and polygon, which contain GPS coordinates. These data can be used to develop precision application maps.

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