Crop Profile for Muskmelon in Maryland

Adapted from Maryland Extension Bulletin 236) Commercial Vegetable Production Recommendations. Additional references are cited throughout this document.

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General Production Information

- Maryland ranked 8th in national muskmelon production in 1997, and accounted for about 1% of total U.S. production (2).
- For 1997 and 1998, Maryland planted an average of 1,500 acres and harvested an average of 1,400 acres of muskmelons for the fresh market. The average cash value of fresh market muskmelons for the same period was $2,709,000.00 (3).
- In 1997, production cost per acre for muskmelons in Maryland was about $1,360.19. Total annual production cost in Maryland for the same year was about $1,632,228.00 (4).
- All of Maryland's muskmelon is grown for the fresh market (5).

Cultural Practices

Production Regions

Counties west of the Chesapeake Bay (Primarily Anne Arundel, Baltimore, and St. Mary's counties) harvest about 33% of the state's fresh market muskmelon (3, 6). Northern Eastern Shore counties (Primarily Caroline, Kent, and Queen Anne's counties) harvest about 41% of the state's fresh market muskmelon (3, 6). The Southern Eastern Shore counties (Primarily Dorchester and Wicomico) harvest about 25% of the state's fresh market muskmelon (3, 6).

Production Methods

Muskmelons, a warm season crop, thrive at temperatures around 65-75º F and require moist but well-drained soils. Muskmelon seeds are generally treated with a fungicide and an insecticide by either the seed company or the grower. Seeds are generally grown in greenhouses and seedlings are transplanted into prepared beds with clear or black plastic mulch when mean soil temperatures reach 60º F (7). On the Eastern Shore of Maryland, 95% of the acreage are transplanted while 5% are directed seeded. About 97% of the acreage are on plastic, with 95% of those on black plastic and 5% on clear plastic (5). The majority of muskmelons grown in southern and central Maryland is also on black plastic (6). Clear plastic laid before planting conserves moisture, increases soil temperature, and increases early and total yields, but does not provide adequate weed control without the addition of herbicides (7). Generally herbicides are not used under clear plastic. Rather, fumigation offers enough control. In Dorchester county, most growers use clear plastic (26). Black plastic prevents weed seed germination and growth, with the

exception of yellow nutsedge, which can penetrate the plastic and continue to grow (5, 7). Less than 3% of acreage on the Eastern Shore are on bare ground. Of these, less than 1% is direct seeded. Approximately 99% of bare ground acreage are transplanted (this represents about 2% of the total muskmelon acreage on the Eastern Shore) (5, 8).

Temperatures below 45º F can stunt plant growth. Transplanting dates in Maryland vary from May 1 through June 5 in different regions of the state. Plants are placed 2 to 3 feet apart in rows spaced 5 to 6 feet apart (6). Prior to transplanting, beds are prepared by laying plastic mulch (black or clear) and often installing drip irrigation to cultivated, fertilized soil with a pH adjusted to about 6.0. Drip irrigation systems are used by many growers because they allow delivery of water and fertilizer directly to crop plants and help to reduce weed growth between plastic strips (5, 26). However, not all growers use drip irrigation. Some growers prepare the soil when it is moist and irrigate with overhead irrigation.

Muskmelons require regular fertilization during the growing season. At bed preparation, 50 lb of N (at least 50% as NO_2), P_2O_5, and K_2O per acre are incorporated into the soil. If drip irrigation is used, an equal amount of completely soluble fertilizer per fertilized-mulched acre is applied by drip irrigation within 1 week of transplanting, again at fruit set, and again 2 weeks before the first harvest. Some growers increase late yields with an additional application of soluble fertilizer about 3 weeks after transplanting (7, 6). Some growers incorporate all of the phosphorous and potassium and add only nitrogen by drip irrigation (6). If the crop is overhead irrigated, most of the fertilizer (up to 150 lb of nitrogen, plus the phosphorous and potassium levels needed as determined by soil testing) is broadcast and incorporated into the soil prior to laying plastic mulch (7, 6). On soils testing low and low to medium in boron, one half pound of actual boron per fertilized-mulched acre is added to each soluble fertilizer application (7).

Muskmelons are picked at the half-slip stage, when half of the tissue of the melon is still attached to the vine (26). Melon harvest on the lower and middle Eastern Shore begins in early July and typically continues for 3 weeks, sometimes longer (6, 5). In central Maryland, harvest usually starts about the third week in July (6). Melons are harvested daily or twice daily during hot weather. Melon quality is dependent upon maintaining the vines and the leaves until the melons are mature (7).

Turning runners before last shielded spray of gramoxone, moving irrigation equipment and harvesting are the main worker's activities during the growing season (27).

Insect Pests

Striped and Spotted Cucumber Beetles/Rindworms

Damage and Life Cycle: Striped cucumber beetles, *Acalymma vittata* (Fabricius), and spotted cucumber beetles, *Diabrotica undecimpunetata howardi* (Barber), are important insect pests of muskmelon and related crops in the mid-Atlantic area. They cause direct feeding damage to plants and also vector bacterial wilt, a serious annual disease of muskmelon. Both species of cucumber beetles have a similar life cycle and inflict similar damage to host plants (11). Cucumber beetles overwinter as adults in neighboring woodlands or other protected areas and move onto crops after transplanting (12). Female cucumber beetles deposit eggs in the soil at the base of host plants or on the underside of leaves. Larvae feed on the roots and stems of the plants for 2 to 3 weeks before they

pupate in the soil (11, 12). Beetle feeding on young transplants can stunt or kill plants, especially when beetle populations are high. (11) A second generation of beetles emerges later in the summer (11, 12). Beetle larvae feeding on rinds (often called "rindworms") during late summer can cause significant cosmetic damage to fruits (11).

Both species of cucumber beetles are vectors of bacterial wilt, a serious disease in muskmelons (11). Most muskmelon cultivars are highly susceptible to this disease (7), although cultivars vary in susceptibility to cucumber beetle feeding (11). The major feeding injury and disease transmission takes place from the time cucurbits are transplanted until they form runners (13). The disease enters the vascular system of the plant and causes the characteristic drooping of leaves (11). An entire plant can die days after the first sign of wilting (10). The disease can spread quickly from plant to plant as beetles feed. Infected plants cannot be saved, and rarely produce marketable fruit. Bacterial wilt is managed by controlling cucumber beetles in the field to limit the spread of the disease (11). (For a full description of bacterial wilt, see disease section).

Frequency of Occurrence: Cucumber beetles are important annual pests of muskmelon. Their control is critical to protect the crop from bacterial wilt (11). The size and timing of cucumber beetle populations can vary widely depending upon weather conditions in winter and in late spring when beetles emerge (11, 14).

Management: Because most muskmelon cultivars are highly susceptible to bacterial wilt, many Maryland growers use preventive chemical treatments to control beetle feeding and reduce disease transmission on young plants. Whether or not a preventive treatment is applied, young transplants are scouted for cucumber beetles. The presence of even a few beetles early in the season can result in economic disease damage. Direct visual counts of beetles on muskmelon may not give a reliable indication of population levels, so plants are examined to determine if the level of feeding injury warrants chemical treatment (13). No treatment threshold has been established in Maryland (14).

Chemical Controls: A Special Local Needs 24(c) label is in effect for the use of carbofuran (3.8 fl oz Furadan 4F/1,000 ft of row) on muskmelon in Maryland (7). Forty percent of the acreage is treated with preventive applications of this soil systemic insecticide, applied either pre-plant incorporated when the plastic is laid or at planting (27). Cold or rainy weather may reduce the effectiveness of carbofuran, especially when soil treatments are applied under plastic too far in advance of transplanting (13, 14). Also, use of carbofuran at planting may cause spider mite outbreaks (26). Bacterial wilt may still be transmitted and spread when beetle populations are high (more than 20 per plant) (13). Fields are scouted after transplants are established, and foliar treatments may be used instead of, or in addition to, carbofuran (11).

