Crop Profile for Watermelons in Missouri

Prepared: March, 2000

General Production Information

(*Citrullus lanatus*)

The Missouri Watermelon Crop Profile was developed from interviews and surveys of key watermelon growers and brokers who manage approximately 25% of the production acreage in the state. Other information was gleaned from the Extension Vegetable Specialist at the University of Missouri. The third key information source was from census data and pesticide usage data obtained from USDA and the Pesticide Impact Assessment Program.

Over 95% of the watermelons in Missouri are produced in the southeast part of the state in two counties, Pemiscot and Dunklin. The remainder is produced throughout the state in small acreages for farmers markets and roadside stands.

- Missouri ranks between 8th or 9th in the production of watermelons.
- Missouri produces 3% of the total United States watermelon crop.
- Cost of production average $400/A plus $0.01 to 0.015/lb to harvest.
- From 1994 - 1998, Missouri producers planted an average 5,500 acres of watermelons with an average yield of 247 cwt/A.
- Average price received was $4.66/cwt for a total of $6,015,200. Commercially, melons are marketed nationwide.

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Cultural Practices

In Missouri, the majority of the watermelon production in the state occurs on sandy to sandy loam soils. The southeast region of the state, largely comprised of these soils has a long history of watermelon production, since it is so well adapted. In particular, two counties in this area, Dunklin and Pemiscot have very deep sand, which is well-suited to the growth requirements of watermelon production.

To obtain yields between 200 to 400 cwt/acre, watermelons require the following management decisions and production inputs:

- disease-free and vigorous transplants
- hybrid disease-resistant varieties
- plants grown on raised beds covered with black plastic
- proper fertilization; usually split N applications
- irrigation; drip or overhead
- excellent disease, insect and weed control
- bees for proper pollination

Because there is a market advantage to have watermelons by July 4th, early planting is desired. However, in most years this is rarely achieved. Typical planting dates range from April 10 to April 25th. Labor Day is traditionally the last market and therefore with the 85-day varieties most growers are planting, the last day to plant is May 10th. Texas is Missouri's main competitor because they produce watermelons all season long. However, in a short year, they can consume all of their production. Georgia is a potential competitor if their production is late. Missouri watermelons will typically come to market 2 to 3 weeks ahead of Indiana.

The average watermelon acreage per farmer is 50 to 80 acres. Only a few producers grow over 100 acres of watermelons in Missouri. Due to risk, management and labor factors, most plantings are laid out in 40 acre blocks. This size planting is the minimum to keep an 8-10 man watermelon crew busy and be able to pick 4 loads/day. Practically all watermelon growers in Missouri are primarily cotton producers. Cotton is an excellent rotation crop with watermelons.

Variety selection and transplant production: Over 95% of the watermelons produced in Missouri are hybrids. Seedless types comprise 1-2% of the market, whereas open-pollinated varieties such as Crimson Sweet, Charleston Grey and Black Diamond capture the remaining 3-4% for local markets. Two hybrid varieties, Royal Sweet and Huck Finn comprise over 80% of the market share. These varieties are chosen for yield capabilities and resistance to Fusarium wilt and Anthracnose. Other commonly grown varieties include Emporer, Sangria, Royal Flush, and Fiesta. Over 80% of the transplants are grown locally. The remainder are purchased from greenhouses in Florida. Transplants are produced under exacting sanitary conditions to keep them disease-free. Fruit blotch, a devastating bacterial disease, is largely controlled through seed company certification programs.

Production practices: Growers will typically lay black plastic down a month before planting to warm the soil. The ground will be cultivated, 100 lbs/A of N, P_2O_5, and K_2O applied prior to laying the plastic.

Over 75% of the acreage is planted with transplants into raised, covered beds. Transplants are planted 2.5 to 3 ft apart and beds are spaced between 8 and 10 feet apart (25 to 35 ft^2 per plant). Approximately 1,200 transplants per acre are planted. Planting densities less than this result in melons larger than the desired 22 lb average. Larger melons are discounted in price.

