Asparagus

Tuesday morning 9:00 am

**Where:** Grand Gallery Room B (lower level)

**Summary:** Focus on the management of asparagus through understanding the physiology of the plant, successful marketing efforts and a report from the industry’s Advisory Board, are highlights of this session.

**CCA Credits:** CM(1.5)

**Moderator:** Eugene Kokx, Michigan Vegetable Council

**9:00 a.m.** The Physiology of Asparagus Growth

- Dan Drost, Utah State University

**9:30 a.m.** Effects of Mild Heat Treatment on Asparagus

- Kirk Dolan, Michigan State University

**9:50 a.m.** AspireUS: Improving Asparagus Performance by Monitoring Root Carbohydrates

- Dan Drost, Utah State University

**10:20 a.m.** Locally Grown Food: Tastes Great... and Less Mileage

- Christine Lietzau, Michigan Dept of Agriculture

**10:40 a.m.** Michigan Asparagus Advisory Board Update

- John Bakker, MAAB, MPAB, and MOC
The asparagus growth occurs when temperatures are warm enough to initiate spear growth in the spring and by generating enough fern after harvest to replace the carbohydrate (CHO) used to fuel spear and fern growth. In temperate production regions (Canada, Michigan, Washington) growth processes that occurred this year (CHO storage, bud initiation and growth, root/crown expansion) will affect next years level of productivity. Because these are connected but are also separated in time, it is hard to state which environmental or management practice has the biggest effect on future growth and yield. The scope of this presentation is to focus your attention on the connection between environments, farming practices, and future productivity so the decision made regarding fertilizer use, pesticide applications, harvest pressure, and irrigation can help maintain acceptable levels of production.

**Plant Growth Dynamics**

An asparagus plant is composed of ferns of different ages (buds, spears, young, mature and old fern), an underground rhizome (crown) which supports the fern and the flesh and fibrous roots of different ages. During the first year after seeding, the plant generally balances dry matter equally between fern and crown growth (Dufault, 83). After planting the crown, stored food reserves are used to generate the fern that manufactures CHO needed for additional fern development and CHO storage and root growth (Drost, 97). Often growers wait two years before they start harvest to ensure that there is enough plant growth to support the harvest of spears and the continued development of the plant. However, more growers are harvesting in the first year after planting to offset some of the costs associated with the establishment of a new planting. Some evidence suggests that early harvests (Wilson, 99) and excessive tillage (Drost, 00; Putnam, 72) contribute to early decline of asparagus.

Asparagus growers realize that high levels of productivity depend on the plants ability to balance root and crown growth and spear growth during harvest (Drost, 99). During the first few years (3-5) after planting, CHO is required for spear growth and continued crown and root expansion. Since fleshy storage roots live for about 5 years, these first few years are important to ensuring the crown grows large and produces many buds (Wilcox-Lee, 91). Too big of a harvest then reduces the number of buds and the CHO levels so that future growth and long-term productivity is adversely affected. Recent studies show a strong correlation between plant populations, root biomass and spear yield (Wilson, 99). Therefore, creating good growing conditions early in the life of the asparagus bed will ensure that stands are maintained. Then during the peak harvest years (years 6-12), crop management effort that maintain active root replacement should ensure that high yields are realized. These crop management efforts will include adequate plant nutrition, careful water management, appropriate tillage, and paying attention to weed and pest problems.

So how much growth should growers expect during the yearly growth cycle of a mature asparagus plant? Research indicates that a typical plant should have approximately 10 large fern that weight 2-3 pounds (Wilson, 02). If you dig up that plant it would have several hundred storage roots, weigh 8-10 pounds, and have 75 or more buds. Roots should be uniformly distributed throughout the soil and the plant population should be greater than 90% of the initial population. Plants like these have the potential for yields in excess of 8,000 lbs/A.
Nutrition Issues

Since spear and fern growth is initiated from stored carbohydrates, nutrients applied in the previous year have the biggest impact on yield (Robb, 84). This tells us a lot about when we should time the nutrient applications, especially nitrogen. Most studies show that N has its biggest effect when applied after harvest. The N is used to help grow bigger fern which can produce more CHO. In most temperate areas, N requirements range from 75-100 lb N/A. Why this amount? If an asparagus crop produces 10,000 lb of fresh spears per acre, this is equal to 1000 pounds of dry weight. Spears are about 4.5% N so only 45 pounds of N would leave the farm. Presently work being conducted in our laboratory and in Washington has confirmed these numbers. It has been estimated that for a mature asparagus crop, the roots and rhizome contain between 600 and 700 pounds of N/acre and that more than 90% of the N in the fern is recycled back to the roots.