Foliar insecticides are used on about 70% of Maryland muskmelon acreage for control of cucumber beetle. One or two applications are used (6). Where foliar insecticides are used in Maryland, about 60% of treatments applied are pyrethroids, mainly permethrin (6.4-12.8 fl oz Ambush 2EC/A or 4-8 fl oz Pounce 3.2 EC/A). Bifenthrin (Capture 2.6-6.4 fl oz 2EC/A) is used on approximately 35% of the acreage in Caroline county (27). Endosulfan (Thiodan l.33-2.67 pt 3EC/A) accounts for about 20% of foliar applications, while carbaryl (Sevin l.25 lb 80S/A) makes up about 10%. Imidacloprid (Admire 16-24 fl oz 2F/A) is used as a soil formulation (15, 28). For large commercial growers, which constitute about 70% of production in the state, imidacloprid is expected to replace most other chemical insecticides used (15). Esfenvalerate (Asana XL 5.8-9.6 fl oz 0.66EC/A), methomyl (Lannate l.5-3 pt LV/A), methoxychlor (2-3 lb 50WP/A), and azinphos-methyl (Guthion 2 pt 2L/A) make up the remaining 10% of foliar applications in Maryland (14). Lannate is used against cucumber beetles only when growers are targeting melon aphids at the same time (15). Approximately 20% of the acreage is treated with permethrin, methomyl or esfenvalerate (27).

It is difficult to control beetle larvae (rindworms) feeding on rinds of developing fruit. Management of adults will reduce rindworm populations. When chemical treatment for rindworms is necessary, esfenvalerate or permethrin are used at the rates listed above (7).

Alternative Controls: Nobiological, cultural, or other alternative controls are used to control this pest in Maryland (14).

Melon Aphid and Green Peach Aphid

Damage and Life Cycle: Several species of aphids feed on muskmelon, and all inflict similar types of injury to plants. Aphids overwinter as eggs on a variety of host plants. Nymphs hatch in spring and feed until they mature. Adults of this first generation reproduce sexually, bearing live young which become winged adults that migrate to crops. This generation feeds on plants and rapidly reproduces asexually, with a generation time of 5 to 7 days (11).

Melon aphids and green peach aphids are the most important of several aphid species that attack cucurbits in Maryland (15). The green peach aphid attacks plants throughout the growing season, but damage is usually worst in May and June, and again in the fall (18). Plants usually are not attacked by melon aphids until the vines form runners. Aphid infestations commonly begin in small scattered areas over the field. Aphids are found primarily on the underside of the leaves, where they suck sap from the plant and cause a reduction in the quality and quantity of the fruit (12). Infested leaves curl downward and may turn brown and die (11). When infestations are heavy, aphid damage can reduce plant vigor and size and may kill the plants (18). In addition to feeding damage, aphids produce "honeydew," a sticky excretion which can cover fruits and promote the growth of a sooty black mold. More importantly, the melon aphid and other aphids also are important vectors of infectious viruses which can reduce yields as much as 50% (11).

Frequency of Occurrence: Aphids, especially melon aphids, are sporadic pests on muskmelon (14). The worst infestations occur during hot, dry summers following cool, dry springs, since such weather conditions reduce the efficiency of aphid natural enemies (12). Chemical applications which deplete populations of beneficial insects may also lead to aphid outbreaks (11).

Management: About 30% of muskmelon acreage in Maryland are scouted by professionals (14). Fields are scouted for the presence of aphids 2 or 3 times during the growing season. Scouting is done by looking for wilting and curled leaves throughout the field. When aphids are detected, more intense sampling is done to determine infestation levels and natural enemy activity (13). The treatment threshold depends upon the growth stage of the plant. For fairly mature plants, an insecticide is applied if more than 20% of runners have 5 or more aphids, natural enemy populations are low, and humidity is low to moderate. Younger plants are more susceptible to viral transmission, so the thresholds are more conservative for younger plants (13, 6).

Chemical Controls: Methomyl (Lannate 1.5-3 pt LV/A) is the most effective product for controlling melon aphid in muskmelon (14). Endosulfan (Thiodan 1.33-2.67 pt 3 EC/A) is also used for melon aphid or other aphid control in muskmelon. Diazinon (1 pt 4EC/A) and oxydemeton-methyl (Metasystox-R 1.5-2 pt 2SC/A) are used for green peach aphid control in muskmelon (7). Imidacloprid (Admire 16-24 oz 2F/A) is used on approximately 15% of the acreage in Caroline County (27). Thiamethoxam (Actara 2-3 oz 25WDG/A or Platinum 5-8 oz 2SG/A) is applied to control melon and green peach aphids in muskmelon (28).

Regardless of the foliar insecticide used, thorough spray coverage on the underside of leaves is important (7). For

localized infestations, spot treatments may be used (11).

Alternative Controls:

Natural Enemies: When making a treatment decision, natural enemy populations are considered (15). Aphids may be controlled by parasitic wasps and a variety of predators, including lady beetles and their larvae, lacewing larvae, and syrphid fly larvae. Many insecticides used in muskmelon are detrimental to these beneficial insects. During periods of high humidity, fungal diseases may also help reduce aphid populations (11). Predators and parasitoids naturally present help to control aphid populations, but there is no manipulated attempt to augment or increase their populations (15)

Cultural Controls: Where possible, growers try to minimize the use of early foliar treatments for beetles. These sprays eliminate natural enemies and lead to secondary outbreaks of aphids (14).

Spider mites

Damage and Life Cycle: Spider mites can be a serious problem on cantaloupes during hot, dry weather. The 2-spotted spider mite and the Atlantic spider mite are the most common species occurring on vegetables in the mid-Atlantic area (12). The two-spotted spider mite can be particularly problematic in our area (6). Adults migrate into fields in the summer and begin feeding on the underside of leaves. A female 2-spotted spider mite can lay 5 to 6 eggs per day for a total of 70 to 200 eggs in her lifetime. Eggs hatch and nymphs quickly develop into adult mites. The life cycle can be completed in as few as 5 to 6 days during hot weather (11). These minute mites feed on the contents of individual cells of the leaves, which become blotched with pale yellow and reddish-brown spots ranging from small specks to large areas on the tops of leaves. Damage can develop very quickly, and a severe infestation can kill or seriously stunt the growth of plants (12).

Frequency of occurrence: Mites are an important annual pest on muskmelon and watermelon (11, 14). They are usually most problematic on muskmelon during the fruiting period (14). Outbreaks are typically most severe during hot and dry weather or when certain insecticide applications (especially carbofuran, carbaryl, and pyrethroids) reduce natural aphid predator and parasitoid populations (11).

Management: Because of their small size and uneven distribution, spider mites are hard to detect until the vines are damaged with hundreds of mites on each leaf(12). Fields are scouted by some growers weekly, from early July through August during hot, dry weather (13). Early mite infestations tend to be concentrated around field edges, so scouting efforts are often focused there (11, 13). However, because mites sometimes balloon into the middle of a field from other areas, scouting should not be limited to the edges of the fields. Mites can cause significant damage due to lack of vigilance mid-field, or their damage may be confused with another problem (26).If feeding injury is detected, plants are sampled to determine the extent of mite infestation. A miticide is applied if 10-15% of the crown leaves are infested early in the season, or in mid-summer if 50% of the runners show leaf injury and mites are present (7, 13).Growers try to avoid overuse of products such as carbofuran which are known to cause mite outbreaks (see above) (6).