Eighty percent of the crop is irrigated. If the grower is using transplants, irrigation is essential to production. An additional 40 lbs. of nitrogen is applied as a side-dress or through fertigation when the vines begin to run. During the first month the crop is in the ground it will be irrigated and fungicide and insecticide spray schedules will begin.

The role of honey bees in watermelon production: One hundred percent of commercial production requires honey bees for top yields. Without pollinator bees, a poor crop that contains bottlenecks and crooked watermelons will occur. A minimum of one healthy, active hive per acre is required. Producers avoid the use of carbaryl after flowering due to its extreme toxicity to bees and other insecticides are applied at dusk after the bees have bedded for the night.

Excellent disease, insect and weed control: Disease control is much more critical for watermelon production than insect or weed control. Crop rotation, plastic and cultivation of row middles are the key weed control tactics employed by growers followed by an application of trifluralin before the vines run. Soon after transplanting, watermelons are sprayed on a regular schedule for disease and insect control. Insecticides are sprayed with fungicides every other fungicide application. If the crop were treated on a strict calendar schedule for the entire season, it would be sprayed 10-15 times per season. However, only 8-10 fungicide and 4-5 insecticide applications are actually made. Spraying is stopped 5 days before the last picking. However, the market price has a major influence on late season applications of fungicides and insecticides. If the price is good and the grower can expect late season profit, then he is more likely to apply additional fungicides and insecticides.

Insect Pests

The primary insect/mite pests affecting watermelon production annually in Missouri are the cucumber beetle and spider mites. The cucumber beetle is the number one insect pest.

Cucumber Beetles

Striped cucumber beetle (*Acalymma vittata*)
Spotted cucumber beetle (*Diabrotica undecimpunctata*)

Two species of cucumber beetles cause damage to watermelon. The larvae of both species feed on the roots and stems of watermelon plants. Damage potential is greatest to young transplants or seedlings that have not yet begun vigorous growth. Heavy beetle populations of greater than 5 per plant can stunt or even kill plants. Later in the season, adult and larval feeding on the watermelon rind creates cosmetic damage that reduces market quality. Because most watermelon varieties grown in Missouri have good bacterial wilt resistance, management of the cucumber beetle is focused on protecting the transplant, minimizing the number of feeding wounds that provide entry points for fungal organisms and protecting the fruit from feeding damage.

Adult beetles overwinter in protected areas along fencerows, leaf litter and near buildings. They begin feeding on a variety of plants with the advent of warmer temperatures in early spring. Adults will migrate in mass to watermelons as soon as they are transplanted. Eggs are laid at the base of plants. The eggs will hatch and the larvae will feed on the roots. A second generation of adults will emerge to begin feeding on foliage and fruit in mid-season.

Spider mites

Two spotted spider mite, (*Tetranychus urticae*)

The Two spotted spider mite is a common pest that occurs nearly every year in watermelons. If populations are left unchecked they can create serious losses for the grower. Spider mites damage watermelons by feeding on the leaves of watermelon leaves, mainly on the lower surface. Their feeding removes chlorophyll and interferes with photosynthesis. Damaged leaves take on a whitish, stippled appearance that later become chlorotic, may brown and die. This sometimes leads to sunburned fruit.

Spider mite populations have the ability to increase very rapidly. Development from egg to adult can occur in as little as 6 days. Typically populations are worse under hot dry conditions and in situations where carbamate and organophosphate insecticides have been used repeatedly and killed off the natural enemies.

Secondary Insect Pests

Aphids occasionally occur, but rarely reach levels at which they need to be managed intensively. Current programs aimed at control of cucumber beetles typically provide adequate control of this pest.

Integrated Pest Management Strategies:

Insect pests in watermelon are managed primarily through suppression strategies. The use of insecticides and miticides dominates the IPM tactics employed by Missouri growers. An average 4.5 insecticide/

miticide applications are applied to 95 percent of the acreage each season. The use of pheromones or attractants to monitor for key insect pests is used on less than 1% of the acreage.