Asparagus also seems to have low requirements for P and K. Most recommendations are based on soil tests and yearly additions may not be required. Yield increases in response to P have been report when asparagus was planted in a soil with very low initial P levels (Table 1). Since P deficiency often result in stunting of growth (roots and shoots), building soil levels prior to planting and keeping levels up during the establishment years could improve field longevity. Determining the needs for additional fertilizer application should be based on both soil and plant nutrient status. While the correlation between fern nutrient levels and productivity is poor, some have suggested that root samples may be better for determining plant needs.

Water Requirements

While asparagus is considered a drought tolerant plant, most studies show that it responds well to additional water applications when grown under drought conditions (Drost, 99). Recommended amounts of water for temperate areas range from 20-30 inches during the fern growth period. Adequate soil moisture levels are needed for young establishing plantings due to the small size and distribution of their root systems.

Irrigation increases yield by increasing the number and size of the buds initiated which increases spear yield the following harvest season. Water shortages during the late harvest and fern establishment periods negatively impact fern growth which ultimately decreases CHO storage and crown growth. Excessive moisture particularly late in the season can cause additional bud break and fern development. Late season fern growth has been shown to lower yields the following spring due to a reduction in CHO content and bud number.

Irrigation method has been shown to impact asparagus productivity levels (Fig 2). Research in Utah and Washington has shown better root growth and yield improvements occur when asparagus is irrigated with drip compared to furrow or sprinkler systems. Much of this is due to better water and root distribution and less late season fern growth.

Conclusions

Successful asparagus production is based on balancing plant growth dynamics with spear harvest. It is becoming clearer that cultural practices early in the life of a planting have long-term effects on productivity. Until recently, growers have only been able to assess the health and quality of the fern. With the release of AspireUS, growers now can monitor root CHO levels which give a better assessment of how the plant is responding to farm management decisions. Continued work on the role the root plays in crop productivity should help us further understand root/fern relationships and future productivity.

Citations


Table 1. Yield response of asparagus to added phosphorus fertilizer.

<table>
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<th>Phosphorus (lb/A)</th>
<th>2001*</th>
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<td>400</td>
<td>1283</td>
<td>1762</td>
<td>2020</td>
<td>5465</td>
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</tbody>
</table>

* 2001 - 4 weeks; 2002 – 5 weeks; 2003 – 6 weeks

Figure 1. The influence of irrigation system on asparagus root distribution and fresh weight.
Effects of Mild Heat Treatment on Asparagus

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Michigan asparagus spears were heated within five hr of harvest at 35-50ºC for 1-5 minutes to obtain an optimal heating time to improve quality. Results showed that heating spears at 47.5ºC (117.5ºF) for one minute was optimal for appearance. Thereafter, spears were heated at this optimal condition and then stored at 2ºC (35.6ºF) and 15ºC (59ºF) for up to 24 days. Spear samples were taken at intervals of 2-4 days over 24 days to measure visual appearance, geotropism, shear force, and total phenolics. Results showed that mild heating improved visual appearance of spears, but unexpectedly increased geotropism. Shear force slightly decreased. Total phenolics did not change significantly. Therefore, when considering using a mild heat treatment, Michigan asparagus producers may use these data to weigh the advantage of improved appearance versus the disadvantage of increase spear curvature.

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The asparagus growth is primarily driven by having temperatures warm enough to initiate spear growth in the spring and generating enough fern after harvest to capture sunlight which replaces the carbohydrate (CHO) used to fuel spear and fern growth (Drost, 97). Asparagus growers need to realize that high yields depend on the CHO manufactured this year being used to fuel spear growth and fern replacement in the next year. In temperate production regions (Canada, Michigan, Washington), growers need to balance CHO use (spear harvest, fern development, root replacement, and bud initiation) and CHO storage if productivity is to be maintained over the life of the crop. This presentation describes AspireUS (www.aspireus.com), a decision support system that helps growers understand the changes in CHO and suggests options for better management of asparagus root CHO levels.

Plant Growth and CHO Cycle

The growth of spears and fern during the yearly production cycle of asparagus is associated with a characteristic utilization and replacement of soluble CHO (Fig. 1). This pattern has been studied extensively and deviations from the pattern can be used to indicate less than optimum performance. Work done by Wilson (2002) in New Zealand has devised a simple method to assess the level of CHO in asparagus roots and correlated this with crop performance. The root system of asparagus can be thought of as a “fuel tank” with the CHO being the level of “gas” in the tank. Knowing how much gas is in the tank during different times of the year enables growers to better manage the asparagus crop to ensure that high CHO levels are stored for spear and fern growth in the future.