Chemical Controls: Even when mite populations are high, infestations tend to be localized and may be spot-treated. The products used by Maryland growers are dicofol (Kelthane 1.25 lb 50WP/A), dimethoate (Cygon 1pt 4 EC/A)and abamectin (Agri-Mek 8-16 fl oz 0. 15 EC/A)(7).Dicofol is applied on approximately 10% of the acreage (27). Abamectin is applied on approximately 20% of the acreage (27). Abamectin is expensive but effective and it

is not used during harvest because of its long (7-day) days-to-harvest interval (15). Since miticides are not effective against the egg stage, 2 applications, 5 days apart, are used to kill mites (11, 15). Maryland growers report some mite resistance to both of these products (19). Bifenthrin (Capture 5.12-6.4 fl oz 2EC/A)is applied to 5% of the acreage in Caroline County (27). Regardless of product choice, proper application techniques are essential for effective mite control. The use of surfactants and the proper spray equipment is essential to ensure that the product reaches the underside of the leaves. Abamectin, dicofol or dimethoate is used on 70% of the acreage (27).

Alternative Controls: Some growers may treat rye windbreaks with a miticide to reduce mite populations before they move on to the crop (15).

Cultural Controls: Grassy areas adjacent to fields may be left unmowed during mid-summer, as a disturbance to these areas may drive mites onto the crop (13). About 20% of Maryland growers practice this strategy (14).

Seedcorn maggot

(Delia platura)

Damage and Life Cycle: Seedcorn maggot is a common insect throughout the Northeast (16). Adults emerge from overwintering puparia during spring planting time and females lay eggs just below the surface of the soil. Eggs hatch in 4 to 7 days, and emerging larvae feed on decaying organic matter. Maggots burrow into the seed and consume the germ, preventing germination or stunting plants (11, 17). Maggots also feed on the developing hypocotyl of young plants. Infested seedlings usually die within a few days (11). Larvae feed for 21 days, then pupate in the soil. There are 4 to 5 generations per season in Maryland (17).

Frequency of Occurrence: Seedcorn maggot is an important annual pest of muskmelon in Maryland (14). Injury is most severe in cool wet springs when germination is delayed. Fields with heavy cover crop use or those high in crop residue and other organic matter are most susceptible to high levels of infestation (11). About half of the economic problems with seedcorn maggot originate from infestations that start in the greenhouse or hardening-off beds. Eggs laid on bedding trays, along with young maggots, are present in transplant plugs and are carried into fields during transplanting (14).

Management: Cultural controls, preventive soil insecticides and seed treatments are used to control seedcorn maggot. About 30% of the muskmelon acreage in the state is scouted by professionals. Weak and dying seedlings within the first week following transplanting is often the first sign of a seedcorn maggot infestation (14).

Chemical Controls: Commercial acres are planted with seed which has been treated with a fungicide and an insecticide, either chlorpyrifos, lindane, or diazinon; however, insecticide rates are usually not high enough to control severe infestations of seedcorn maggots. Carbofuran applied for cucumber beetle control helps to suppress seedcorn maggot populations. The use of carbofuran at planting may cause spider mite outbreaks (26). In addition, diazinon is preplant incorporated on about 5% of acreage grown (14). Rescue treatments are not used (6).

Alternative Controls: A variety of cultural control measures are effective against this pest. Late plantings during cool springs and shallow placement of seed may speed germination and reduce injury levels, but this is not a good marketing decision for growers since early harvest melons yield higher prices (11, 14). All fields are plowed prior to fly emergence in early spring (15, 26).

Minor Insect and Mite Pests in Maryland

The following insect pests are rarely a problem under current management practices in muskmelon in Maryland, but all have the potential to occasionally become important pests. Insecticide applications made for cucumber beetles and other important insect pests may generally help to keep these insect populations in check (14, 15). Populations of these insects may reach pest status some years on some fields when conditions favor outbreaks (6).

Leafhoppers

Damage and Life Cycle: Leafhoppers feed by piercing the leaves and sucking plant juices. Early symptoms of leafhopper feeding include a yellowing of the leaf veins and curling of the leaves (11). High levels of leafhoppers in muskmelon can significantly reduce plant vigor and cause extensive leaf-yellowing of the leaves known as "hopper burn." Affected plants have a reduced root system, are often stunted, and yield less fruit. Fruit quality is also diminished. The worst damage is inflicted on seedling plants (11). Generally the damage inflicted is very minor and doesn't result in significant yield loss (14).

Frequency of Occurrence: Always present, leafhoppers are usually a minor pest, though on rare occasions they may cause significant damage to commercial muskmelon plantings in Maryland (14, 26, 6).

Management: Fields sprayed early in the growing season to control cucumber beetles rarely develop problematic levels of leafhoppers. Muskmelon tolerates moderate levels of potato leafhoppers well, but when populations are unusually high, insecticide treatment is applied (6). Insecticides are not used preventively to control this pest (14).

Chemical Controls: Approximately 10 - 20% of acreage are treated annually specifically for leafhoppers (26, 27). Insecticide applications made to control cucumber beetles may be helping to suppress leafhopper populations (6). The most commonly used insecticides are esfenvalerate (Asana XL 5.8-9.6 fl oz 0.66EC/A) and permethrin (4-8 fl oz Pounce 3.2EC/A). Each of these is used in nearly 50% of cases where treatment is warranted (14). Esfenvalerate and permethrin are each used on 3% of the acreage (27). Diazinon (1 pt 4EC/A) and dimethoate (1 pt 4EC/A) may be are used to a much lesser extent. Bifenthrin (Capture 2.6-6.4 fl oz 2EC/A) is used on approximately 1% of the acreage (15, 27).

Alternative Controls: There are no effective alternative controls for leafhopper that are practiced in Maryland (14).

Squash Bug

(Anasa tristis)

Damage and Life Cycle: The squash bug attacks all the cultivated plants of the cucurbit family, including muskmelon, but favors squash and pumpkins. Both adults and nymphs feed on the leaves by piercing through the surface with their sharp mouthparts and sucking the plant sap. In the process of feeding, they inject toxins which interfere with the physiological functions of the leaf. The first evidence of injury is the formation of pale green areas on the leaves. These areas later wilt, turn brown and die. When squash bugs are abundant, the foliage has a somewhat burnt appearance (12).

Frequency of Occurrence: The squash bug is a regular pest in home gardens and is occasionally a problem in commercial plantings of muskmelon in Maryland (14).

Management: This pest is managed with remedial applications of insecticides as needed (14).

Chemical Controls: Insecticide treatments for squash bug are rarely needed (14, 6). Less than 5% of Maryland muskmelon acreage are treated for squash bug, on an as-needed basis. Pyrethroids [permethrin (12.8 fl oz Ambush 2EC/A or 8 fl oz Pounce 3.2EC/A)] are the primary products used, about 90% of the time. Bifenthrin (Capture 2.6-6.4 fl oz 2EC/A) is used on 5% of the acreage (27). Other insecticides used for squash bug control in muskmelon include esfenvalerate (Asana XL 5.8-9.6 fl oz 0.66EC/A) and carbaryl (Sevin l.25 lb 80S/A) (7).

Alternative Controls: There are no alternative strategies used to control this pest in Maryland (14).

Squash Vine Borer

(Elasmopalpus lignosellus)

Damage and Life Cycle: Squash vine borers overwinter as pupae in the soil (11). After emergence, the wasp-like moth can be seen flying swiftly and noisily about plants during the daytime from June through August (12). Eggs are laid singly at the base of blooming plants and hatch in 7 to 10 days (11). Small larvae usually are found tunneling out the inner tissues of petioles near the base of the plant, where they feed for 14 to 30 days (11, 12). Later in the season, older larvae are located throughout the stems and sometimes in the fruit. The first indication that the borer is present is the sudden wilting of one runner or the entire plant. Inspection of the wilted vine usually reveals masses of coarse greenish-yellow excrement pushed out of holes in the vines. Infested vines often are completely girdled and usually rot and die (12).