Loss of carbamate and to a lesser extent organophosphate insecticides will significantly impact grower's ability to manage insect pests effectively since there will be fewer chemistries in which to rotate. If registrations of carbofuran and endosulfan were discontinued but registered uses of carbaryl and esfenvalerate were retained, then the key insect pests could still be controlled. Mite problems are expected to increase, since there will be a greater reliance on synthetic pyrethroid chemicals.

Prevention Strategy
No specific prevention tactics are used for insect control in Missouri watermelons.

Avoidance Strategy
No avoidance tactics are used to control insect pests in Missouri watermelons.

Monitoring Strategy
Because large populations of cucumber beetles (greater than five per plant) on young plants can lead to crop failure if left uncontrolled, growers will scout for beetles especially early in the season.

Suppression Strategy
Insecticides are applied throughout the season when economic thresholds are exceeded. In most years four to five applications are necessary and are coordinated with fungicide applications for disease management.

Chemical:

- **Esfenvalerate** (Asana XL) is applied on approximately 90% of the acres by ground at the rate of 0.04 a.i. per acre with a typical PHI of greater than the labeled 3 days. On the average 4 applications are made during a season. Asana is readily available to most growers since this is used heavily in cotton and most of the growers also produce cotton. So even though this chemistry is less effective that others it is used widely because of its availability and fit into cotton insect management programs. It also has the advantage being relatively safe to bees.

- **Permethrin** (Pounce 3.2EC, 25WP, Ambush 2EC,25WP) is applied on approximately < 50% of the acres by ground at the rate of 0.2 lbs a.i. per acre with the labeled PHI of 0 days observed. An average of 1.5 applications per season is made.

- **Carbaryl** (Sevin 50WP. 80SP, XLR) is applied to about 50 % of the acres by ground at the average rate of 1.0 lbs a.i. per acre. The labeled PHI of 3 days is observed. This chemistry is typically applied before bloom to avoid toxicity problems with bees. Although this chemistry provides good control it is not used widely for two reasons. It is not used in cotton production and it also leads to aphid outbreaks.

- **Endosulfan** (Thiodan, Endosulfan, Phaser 50WP, 3EC) is applied to <5% of the acres by ground at the average rate of 1 lbs a.i. per acre. The labeled PHI of 2 days is observed. This product is generally less expensive and more effective, however, since it is not use as heavily in this region for cotton insect management, its use is limited with those growers who also produce cotton. Typically applied post-bloom.

- **Carbofuran** (Furadan 4F) is applied to <5% of the acres by ground at an average rate of 0.08 lbs a. i. per 1000 ft row. Carbofuran is applied at transplanting and will control cucumber beetles for 45 days. However, few growers use this product because of the risks in handling it.

- **Dicofol** (Kelthane 35WP) is applied on approximately 75% of the acres by ground at the rate of 0.5 a.i. per acre with a typical PHI of greater than the labeled 2 days. On the average 1 application per season is made for control of spider mites.

- **Dimethoate** (Dimethoate 4EC) is applied on approximately 25% of the acres by ground at the rate of 0.75 lbs a.i. per acre with the labeled PHI of 3 days observed. An average of 1 application per season is made for control of spider mites.

- **Abamectin** (Agri-mek 0.15EC) is applied to <1 % of the acres by ground at the average rate of 0.01 lbs a.i. per acre. The labeled PHI of 7 days is observed. If this product is used, it is only applied once per season for control of spider mites.

Diseases

Anthracnose (*Colletotrichum orbiculare*)
This is a common fungal disease problem of watermelon foliage and fruit. Infections can occur on leaves, petioles, stem and fruit. Leaf infections begin as small, brown to black irregularly shaped lesions that are associated with leaf veins. As the lesions enlarge, the centers may crack and drop out, giving the leaf a shot-hole appearance. Lesions on petioles are elongated, tan areas with brown margins. Infections on fruit appear as sunken, circular cankers with pink centers and brown margins. The fungus survives on crop debris and through infected seed. Secondary spores are produced on infected plants through season and spread within the field by rain splash and wind.

