Potential for Site Specific Management in Midwest Mint Production

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Introduction

Peppermint (*Mentha piperita*) and the spearmints (*M. spicata* and *M. cardiaca*) ("mint") are grown in the Midwest as high value essential oil crops. In 2003, over 19,000 acres of mint returned almost $10 million to growers in Indiana, Michigan, and Wisconsin (NASS, 2004). In Indiana, mint is the state's largest acreage horticultural crop. Despite its importance in the Midwest, mint is considered an "at-risk" crop due to pressure from foreign production and synthetic flavorings and regulatory loss of key herbicides. Mint growers need strategies to increase efficiency and decrease input and management costs. In 2002, research was begun to evaluate the potential of three site-specific management technologies for optimizing crop management in mint: 1) Multispectral remote sensing; 2) GPS-referenced directed scouting; and 3) GIS-based analysis of data.

Midwest Mint Production

Midwest mint is grown exclusively for distillation of essential oil which is used as a flavoring in gum, candy, and oral hygiene products. Mint is grown as a short term perennial in a 3- to 5-year rotation.

First year mint ("row mint") rhizomes are planted in rows in the early spring. In most years, row mint is harvested around the first week of August. To harvest, the mint is mowed and placed in windrows to dry for 24 to 48 hours. Dried hay is then chopped using a modified forage chopper into 3 to 5 inch pieces and blown into a mint tub, a large tub that has steam pipes running through the bottom. Once the mint tub is full of hay, it is taken to the distillery. The tub is sealed and attached to a steam delivery hose at the bottom of the mint tub and a vapor recovery hose at the top of the mint tub. As steam enters into the bottom of the mint tub, it vaporizes the mint oil. The water vapor and vaporized mint oil rise, are forced into the vapor recovery hose, and enter a cold-water condenser. As the mint oil and water vapor mixture condenses into a liquid form, it is forced into a separator, and the mint oil, which is lighter than water, floats to the surface and can easily be drained off from the water.

After harvest, mint fields are allowed to regrow. Usually, fall tillage is done to provide insulating cover through the winter and facilitate disease and insect control. (Green, 2000). Traditionally, most mint fields have been moldboard plowed in order to obtain the greatest cover for winter survival and pest control; however, some producers have begun chisel plowing or even using no-till practices in order to reduce the potential for soil erosion from wind and runoff (Weller et al, 2000).

Fall tillage has the effect of breaking up, spreading, and burying the mint rhizomes. In the spring, the mint will reemerge in a solid pattern across the field. Second year mint is referred to as "meadow mint." Meadow mint grows more vigorously than row mint and is usually harvested in July.

A field is kept in peppermint production for 3 to 5 years, depending on disease pressure. A spearmint field may be kept in production for 10 years or more. In Indiana, peppermint is generally rotated with corn and soybeans. Fields rotated out of peppermint production are not rotated back to peppermint within 3 to 5 years of the previous mint crop.

All mint oil is produced on contract and sold to one of several companies who blend oil from several growers and sell it to an end user. End users are companies such as Wrigley's, Colgate, or Proctor and Gamble.

Since mint requires a 15-hour photoperiod in order to flower and produce desirable flavor components, production is confined to the area north of the 40th parallel (Weller 2000). The major areas of production are in Indiana are Starke, St. Joseph, and Newton Counties. Mint is also raised in southern Wisconsin and southern Michigan. The other large area of mint production in the US is the Pacific Northwest.

Current Site Specific Management in Mint

Recent research with remote sensing, GPS, and GIS monitored the condition of a mint crop during its development within a field. Aerial multispectral images of peppermint and spearmint fields show that variation in mint stand health can be detected using remote imaging and that these variations correspond closely with variations in soil type (Figures 1 and 2).

Figure 1 – Multispectral images showing crop vigor in two mint fields.