Frequency of Occurrence: The squash vine borer is a rare pest of muskmelon in Maryland. Commercial plantings usually escape noticeable injury in the mid-Atlantic area (12, 15).

Management: There are no practical methods for direct sampling of adults or eggs in the fields (11). Plants are checked for general vigor and other factors, and borer damage may be detected, but no regular monitoring is done specifically for this pest (14).

Chemical Controls: The products used in Maryland muskmelon are esfenvalerate (Asana XL 5.8-9.6 fl oz 0.66EC/A) applied on approximately 50% of the acreage, methoxychlor (2-3 lb 50WP/A) applied on approximately 10% of the acreage, and endosulfan (Thiodan 1.33-2.67 pt 3EC/A) applied on 20% of the acreage (7, 27). Bifenthrin (Capture 2.6-6.4 fl oz 2EC/A) is used on approximately 5% of the acreage (27).

Alternative Controls: In small plots, infested runners may be removed or infested plants destroyed, but no cultural or alternative practices are used by commercial growers (14).

Pickleworm

(Diaphania nitidalis)

Damage and Life Cycle: Pickleworms overwinter in semitropical regions, and annual infestations depend on moth flights north. Eggs are deposited on hairy plant parts, such as the blossoms and young leaves. Young larvae usually feed among small leaves at the growing tips of vines or within blossoms. When larvae are about half grown, they bore into fruits and continue to feed there, causing internal damage to the fruit. Both young and old fruits are attacked, but young fruits are preferred (12).

Frequency of Occurrence: Pickleworm is a rare problem in the mid-Atlantic area, but it occasionally attacks muskmelon after early August (12, 15). Infestation levels vary, depending upon the size of moth population migrating from the south (12).

Management: Pickleworm is not considered in the IPM programs for muskmelon in Maryland (13). On rare occasions, this pest may be managed by remedial insecticide applications (14).

Chemical Controls: Very little, if any, insecticide is used to control this pest (14). Esfenvalerate (Asana XL 5.8-9.6 fl oz 0.66EC/A, methomyl (Lannate 1.5-3 pt LV/A), permethrin (6.4-12.8 fl oz Ambush 2EC/A or 4-8 fl oz Pounce 3.2 EC/A), carbaryl (Sevin 1.25 lb 80S/A), and endosulfan (Thiodan l.33-2.67 pt 3EC/A), are all recommended for use in Maryland (5). In addition, bifenthrin (Capture 2.6-6.4 oz 2EC/A) is used on approximately 5% of the acreage (27).

Alternative Controls: Pheromone traps have been developed to monitor populations of pickleworms.

Diseases

Infectious diseases of muskmelon are caused by fungi, bacteria, and viruses, and some are vectored by insects. Successful and cost-effective disease management requires accurate identification of pathogens and timely application of control measures. Some diseases are controlled mainly by management of insect vectors, while for others, cultural or chemical controls may be necessary, at least in some years (7).

In Maryland, the most important disease of muskmelon is Fusarium wilt. Downy and powdery mildew, and other foliar diseases such as Alternaria leaf blight and gummy stem blight, can be significant as well. Scab can also be of major importance when weather conditions favor disease development early in the growing season.

General Disease Control Strategies: All cantaloupes are sprayed on a 7 to 10 day schedule beginning when the vines start to run or meet in the row (1 ½ feet long). A preventive fungicide application program must be started early to improve disease management. Rotation with non-cucurbits is important to manageAlternaria leaf blight and gummy stem blight. A rotation out of muskmelon production for 5 years is necessary for management ofFusarium wilt. A 3-5 year rotation is used by all growers. Rotation and fungicide spray programsare the two main disease control strategies implemented by all growers (26).

Bacterial Diseases

Bacterial wilt

Damage and Life Cycle: Bacterial wilt is the only important bacterial disease on muskmelon in Maryland. *Erwinia stewartii*, the bacterium that causes bacterial wilt, overwinters in the digestive tract of cucumber beetles (primarily striped) and is transmitted by beetles feeding on the leaves (12). The disease is characterized in its early stages by wilting and dying of individual leaves and in its later stages by wilting of leaves on laterals or throughout the entire plant (20). Eventually, the plant wilts and usually dies. Fruit produced by infected plants is unmarketable (13).

Frequency of Occurrence: Bacterial wilt is an economically important disease on many crops throughout the Eastern United States, and is an important consideration for muskmelon growers in Maryland. Occurrence and severity of the disease depend on winter weather conditions and the susceptibility of the muskmelon variety. Epidemics of bacterial wilt may follow warm winters, which favor cucumber beetle survival. The extent of bacterial wilt damage depends on the growth stage of the plant infected, the bacterial strain, host susceptibility, and nutritional factors (9).

Management: Bacterial wilt is managed by early to mid-season insecticide treatment to control cucumber beetles and limit the spread of the disease (11).

Chemical Controls: There are no chemical controls that work directly on bacterial-wilt infected plants (13). The disease is managed by chemical control of the cucumber beetle vector (7). (See cucumber beetle section).

Alternative Controls: Resistant cultivars are not available. No biological or cultural controls are used to combat bacterial wilt in Maryland muskmelons (9).

Viral Diseases

Viruses are an important consideration in muskmelon production in Maryland (9). At least four distinct viruses of muskmelon are believed to be of economic importance in Maryland. They are cucumber mosaic virus (CMV), watermelon mosaic virus (WMV), papaya ring spot virus (PRSV) and zucchini yellow mosaic virus (ZYMV) (7). Disease symptoms and management are similar for all four viruses. Specific viral identification is costly and time consuming and is rarely done (9).

Damage and Life Cycle: All four of these viruses are transmitted by aphids, and CMV may also be spread by cucumber beetles (20, 21). CMV can overwinter in Maryland in a broad range of biennial and perennial host plants, including pokeweed, and can be carried by aphids to new plantings (5, 9). WMV overwinters in *Trifolium* species while PRSV overwinters in wild and cultivated cucurbits (9). These viruses cause mosaic, distorted growth of plants, discoloration of leaves, and stunting of plants (20). Infected fruit may be small and distorted (9).

Frequency of Occurrence: These viruses are very common in Maryland, and though occurrence is widespread, when infection occurs late little yield loss results (9).

Management: No chemicals are available specifically to control viruses. Controlling aphid populations with insecticides is not an effective means of reducing virus diseases (9). Chemical control of weeds that can serve as alternate viral hosts, especially pokeweed, is practiced by growers to reduce yield loss due to viral transmission by aphids fromweeds (5, 9, 26).

Chemical Controls: In early spring, clumps of emerging pokeweed occurring around field borders, fence rows and non-irrigated ditch banks are spot-treated with a dilute spray solution of dicamba (Banvel) when shoots are 6 to 20 inches high. Dicamba is not labeled for use on muskmelon and is avoided where drift or runoff may affect crops (5).

See Insect section for chemical controls used against aphids. These controls are most effective at reducing the spread of viruses when they are applied early in the growing season (9).

Alternative Controls: Virus-resistant cultivars are not available (6). Many fresh market growers isolate late plantings from early plantings and plant fields as far as possible from existing cucurbit plantings to help prevent the spread of infection (7). Maintaining good weed control to prevent the buildup of aphid populations is also an important strategy (5).

Fungal Diseases

Powdery Mildew

Damage and Life Cycle: Powdery mildew, caused by the fungus *Podosphaera xanthii* and to a lesser extent by *Erisiphe cichoracearum*, occurs on cucumber, pumpkin, squash and muskmelon (20). The fungus may be introduced into the field from airborne conidia from southern cucurbits or from greenhouse transplants. The fungus does not overwinter in Maryland (9). High temperatures promote the development of the disease. A powdery white growth first appears as spots on the leaves and young stems. Symptoms appear first on the crown leaves (20). A severe infestation causes rapid defoliation, a reduction in yield, and poor quality fruit with reduced sugar content (10).