Alternaria leaf blight *(Alternaria cucumerina)*
This is a common fungal leaf spotting disease. If this disease becomes established early and suitable

weather conditions exist through the season, considerable defoliation can occur. Premature defoliation may lead to reduced yields due to sun scalding of the fruit, and decrease the quality of marketable fruit. Lesions first form on the older leaves near the crown and initially appear as small tan spots that later expand into brown necrotic areas. These spots as they become older are composed of alternating dark and light concentric circles. Initial leaf infections begin from fungal structures that have survived on crop debris. Once infections have established on the leaves, secondary infections occur as spores are produced within these lesions. Rain splash and wind spread the disease through the field.

Fusarium Wilt (*Fusarium oxysporum f. sp. niveum*)
This soil-borne vascular disease causes the vines to turn yellow and wilt around the time of fruiting. Typically the older leaves will yellow first, followed by the entire plant. A diagnostic feature of this disease is the presence of a brown discoloration of the vascular tissue. This is readily seen on longitudinal cuts made of the lower stem and roots of infected plants.

The fungus resides in the soil and is transported to new sites by mechanical movement of infested soil, diseased plant material and infected seed. Fusarium wilt is most severe in light sandy soils with a pH of 5.5-6.5, high nitrogen levels and available moisture of less than 25%. In fields with a history of this disease, serious losses can occur if susceptible varieties are used. The fungus produces survival structures, chlamydospores that persist in the soil for a long time. Initial infections arise from germinating chlamydospores that invade the root system. Soon after infection the fungus become systemic as it is transported through the vascular system. Upon the death of the plant, chlamydospores are again formed and enter into the soil.

Gummy Stem Blight (*Didymella bryoniae*)
This fungal disease affects the leaves, stems and fruit of watermelon. Fruit infections are also known as black rot. Irregularly shaped brown spots develop on leaves just above the petiole attachment. These areas gradually enlarge to blight the entire leaf. Stem and petiole infections first appear water soaked, but later develop into tan lesions. Older lesions become cracked and exude an orange-red gummy substance. Stems may be girdled or killed. Unlike fusarium wilt infections, which may also produce a similarly colored exudate, there is no vascular discoloration associated with gummy stem blight. The fungus overwinters on crop residue and is seed borne. Periods of wet, rainy weather and prolonged leaf wetness are favorable conditions for disease development. Stem and fruit infections are established through wounds.

Integrated Pest Management Strategies

Anthracnose, Alternaria leaf blight, Fusarium wilt and Gummy stem blight are the primary disease problems face on a regular basis each season. However, Fruit Blotch, a bacterial disease, has the potential

to cause the greatest economic losses for watermelon growers. The disease is seed-borne and very low seed-infection levels allow the bacterium to be disseminated in transplant production. If registrations of benomyl and mancozeb were discontinued, then in years where weather conditions favor disease development, growers would lose the crop to diseases. There would be no effective alternatives for control of downy mildew and poor control of gummy stem blight. Mancozeb is a cheap and effective fungicide and is critical for resistance management to retain the effectiveness of benomyl and thiophanate-methyl. The loss of benomyl would put many commercial growers out of business.

For maximum yields, growers apply fungicides religiously every 7-10 days if dry and every 5-7 days if wet, beginning about May 1st. In a typical season 8 to 10 fungicide applications would be made to 95% of the watermelon acreage. A typical fungicide program will include rotation of benzamidazoles, EBDCs, and chlorothalonil so that there is a 50-day interval between use of the same fungicide.

Prevention Strategy

Disease-free seeds/transplants: Because Anthracnose and Gummy stem blight can be seed-borne, disease-free seeds are important for management of these diseases. In addition, transplants produced from seeds are grown in soil-less media in greenhouses under strict sanitary practices.

Avoidance Strategy

- Crop Rotations: Growers reduce primary inoculum levels of the key diseases and root knot nematode through 2 to 3 year rotations away from cucurbit crops, by deep tillage of crop residue and the use of black plastic. There is no situation where a grower could rotate away from watermelons (near virgin ground) and thus eliminate the need for fungicides.