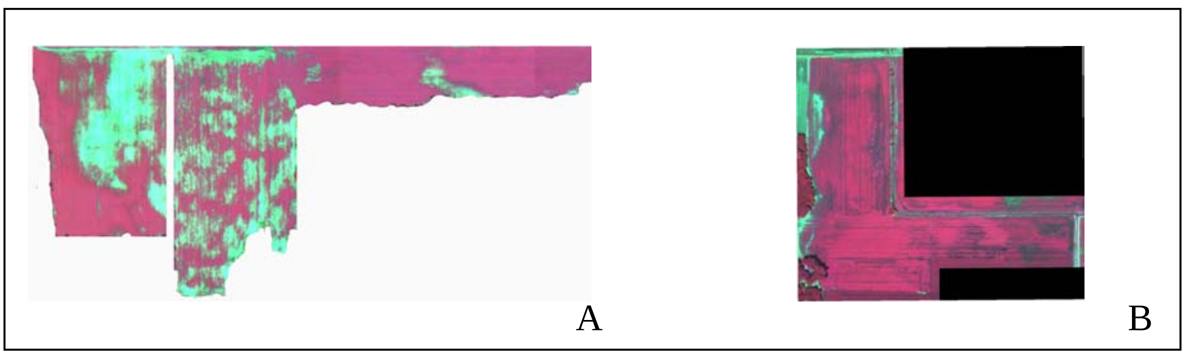
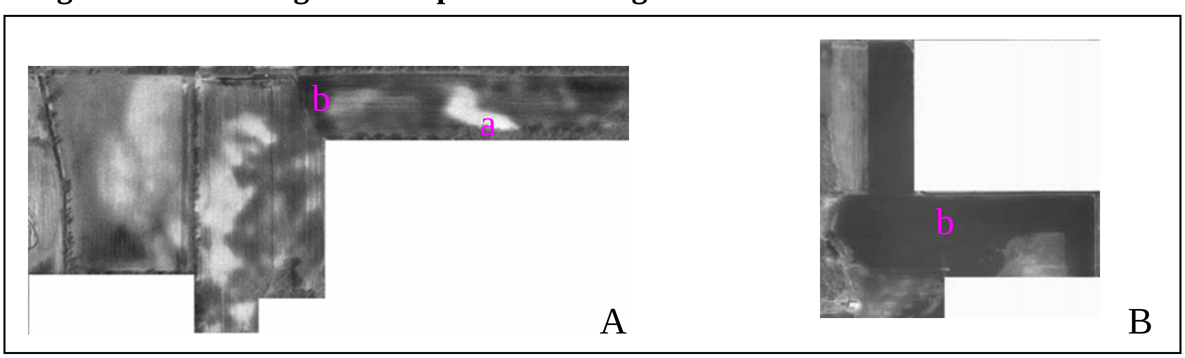


Figure 2 – USGS digital orthophotos showing variations in soils in two mint fields.



Multispectral images 14 days before harvest show healthy vegetation areas in pink, decreasing vegetation areas in green and bare soils (no vegetation) in blue. In addition to illustrating in-field variation, images differentiated between Fields A (poor) and B (healthy). Aerial images showed field vigor variations not readily apparent from ground scouting (Figure 1).

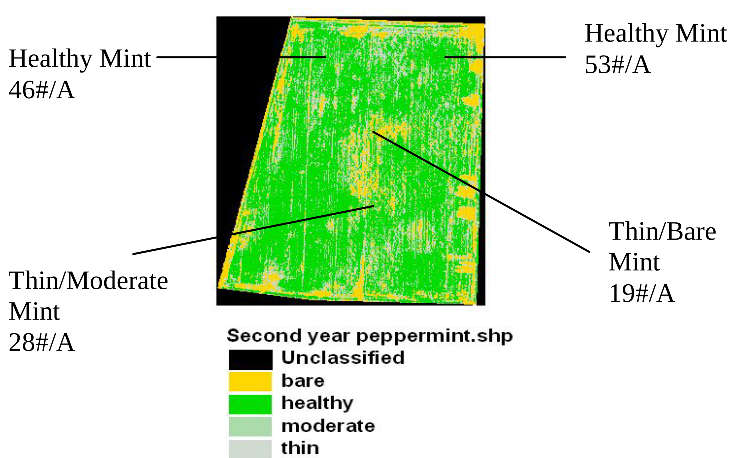
Multispectral images compared to USGS digital orthophotos of bare soil suggest a strong correlation between soil type and mint vigor. In these images, sandy soil (a) was differentiated from muck soil (b). Field A had many soil types while Field B had less variation and soil type correlated well with mint vigor shown in multispectral images (Figure 2).

Directed crop scouting in 2002 noted stressed areas and defined areas to determine specific causes of sparse mint canopies. Multispectral images from 2002 studies were compared to ground scouting data obtained during the same time frame and used to develop directed scouting approaches for pests and crop management. The approach used to gain the most value from the aerial images involved geo-referencing the aerial photos (on GPS-equipped, hand-held computers) and noting if variation occurred. Secondly, each field was ground scouted and field conditions including weed species present and severity, crop vigor and stand, soil type changes, disease pressure, nutrient deficiencies, and moisture status were geo-referenced. The multispectral images were reanalyzed to determine if field variations were detectable. Future research will use spatial statistics to quantify field variations relating to crop growth and pest infestations.

Classification of multispectral images, using supervised and unsupervised classification correctly assessed different field conditions 7 days before harvest. Unsupervised classification of a multispectral image (A), where the computer automatically assigns pixels in an image to a certain number of categories, placed field areas into four categories: healthy, moderate, thin, and bare (B) (Figure 3). Ground verification showed oil yields from healthy mint were higher than from moderate or thin mint.

Figure 3– Unsupervised classification of peppermint crop health (B) based on aerial multispectral image (A).