Frequency of Occurrence: Powdery mildew occurs annually from mid-July through the end of the season (7). In susceptible cultivars, powdery mildew results in large yield and quality losses if left uncontrolled (9).

Management: Most growers plant one of the many resistant cultivars that are available. Fields are observed for the presence of powdery mildew. Fungicide treatment is recommended when one lesion is found on the underside of 45 old leaves, and this threshold is followed by most growers (7, 6).

Chemical Controls: When thresholds are exceeded, growers alternate chlorothalonil (combined with either benomyl, thiophanate-methyl, myclobutanil, or triflumizole) with azoxystrobin every 7 to 10 days (9). Azoxystrobin (Quadris 11-15.4 fl oz 6L/A) is an effective broad spectrum systemic fungicide labeled on all cucurbits. Chlorothalonil (Bravo, Equus or Echo 2-3 pt 6F/A) is a broad spectrum contact fungicide. Both are effective, but good coverage is critical for chlorothalonil and difficult to achieve in muskmelon. Chlorothalonil is combined with either benomyl (Benlate 0.25-0.5 lb 50WP/A) (most popular choice but currently being phased out of use), thiophanate-methyl (Topsin M 0.25-0.5 lb 70WP/A) myclobutanil or triflumizole. Resistance to benomyl and thiophanate-methyl has been recorded in some Maryland populations of *P. xanthii*. These products no longer provide adequate control for powdery mildew (9). While chlorothalonil has been the traditional control, the availability of new, effective products is rapidly changing this. However, many of these products (azoxystrobin, trifloxystrobin, myclobutanil and triflumizole) are at risk for resistance development and need a rotation partner such as chlorothalonil) (9).It is important to alternate fungicides with different modes of action to delay the development of resistant strains of pathogens to newer fungicides (28).

Trifloxystrobin (Flint) was registered in fall 1999 for use on cucurbits. It has good activity on powdery mildew. Myclobutanil (Nova 2.5 oz 40WP/A) is used on approximately 80% of the acreage (27).

Alternative Controls: Resistant cultivars are widely used in Maryland. However, because of downy mildew and other foliar diseases, a fungicide application program is used on all acreage (6. 7, 9). No cultural or biological controls are used (9).

Damping-off

Damping-off refers to a disease caused by several species of *Pythium* that cause seeds to rot before they germinate, shoots to decay before they emerge, or seedlings to collapse (9).

Frequency of occurrence: Damping-off is generally only a concern limited to seeded fields, which make up less than 5% of commercially grown muskmelons in Maryland. Where muskmelons are grown using transplants on plastic raised beds, damping-off is less common (6). Severity of infection is dependent upon the weather, and presence of the pathogens. The *Pythium* species which cause damping-off differ in the temperature that is optimal for their growth. Therefore the disease can be a problem in cool wet or warm wet soils. In severe infections, up to 25% of muskmelon plantscan be affected in some fields (9).

Chemical Controls: Seed treatments are the most cost-effective means of control. In addition, under certain field conditions, mefenoxam Ridomil Gold (1 to 2 pt 4E/A 0.5-1.0 lb ai/A) or Ultra Flourish (2-4 pt2E/A) is applied in a 7-inch band after seeding(7, 28). This is done when planting into damp soil or low-lying fields, or when re-planting into a field previously planted in cucurbits.

Alternative Controls: Cultural practices that aid in disease management include: selecting well-drained fields; using raised, plastic covered beds for planting; and avoiding planting into cool wet soils (21, 6). Resistant cultivars are not available (9).

Gummy Stem Blight

Damage and Life Cycle: Gummy stem blight is caused by the fungus *Didymella bryoniae* (20). The pathogen overwinters in seed and in soil on residue from diseased plants. It can survive for a year and half in the absence of a plant host. In some years, infected transplants serve as a source of inoculum. Infection occurs when temperatures are warm and moisture is available. Wounding, insect damage, and powdery mildew infection predispose plants to infection with gummy stem blight (9). Gummy stem blight begins as pale brown or gray spots on leaves, petioles and stems. Stem spots often develop into elongate streaks with a gummy exudate. On affected vines, leaves turn yellow and die. In severe infections, plants are killed. Tiny black reproductive structures appear on stems, leaves and fruit (20).

Frequency of Occurrence: This disease occurs primarily in late summer (7). It is less of a problem on muskmelon than on watermelon, but in can impact yield if it is not controlled (9, 6).

Management: This disease is managed with a combination of chemical and cultural controls (7).

Chemical Controls: Preventive fungicide applications begin when the vines start to run or meet in the row and are repeated every 7 days. Azoxystrobin (Quadris 11-15.4 fl oz 6L/A) is commonly used up to every other week and is alternated with chlorothalonil (Bravo, Echo, Equus) in Maryland (7, 9). Mancozeb (2-3 lb 80WP/A) is rarely used, accounting for 5-10% of sprays (9). Reduced sensitivity of *Dibryoniae* to azoxystrobin was confirmed in Maryland in 1998 (9).

From mid-season on, chlorothalonil (occasionally combined with either Benlate or Topsin M) and mancozeb are the main products used to enhance control and to delay the development of fungicide resistance. Resistance to benomyl occurs in the *Didymella bryoniae* population in Maryland and as a result, the use of Benlate and Topsin M is decreasing (9). The manufacturer of benomyl is ending production of this chemical (9).

Alternative Controls: Growers use disease-free commercially produced seed which is treated with a fungicide, and they rotate fields out of cucurbits for at least 2 years. Fruit must be handled with care at harvest to avoid injury which increases the risk of infection (21). A weather based fungicide application model is available for some regions through Maryland Cooperative Extension. However, it has been widely adopted only by watermelon growers (9).

Scab

Damage and Life Cycle: Scab is caused by the fungus *Cladosporium cucumerinum,* which overwinters in seeds and on residue from diseased plants. It affects muskmelon and susceptible cucumbers. Moist, humid weather conditions accompanied by cool nights promote disease development. The fungus can attack any aboveground portion of the plant, including leaves, petioles, stems and fruits. Girdling may occur on stems and petioles, and plant portions beyond these regions die. Dark spots up to one half inch in diameter develop on the fruit. These spots may become covered with a velveting green growth under moist weather conditions (20). The disease is most damaging because of the unsightly scab lesions that develop on fruit, usually making them unmarketable.

Frequency of Occurrence: Scab is an infrequent disease of muskmelon in Maryland. Because this disease requires cool temperatures, it is typically only seen very early or late in the growing season. Most often, it affects seedlings of muskmelon (9).

Management: Scheduled fungicide applications used for general disease control also control scab. This disease is not much of a problem (26).

Chemical Controls: Preventive treatments are not typically used. Growers will apply treatments if necessary, based on weather conditions early in the growing season (9, 6). Chlorothalonil (Bravo, Echo, Equus 2-3 pt 6F/A) is the only product used (28).

Alternative Controls: Growers practice a minimum two year rotation away from cucurbits and select sites with good drainage. Growers use only disease-free fungicide-treated seed to control seed decay and damping-off (21).

Downy Mildew

Damage and Life Cycle: Downy mildew is caused by the fungus *Pseudoperonospora cubensis*(20). The pathogen does not overwinter in Maryland but can be carried on the wind into our area (9). Irregular yellowish to brown spots on the underside of the leaves characterize the early disease stages. Under moist weather conditions, a purplish mildew develops on the underside of the leaf spots. Leaf spots increase in size, killing the leaves (20).