- Resistant Varieties: The Fusarium wilt fungus forms chlamydospores that persist in the soil for a long time and cannot be controlled with fungicides. Thus the primary way in which this disease is managed is through the careful selection of resistant varieties. Although most growers follow a 2 to 3 year cycle of crop rotation for other diseases, it is generally too short of a rotation to help with management of fusarium wilt. This is especially true if there is a history of heavy fusarium wilt pressure and a susceptible variety is used.

Monitoring Strategy

Currently, there are no disease monitoring programs implemented on commercial fields. The disease forecasting program, MELCAST (developed by Purdue University) is being considered for testing for Missouri watermelon production.

Suppression Strategy

Primary control within the season is achieved through regularly timed fungicide applications that begin shortly after transplanting and continue on a 7 to 10 day schedule depending upon weather conditions. About 90% of the applications are made by ground. Ten percent of the applications are made airplane. This usually occurs later in the season when the vines are large.

Chemical:

- **Benomyl** (Benlate 50WP) is applied to 50% of the acres by ground at the average rate of 1.0 lbs. a. i. per acre, which is the labeled rate. An average of 2 applications are made per season. It is typically the first fungicide applied.

- **Thiophanate methyl** (Topsin-M 70WSB) is applied to 40% of the acres by ground at an average rate of 0.4 lbs. a.i. per acre. An average of 2 applications are made per season. Growers prefer to use this during periods of wet weather because of the greater protection imparted due to systemic properties of the chemical.

- **Chlorothalonil** (Bravo 720F, 82.5DG, 75WP) is applied to 90% of the acreage at the average rate of 1.5 lbs. a.i. per acre. An average 2-3 applications per season are made. The PHI is 0 days. This fungicide is commonly rotated with a Mancozeb, Benlate, and Topsin M.

- **Mancozeb** (Manzate200, Dithane M45) is applied to 90% of the acreage at the average rate of 2.0 lbs a.i. per acre. An average 2-3 applications per season are made. A PHI of 5 days is followed. This fungicide is commonly rotated with a Bravo, Benlate, and Topsin M.

- **Copper hydroxide** (KocideDF) is applied to10% of the acreage at an average rate of 1 lb a.i. per acre. Generally used when downy mildew or bacterial fruit blotch are a concern.

- **Methyl Bromide** is applied on <1% of the acreage by fumigation for nematode, disease, and weed control.

- **Telone** is applied on <l% of the acreage by fumigation for nematode control.

Secondary Diseases
Downy Mildew, Bacterial Fruit Blotch and Powdery Mildew are sporadic problems. With the exception of bacterial fruit blotch most of the fungicides in the regular spray program will provide some protect against these diseases. If downy mildew is detected, most growers apply metalaxyl to the spray schedule at the first sign of disease. If bacterial fruit blotch becomes a problem, a copper-containing product is added to the spray mixture.

Nematodes
While there are several different genera of plant parasitic nematodes found in the major watermelon production areas of the state, only root knot nematode (*Meloidogyne* spp.), causes sporadic economic problems. Above ground symptoms of a root-knot nematode infection include lack of vigor and wilting of plants. A very high infestation can kill the plant. Infected plants will have the characteristic swellings on the roots, have smaller, misshapen fruit and uneven ripening of the fruit.

Weeds

Key weeds that are common problems for Missouri producers are pigweed, lambsquarters, common cocklebur, velvetleaf, purslane and carpetweed. Noxious weeds such as johnsongrass require periodic control.

Integrated Pest Management Strategies

In general, management of weeds is accomplished through a thorough tillage of the seedbed after which black plastic is laid down. A pre-emergence herbicide is used in between rows and cultivation or post applications of herbicides are used for in-season weed control.

Prevention Strategy
Tillage and black plastic provide significant weed control during the season.

Avoidance Strategy
Crop rotation is very important in weed management. Excellent weed control in cotton the year preceding watermelons is highly desired by growers.

Monitoring Strategy
Fields are scouted by producers for weed infestations and tillage operations and/or post-emergence herbicide applications are timed accordingly.