There are three distinct periods in the growth cycle of the asparagus plant: DORMANCY, HARVEST, and FERN growth. These occur in most asparagus production areas though the timing and duration may vary greatly. This annual cycle has a characteristic pattern of above-ground growth and depletion and accumulation of root CHO. The CHO status during any of these periods can then be used to help make management decisions. When first using the AspireUS system, it is recommended that growers sample with more frequency to ensure that they get a good understanding of the dynamics of CHO use and replacement for their farming operation.

Six sampling times are recommended and these are associated with key times during the yearly growth cycle (Fig. 1). First, “pre-harvest” which occurs at the end of winter but before spear harvest begins in spring. Second, the “harvest period” reading assesses CHO depletion due to harvest duration and if low CHO may restrict fern establishment. It is recommended that this sample be taken approximately two weeks before the anticipated close-up date. Some growers take additional reading during harvest to determine how rapidly CHO is being used. Third, the “fern-establishing” measurement occurs about 1 month after harvest and indicates the maximum depletion of root CHO associated with the development of the fern. Fourth, the “mid-summer fern growth” assesses CHO recharge about 1 month after full fern growth. In areas with long growing seasons, if values are low efforts to increase fern growth may occur during this period to stimulate the plant to produce more CHO. Fifth, the “late-summer fern growth” is second appraisal of CHO a month later. Lower than expected CHO replacement during the two summer fern growth measurements are often associated with drought, disease outbreaks, insect damage,
additional fern development in late summer, or anything that alters fern growth. Finally, after fern senescence in the fall, a “dormancy” or final CHO measurement can tell if the root system has fully stored the CHO needed for the next cropping season.

**Measuring Root CHO levels**

Asparagus stores simple (glucose, fructose and sucrose) and complex (fructans) carbohydrates produced from photosynthesis in the fern during summer. These CHO are then used for spear growth, fern establishment and root and crown expansion. At each sampling period, 20 random root samples are collected from the field. These samples are processed and the BRIX% is measured with a refractometer. These values are entered into AspireUS which statistically assesses the CHO content for the crop. Some growers are saving the extra harvested roots and sending them off for nutrient evaluations similar to fern analysis.

**Interpretation of the findings**

Knowledge of how to use the CHO information was developed from extensive plant measurement taken on experimental and commercial crops used to develop the AspireUS system. CHO content evaluates the crop age and period during the growth cycle. The system identifies and quantifies deviations from the ideal crop conditions by comparing the data to performance benchmarks. The system then generates comments and suggests management options to help improve crop performance.

**Benefits of using AspireUS**

There are many ways that AspireUS can be used to help make crop management decisions. At present growers are using the system to help determine when to stop harvesting young newly established plantings (Wilson, 99). This helps ensure that the field is not over-harvested. Other growers have used the CHO measurements to help determine if harvest can be extended later in the season. Provided CHO values are sufficiently high and prices/markets are good, this can increase profits. We have proposed that the CHO measurements could be used to help decide if additional fungicide applications are warranted to control important foliar diseases. If the plant has successfully recharged the root with CHO, a spray late in the summer could be skipped thus saving time and money. We have also noted the effect of an aphid outbreak on root recharge and the lower yield that occurred in the following year (Fig. 2). Others use the system to help decide how much harvest may be warranted in the next year. Provided CHO recharge does not occur by the fall dormant period, growers use this information to scale back their harvest length so they don’t over-harvest and stress the planting.

Growers using AspireUS have a built in record of their crops CHO history. CHO information can be retrieved from the database at any time in text, graph, or table form. It includes a diary function that gives the user a place to store yield records and other useful information about their crop. If there are questions about the finding and their interpretation, we are available by phone or email to quickly address those concerns and help come up with potential solutions.

**Conclusions**

The AspireUS system was developed with support from the New Zealand Asparagus Council and The New Zealand Institute of Crop and Food Research Ltd. Use of the system is restricted to registered users on a yearly fee basis. Details about how to register for the system and the costs are outlined on the web site (www.aspireus.com). At present, over 7000 acres are registered in North America (US, Canada and Mexico). The system is also being used in Europe in the white asparagus production areas of Germany and the Netherlands. Growers find the system is easy to use and provides good insight into the yearly dynamics of their asparagus crop. Root mass, while not presently being considered, will eventually be part of the system as the combination of CHO level and root biomass provides a better indication of future crop productivity.

**Citations**


Figure 1. Yearly growth pattern of fern and root carbohydrates.

Figure 2. Seasonal change in carbohydrates for ideal and aphid (Grower3) damaged asparagus field.