Frequency of Occurrence: This disease generally does not occur in Maryland before mid-August (7). However, when it becomes established in a field, damage occurs quickly (9).

Management: Fields are scouted for disease occurrence beginning in mid-July. A web site maintained by Dr. Gerald Holmes, North Carolina State University, forecast movement of *P. cubensis* northward. Information from the site is used to provide early warnings to growers (9). This disease is controlled with fungicides. Preventive treatments are used where a problem with downy mildew is anticipated (7).

Chemical Controls: Some growers begin fungicide applications when vines run and repeat them every 7 days (7),

but most growers apply rescue treatments based on scouting. Ridomil is applied when downy mildew occurs and may be applied with, or rotated with chlorothalonil (Bravo, Echo or Equus 1.5-2 pt 6F/A) to control for other diseases (26, 28). Azoxystrobin (Quadris 11-15.4 fl oz 6L/A) is used on 50-70% of the acreage in Maryland (26). Mancozeb (2-3 lb 80WP/A) is also used (7).

Mefenoxam + chlorothalonil (Ridomil Gold/Bravo or Fluoronil l.5-2 lb 81WP/A), mefenoxam + copper hydroxide (Ridomil Gold/Copper 1.5-2 lb 70WP/A), and fosetyl-aluminum (Aliette-3 lb 80WDG/A) are also effective on downy mildew, although fosetyl-aluminum is not used very often (26). When these are used, growers apply chlorothalonil on alternate weeks. Gavel (zoxamide plus mancozeb) was registered in the spring of 2002 for use on cucurbits, and is also effective on downy mildew (9).

Alternative Controls: No cultural or biological controls are currently available for control of downy mildew (9). Some growers plant a variety (Saticoy) that is resistant to downy mildew (26).

Fusarium Wilt

Damage and Life Cycle: Fusarium wilt is caused by the soil-borne fungus *Fusarium oxysporum* f. sp. *melonis*. It can be spread in drainage water or soil moved by workers or equipment from field to field. It can also be introduced on seeds (20). When muskmelons are planted repeatedly in the same field, *F. oxysporum* f. sp. *melonis* will build up in the soil (9). Symptoms of Fusarium wilt include damping-off of seedlings and wilting, stunting, and discoloration of vascular tissue on established plants. Wilting starts at vine tips and quickly spreads, killing the plant (20). A white mold infrequently develops at the base of the stem and a gummy exudate may be present (9).

Frequency of Occurrence: Use of resistant cultivars and fumigation minimizethe damage from Fusarium wilt (9). If not controlled by resistance, fumigation, and crop rotation, this disease can cause 100% loss in some areas (6).

Management: This disease is managed by the use of resistant cultivars, cultural practices, and fumigation (9).

Chemical Controls: Growers commonly use fumigation to prevent early season infection by Fusarium, but this is not an adequate control by itself (9).

Alternative Controls: There are several strains of the fungi in our area, and available cultivars vary in their level of resistance to the various strains. The variety Athena has resistance to the most prominent strains in our area (7). Also used are Saticoy, Marigold casava, and Yellow canary (26). A high percentage of growers use a 5 year rotation for muskmelons wherever possible (9).

Alternaria Leaf Blight

Damage and Life Cycle: Alternaria leaf blight or Alternaria leaf spot is caused by the fungal pathogen *Alternaria cucumerina*. It affects cucumbers and other cucurbits but is most damaging on muskmelon. The fungus overwinters on seeds and infected plant residue. Spores produced on the leaves of infected plants are spread by wind and water or by workers or equipment moving in between fields. Weak or senescing plants are most susceptible to the disease. Once infected, a plant develops small, circular, water-soaked spots which expand to about 0.5 inches. Dark concentric rings are apparent in larger spots. As the disease progresses, spots coalesce and leaves die. Defoliation usually begins with crown leaves (20).

Frequency of Occurrence: This is the most common and important disease of muskmelon on cultivars that are resistant to powdery mildew, the most common cultivars grown in Maryland (9).

Management: This disease is managed by crop rotation into non-cucurbit crops and scheduled fungicide sprays (7, 9). A fungicide application model to schedule fungicide sprays is available through Maryland Cooperative Extension. However, it is not widely used by growers (9).

Chemical Controls: Chemical applications begin when the vines start to run and are repeated every 7 days. This disease is the primary one that growers treat for. As a result, close to 100% of the acreage is treated with one of the following fungicides (6, 7, 9): azoxystrobin (Quadris 11-15.4 fl oz 6L/A), chlorothalonil (Bravo, Echo, Equus 2-3 pt 6F/A), or mancozeb (2-3 lb 80WP/A). Chlorothalonil or mancozeb is alternated with Quadris every 7 days. This is specifically important to delay the development of resistant strains of the pathogen to Quadris (28).

Alternative Controls: Muskmelons are rotated with unrelated crops (all cucurbits serve as alternate hosts). Inoculum is reduced by plowing-under of crop refuse as soon after harvest as possible (9, 26).

Nematodes

Nematodes are extremely common, tiny, nonsegmented roundworms, many of which are soil-dwelling. Plant parasitic nematodes complete their life cycle by feeding on living plants, most often the roots. They may feed on plant tissues from the inside (endoparasitic) or from the outside (ectoparasitic) (16). Several species of plant pathogenic nematodes occur in Maryland soils (7), generally as mixed populations unevenly distributed throughout a field (16).

Nematode populations in Maryland can cause serious economic damage to muskmelon, but the extent of this potential is not fully appreciated. Yield loss can be extensive in affected areas (9). Presently, few growers sample for nematodes prior to planting. However, the severity of nematode problems seems to be increasing. This is possibly due to increasing rotation with potatoes and other vegetable crops that are good hosts of root knot nematodes, or the warmer winters recently experienced in Maryland. As a result, more growers on the eastern shore are sampling for nematodes. Because muskmelon is grown in rotation with other vegetable crops, some of which are more susceptible to nematodes, sampling and chemical treatment for nematodes may occur in the same fields, but generally not during the muskmelon growing season (9). For more information on nematode sampling and management practices, see Maryland's Tomato Crop Profile (22).

Weeds

Weed Management in Muskmelon: Weeds have the potential to cause economic loss in muskmelon in several ways. These include competition for nutrients, water and light, which will reduce yields; interference with application of fungicides and insecticides resulting in reduced pest control; and a reduction in the efficiency of harvesting. Weeds may also act as reservoirs for insect pests, nematodes, and diseases (5, 23). Annual weed escapes can produce seed that will be in the soil and increase weed populations for the next several years, and

perennial weeds may also persist if not properly controlled (23). Therefore, any weeds present may not only be a problem this year but also for many future years. Fields are not allowed to remain idle after harvest because weeds will produce seeds until frost. Fields are always disced and/or plowed after harvest to prevent late summer and fall weed seed production (24), and cover crops are often planted to prevent erosion and reduce weed seed germination (5).

Major Weeds: The most important weeds in muskmelon in Maryland are pigweed (about 90% smooth pigweed, but also redroot pigweed and Palmer amaranth), morningglory species (about 60% ivyleaf morningglory, 25% tall morningglory, 10% entireleaf morningglory) less than 5% pitted morningglory and less than 5% each of cypressvine and red morningglory), common purslane, carpetweed, common lambsquarters, common ragweed, yellow nutsedge, cocklebur, fall panicum and large crabgrass (5).

Cultural Controls: Herbicides alone seldom control all weed species. They must be used in conjunction with cultivation to ensure high yields in muskmelon crops. When weed escapes occur, cultivation is preferable to hoeing or applying post-emergence herbicides (24). Hoeing is more expensive and labor intensive than cultivation, and post-emergent herbicides may injure the crop and cause a delay in harvest. Also, since post-emergent herbicides are selective, it is unlikely that all weed escapes will be controlled (5).