Suppression Strategy
Approximately 95% of watermelon fields are treated with herbicides to suppress weed competition.

Chemical:

- **Trifluralin** (Treflan 4E) is applied to 85% of acres by ground at an average rate of 1 lb a.i. per acre. Typically included in the spring burndown. Also used as needed in spot applications.
- **Alanap-L** (Naptalam**)** is applied to >50% of the acres as pre and post-emergence application at an average rate of 3.0 lb a.i. per acre. Most often mixed with Bensulide.
- **Bensulide** (Prefar) is applied to >50% of the acres as a pre and post-emergence application at an average rate of 1.25 lb a.i. per acre. Most often mixed with Alanap-L.
- **Sethoxydim** (Poast 1.5 EC) is applied to 95% of the acres as post-emergence application for the control of grassy weeds. The average application rate is 0.30 lb a.i. per acre.

- **Glyphosate** (Roundup Ultra) is applied to 50% of the acres as a spot treatment for weedy escapes. The average application rate is 1 lb a.i. per acre.

- **Paraquat** (Gramoxone Extra 2.5E) is applied to 50% of the acres as a spot treatment for weedy escapes. The average application rate is 0.63 lb a.i. per acre.

- **Ethalfluralin** (Curbit EC) is applied to 10% of the acres. It is often used as a rescue in fields with heavy weed pressure. It is a very effective broadleaf herbicide but also very expensive.

Table 1. Pre-harvest and Restricted Entry Intervals, and Strengths and Weaknesses of Critical Pesticides on Watermelons in Missouri

Insecticides (I) Fungicides (F) Herbicides (H)	PHI (days)	REI (hrs)	Strengths	Weaknesses
endosulfan (I)	2	24	highly effective against cucumber beetles	maximum 3 lbs a.i. per year
esfenvalerate (I)	3	12	highly effective against cucumber beetles	promotes mite infestations
carbaryl (I)	3	12	highly effective against cucumber beetles	toxic to bees and mite predators must be used pre-bloom
benomyl (F)	1	24	excellent control of key diseases; systemic fungicide	overuse promotes resistant biotypes; not effective against downy mildew
thiophanate-methyl (F)	0	12	excellent control of key diseases; systemic fungicide; preferred under wet weather conditions	overuse promotes resistant biotypes; not effective against downy mildew
mancozeb (F)	5	24	broad spectrum; no resistance problems; some control of downy mildew	not systemic
chlorothalonil (F)	0	48	broad spectrum; no resistance problems	expensive; not systemic; not effective against downy mildew; may cause sunburn
trifluralin (H)	NA	12	Excellent pre-emergence control of grasses and	Must be incorporated within 24 hrs of application

				may cause sunburn
trifluralin (H)	NA	12	Excellent pre-emergence control of grasses and some small-seeded broadleaf weeds.	Must be incorporated within 24 hrs of application
sethoxydim (H)	20	12	Excellent post-emergence control of grasses	No residual activity
bensulide (H)	NA	12	Controls many grass and small-seeded broadleaf weeds	Does not control emerged weeds; Must be incorporated with tillage or irrigation; 120 day re-crop interval
naptalam (H)	NA	48		

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References

1. DiCarlo, H. F. and C. De Courley. 1994. Growing Watermelons in Missouri. University of Missouri Extension Publication G6380.

2. Missouri Agricultural Statistical Service. 1994-1999. Missouri Farm Facts. Missouri Department of Agriculture and United States Department of Agriculture.

3. National Agriculture Statistical Service. 1997. 1997 Census of Agriculture.

4. Personal Communication with Tim Baker, University of Missouri Horticulture Extension Specialist.

5. Personal Communication with Paul Teague, Delta-Fresh, Inc.

6. Pesticide Use Surveys: Missouri, 1992. I. Vegetables II. Nursery Crops. Pesticide Impact Assessment Program, USDA ES 91 EPIX-1-0018.

7. University of Missouri Extension. 1999. Midwest Vegetable Production Guide '99 for Commercial Growers. University of Missouri Manual FMX-384.