A



B

Supervised classification, where the image analyst trains the computer in which categories to place pixels, created accurate weed distribution maps for some weed species. Figure 4 shows crop health and weed distribution classification in a meadow spearmint field based on a multispectral image taken 7 days prior to the second harvest (late August). Weed infestations correspond to weaker mint stands or bare areas. Classification of weed species has been most accurate when weeds differ in appearance to mint, such as white cockle, foxtails, Canada thistle, and hemp dogbane. Maps developed to date have had accuracies of greater than 90%.

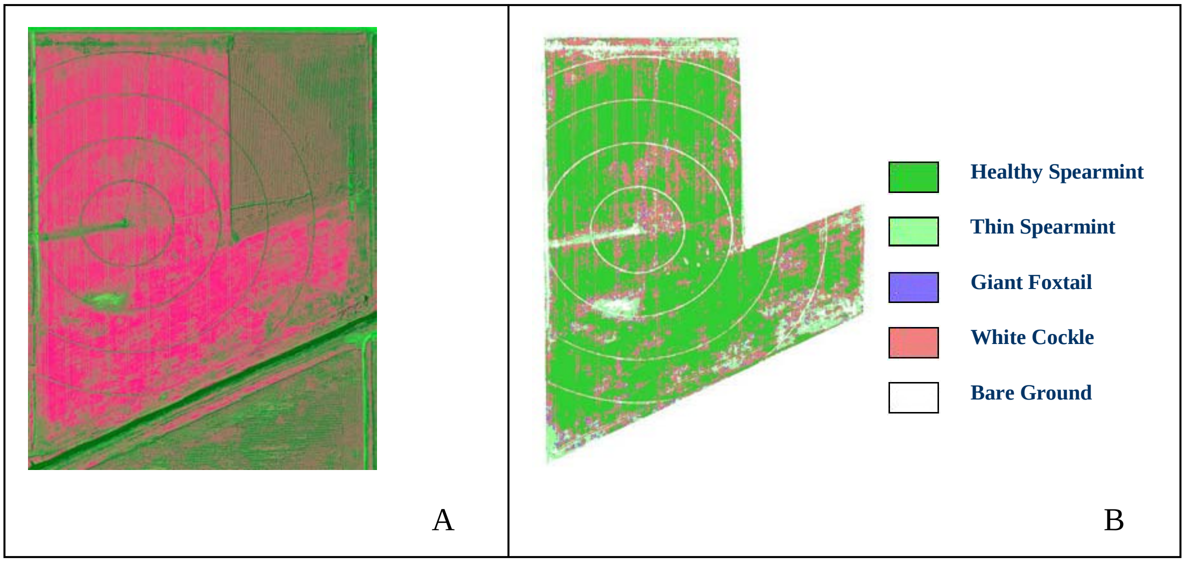


Figure 4 - Supervised classification of spearmint crop health and weed distribution (B) based on aerial multispectral image (A).

Multispectral images show fields with the most vigorous mint growth had the best weed control. Weed patches developed where there was no mint to compete with the weeds and remained constant through the season. Weeds did not expand and invade the surrounding mint stand, nor did mint spread into the weed patch and begin to compete with the weeds. Multispectral images of fields with sparse mint coverage showed weed species invaded those areas immediately after harvest, when weed growth rates exceeded that of the crop. Widely distributed infestations of annual weeds, with the exception of *Amaranthus* species were not noted in meadow peppermint fields. GPS-directed field scouting found weed infestations were more prevalent in areas of the field where the mint stand was weak or absent. This suggests that in addition to timely herbicide applications, a healthy mint stand is also necessary to control weeds. This is in agreement with past weed control studies (Weller, 1994; Gumz, 2001) and suggests a strong correlation between soil type, mint stand vigor, and weed infestation. Further research on the management of mint production according to soil type, in order to optimize weed control is justified.

The Future of Site-Specific Management in Mint

Remote sensing, GPS-directed scouting, and GIS analysis are being integrated to form a basis for making crop management decisions. Although research has been done on each of these technologies individually, it is the integration of the three that will allow for accurate diagnosis of field conditions. GPS-directed scouting will allow a grower to go precisely to specific field areas identified in the remotely sensed images in order to diagnose a problem. GIS analysis allows integration of data regarding interactions between soils, mint crop health, and weed infestations or other crop conditions, such as diseases, insects, or abiotic stress. This research will allow the capability to classify multispectral images without exhaustive ground-truthing or spectral analysis.

As the accuracy of remote sensing technology increases, greater opportunities for its use will become apparent. For example, a grower could assess the potential yield of a field he is considering planting to mint based on soil types. An assessment of economic return from a field could be made before investing time and money in planting.

The logical extension of our current research is to combine it with progress being made in the area of site-specific herbicide application. Accurate weed maps combined with accurate variable rate herbicide sprayers would allow growers to spray herbicide only on weed patches reducing herbicide costs, improving yields, and reducing total pesticide load in the environment

For further information:

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