Crop Rotations: Soil persistence (carryover) from some herbicides used on previous crops may cause injury to muskmelon. Advance planning in herbicide selections is essential to safely rotate muskmelon after most agronomic crops and some vegetable crops. The herbicides imazaquin (Scepter), imazethapyr (Pursuit) and chlorimuron-ethyl (Classic) have a great potential for vine crop injury in the next season (24). Metribuzin (Sencor) is a triazine herbicide with a short soil life and does not cause soil residual carry-over injury to vine crops (5, 21).

Chemical Controls: Fumigation: On the Eastern shore, nearly all muskmelon acres where black plastic is used are fumigated at the time plastic is laid, for annual weed control in the holes and particularly to control yellow nutsedge (5, 26). Yellow nutsedge can penetrate black plastic and become a severe problem (5). Fumigants also provide control for certain diseases, as well as soil-dwelling insects (5, 9). Weeds between the rows are controlled with preemergent herbicides applied at planting between the rows. Fumigation does not control *Fusarium* well (6). Growers use crop rotation for control of fusarium and other diseases (26). The fumigants used are methyl bromide (200 lb/A, in the mulched row) on 90% of acreage (this is being phased out) and metam sodium (Vapam 75 gal/A) on 10% of acreage (5). West of the Chesapeake Bay, somewhat more than 50% of acreage are fumigated and there is more rotation of crops (6).

I. Preplant Incorporated

Preplant incorporated and preemergence herbicide selection is based on the mixture of weeds present in the field, the soil type, and the percent of organic matter in the soil (7).

- naptalam--2 lb ai/A (1 gal/A Alanap 2SC) incorporated 2 inches into the soil prior to seeding or transplanting offers limited control of certain grassy and broadleaf weeds and fair control of velvetleaf. Naptalam offers poor control of Pennsylvania smartweed and eastern black nightshade. Weed control may not be satisfactory on sandy soils with less than 1% organic matter (7). This herbicide is applied to 25% of muskmelon acreage in Maryland annually (5).

- bensulide + naptalam--4-6 lb ai + 2 lb ai/A (1-1.5 gal Prefar 4EC + 1 gal Alanap 2SC/acre) may be incorporated in the upper 2 inches of soil prior to seeding or transplanting for increased control of grassy weed species over

naptalam alone (7). This herbicide combination is applied to 10% of muskmelon acreage in Maryland annually (5).

II. Preplant Incorporated or Preemergence Herbicides

- bensulide--5 to 6 lb ai/A (5-6 qt/A Prefar 4EC) is used for control of grasses. Bensulideis tank mixed with other herbicides, such as naptalam, to control more weed species. Bensulide may be applied preplant incorporated or preemergence. If applied preemergence, rainfall or irrigation must occur prior to weed emergence to activate the herbicide. Depending on the time of year, this period may be 2 to 6 days after crop planting (7). The irrigation amount should be less than 0.4 inches or excessive dilution of the herbicide may occur (24). If incorporated, the depth should be 1 to 2 inches (7). This herbicide is applied to 5% of muskmelon acreage in Maryland annually (5).

- glyphosate--1.0 ai/A (2 pt/A Roundup) is applied preplant to kill rye cover crop established between plastic strips for wind control. This herbicide is applied to approximately 25% of acreage in Maryland annually, though not directly to the crop plants (7).

II. Preemergence Herbicides

- clomazone--0.094-0.188 lb/A. Growers apply 4 to 8 fl oz/A Command 3ME preemergence to direct-seeded muskmelon to control annual grasses and many broadleaf weeds including common lambsquarters, velvetleaf, spurred anoda, and jimsonweed. Mustards, morningglory species, and pigweed species will not be controlled. Growers should use the lowest recommended rate on coarse-textured, sandy soils low in organic matter. Higher rates should only be used on medium- and fine-textured soils and sites that have been heavily manured. Command is combined with Curbit 3EC to control pigweed species where Curbit is registered for use. Some temporary crop injury (partial whitening of leaf or stem tissue) may be apparent after crop emergence. Complete recovery will occur from minor early injury without affecting yield or earliness. Banding the herbicide reduces the risk of crop injury and offsite movement due to vapor drift.

- ethalfluralin--0.56 to 0.75 lb ai/A of ethalfluralin (1 to 2 pt/A Curbit 3EC) is applied preemergence to control annual grasses and certain annual broadleaf weeds, including carpetweed and pigweed species (28). Control of many broadleaf weeds, including mustard sp., and others may not be acceptable. Dry weather following application may reduce weed control. Growers cultivate to control tolerant weeds or if rainfall or irrigation does not occur prior to weed emergence. Ethalfluralin is not preplant incorporated or applied under plastic mulch or applied when soils are cold or wet, as injury may occur (7). Ethalfluralin is applied to 70% of direct seeded muskmelon acreage in Maryland annually (less than 5% of acreage, overall), and is applied between the rows for 80% of muskmelon acreage planted in plastic (direct seeded and transplanted, which is about 76% of acreage, overall) (5).

IV. Postemergence Herbicides

- naptalam--1 to 2 lb ai/A (2-4 qt/A Alanap 2SC) is applied when the crop is ready to vine to extend residual weed control and to suppress or control smooth pigweed. It is not used early in the season when growing conditions are cold and wet. It is not applied less than 6 hours prior to rainfall and is not mixed with liquid fertilizer. Naptalam provides fair control of velvetleaf. Naptalam offers fair to poor control of Pennsylvania smartweed and eastern black nightshade (7). This herbicide is applied to 5% of muskmelon acreage in Maryland annually (5).

- paraquat--(Gramoxone Max 3SC) - A Special Local Needs 24(c) label has been approved for the use of

Gramoxone Max 3SC postemergence as a directed shielded spray in Maryland and other mid-Atlantic states. Gramoxone Max 3SC (1.5 pt/A 0.6 lb/A)is applied as a directed spray to control emerged weeds between the rows after crop establishment (28). Growers use shields to prevent spray or spray drift contact with the crop plants and do not exceed a spray pressure of 30 psi. Paraquat provides poor control of Pennsylvania smartweed (7). Paraquat is used fairly extensively in the acreage where in row rye or small grain strips are used between the rows for wind and sand protection (6). This herbicide is applied to less than 30% of muskmelon acreage in Maryland annually (5).

- clethodim--0.094 to 0.125 lb/A (6 to 8 fl oz Select 2 EC/A) is applied with oil concentrate to be 1% of the spray solution (1 gallon per 100 gallons of spray solution) postemergence to control many annual and certain perennial grasses, including annual bluegrass. The use of oil concentrate may increase the risk of crop injury when hot or humid conditions prevail. To reduce the risk of crop injury under these conditions, growers omit additives, switch to nonionic surfactant, or switch to a postemergence grass herbicide that does not require the addition of oil concentrate. Control may be reduced if grasses are large or if hot, dry, weather or drought conditions occur. For best results, annual grasses should be treated when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Wild onion or broadleaf weeds will not be controlled. Growers do not tank mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased or reduced control of grasses may result. A minimum preharvest interval of 14 days should be observed (28).

- sethoxydim--0.2-0.3 lb ai/A (1 to 1.5 pt/A of Poast 1.5 EC) is applied with oil concentrate as 1% of the total spray solution for postemergent control of annual grasses and certain perennial grasses. The use of oil concentrate may increase the risk of crop injury when hot or humid conditions prevail. To reduce the risk of crop injury, growers omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate (7). Sethoxydim is applied for control of grasses growing in the holes in black plastic, in competition with transplants (5) Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, growers treat annual grasses when they are actively growing and before tillers are present (7). Sethoxydim provides excellent control of lovegrass. Smooth and large crabgrass should be sprayed when small, about 1 inch high with 2 to 3 leaves, for effective control (5, 24). Generally, sethoxydim is most effective if applied 3 to 5 days prior to cultivation because it will weaken grasses and make them more vulnerable to killing by cultivation. A second application may be made for grasses that are difficult to control or for new flushes of germinating grasses. Sethoxydim will control shattercane and it is also effective for control of volunteer rye and wheat (25). Two applications at a rate of 1 to 1.5 pt/A are used to control most perennial grasses (except those with very narrow or waxy leaves) (7, 25). Wild onion and broadleaf weeds will not be controlled with sethoxydim. Growers do not tank-mix sethoxydim with pesticides or apply within 2 to 3 days of any other pesticide unless labeled, because the risk of crop injury may be increased or reduced control of grasses may occur. A minimum preharvest interval of 14 days is observed and applications must not exceed 3 pt/A in one season (7). This herbicide is applied to 20% of muskmelon acreage in Maryland annually (5).

- halosulfuron--0.023 to 0.31 lb ia/A (0.5 to 0.66 oz/A Sandea 75DF) is applied postemergence to control pigweed, ragweed and nutsedge (5). A Special Local Needs 24(c) label has been approved for the use of Sandea 75DF.

V. Postharvest

- paraquat--(Gramoxone Max 3SC) - A Special Local Needs 24(c) label has been approved for the use of Gramoxone Max 3SC as a broadcast spray for post-harvest desiccation of the crop in Maryland and Virginia. Paraquat may be applied at 1.5 pt/A (0.6 lb/A) postharvest to prepare plastic mulch for replanting or to aid in the

removal of mulch. It provides poor control of Pennsylvania smartweed (7). This herbicide is applied to 15% of muskmelon acreage in Maryland annually (5).

Chemical Control Issues for Herbicides: Good preemergent weed control in muskmelon is critical, since postemergent weed control options are severely limited, particularly for broadleaf weeds. Sethoxydim is the only chemical that provides good postemergent grass control, and paraquat and naptalam are the only products available for postemergent broadleaf weed control. Paraquat must be applied as a directed spray between the rows to prevent damage to the crop. For this reason, it may not sufficiently control weed infestations that encroach on the crop plants (23).

Because of the very narrow range of herbicides available for weed control in muskmelon, the loss of any of these products could have a significant negative impact on muskmelon production in Maryland. This narrow product range also raises concerns about the development of resistant weed populations (23).

Table 1. Herbicides for control of grasses and sedges in muskmelon.

	GRASSES AND SEDGES						
Herbicide	Barnyard-grass	Crabgrass, large	Fall Panicum	Foxtail sp.	Goose-grass	Johnsongrass (seedling)	Yellow nutsedge
Preplant Incorporated:							
naptalam[2]	P	P/F	P	F	P/F	I	N
bensulide (tank mix w/naptalam)[1]	G	G	G	G	F/G	G	N
Preemergence or Preplant Incorporated:							
bensulide[1]	G	G	G	G	F/G	G	N
Preemergence:							
ethalfluralin[2]	F	G	G	I	G	I	N
paraquat [1]	F/G	F/G	F/G	G	F/G	G	G
Postemergence:							
naptalam[2]	N	N	N	N	N	N	N
paraquat[2]	F/G	F/G	F/G	G	F/G	I	G
sethoxydim[2]	G	G	G	G	G	G	N
clethodim[2]	G	G	G	G	P	G	N

Herbicide performance is affected by weather, soil type, herbicide rate, weed pressure and other factors. These ratings indicate ONLY relative effectiveness in tests conducted by the University of Delaware, University of Maryland System, The Pennsylvania State University, Rutgers, The State University of New Jersey, and Virginia Polytechnic Institute and State University. Actual performance may be better or worse than indicated in this chart (24).

[1] modified from 1999 Commercial Vegetable Production Recommendations, University of Maryland Cooperative Extension Bulletin 236

[2] modified from 2002 Commercial Vegetable Production Recommendations, University of Maryland Cooperative Extension Bulletin 236

Key:
G = good
F = fair
P = poor
N = no control
I = insufficient data

Table 2. Herbicides for control of broadleaf weeds in muskmelon.

	BROADLEAF WEEDS								
Herbicide	Carpet-weed	Cocklebur, Common	Galinsoga, Hairy	Jimson-weed	Lambsqtr., Common	Morning-glory sp.	Pigweed sp.	Purslane, Common	Ragweed, Common
Preplant Incorporated:									
naptalam[2]	F	P	F	F	F	F	F/G	F/G	F
bensulide (tank mix w/ naptalam)[1]	N	N	N	N	F/G	N	F	F	N
Preplant Incorporated or Preemergence:									
bensulide[1]	N	N	N	N	F/G	N	F	F	N
Preemergence:									
ethalfluralin[2]	G	N	N	N	P/F	P	F	F/G	N
paraquat as Contact-Kill[1]	G	G	G	G	F/G	F/G	G	F/G	G
Postemergence:									
naptalam[2]	N	N	P	I	P	P/F	F	F	P
paraquat[2]	G	G	G	G	F/G	F/G	G	F/G	G
sethoxydim[2]	N	N	N	N	N	N	N	N	N

Herbicide performance is affected by weather, soil type, herbicide rate, weed pressure and other factors. These ratings indicate ONLY relative effectiveness in tests conducted by the University of Delaware, University of Maryland System, The Pennsylvania State University, Rutgers, The State University of New Jersey, and Virginia Polytechnic Institute and State University. Actual performance may be better or worse than indicated in this chart (24).

[1] modified from 1999 Commercial Vegetable Production Recommendations, University of Maryland Cooperative

Extension Bulletin 236

[2] modified from 2002 Commercial Vegetable Production Recommendations, University of Maryland Cooperative Extension Bulletin 236

Key: G = good
F = fair
P = poor
N = no control
I = Insufficient data

Compiled and Edited by:

Mr. Al Fournier, Program Assistant, Pesticide Education and Assessment Program (PEAP), University of Maryland.

Edited by:

Mr. Harry F. Rasmussen, Program Assistant, (PEAP), University of Maryland.

Ms. Monica Marcelli, Program Assistant, (PEAP), University of Maryland.

Dr. Amy Brown, (PEAP) Coordinator, University of Maryland

Reviewers:

Mr. Albert Baugus, Pest Management Consultant, Saulsbury Bros. Incorporated, Ridgely, Maryland.

Ms. Betsy Gallagher, Senior County Extension Agent, Dorchester County. Maryland Cooperative Extension Service.

Mr. James Lewis,Senior County Extension Agent, Caroline County. Maryland Cooperative Extension Service.

Ms. Betty Marose, Department of Entomology, University of Maryland.

Mr. Robert Rouse, Extension Specialist, University of Maryland, Wye Research and Education Center.

Mr. Steve White, Farmers and Planters Company, Salisbury, Maryland.

Contacts

Dr. C. Edward Beste, Natural Resource Sciences & Landscape Architecture, University of Maryland.

Dr. Galen Dively, Department of Entomology, University of Maryland.

Ms. Ethel Dutky, Department of Entomology, University of Maryland.

Dr. Kathryne Everts, Natural Resource Sciences & Landscape Architecture, University of Maryland

Dr. James Linduska, Department of Entomology, University of Maryland.

Mr. David Myers, Extension Agent, Anne Arundel County Extension.

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1. Although the terms 'cantaloupe' and 'muskmelon' are often used interchangeably, they are not the same thing. The melons grown in Maryland are *reticulatus* types, which have a netted skin and are correctly referred to as muskmelons. True cantaloupes, of the *cantaloupensis*, have a non-netted, occasionally warty skin, and are grown in Europe and parts of Africa (1).