

**Cost Analysis of UV-C Treatment and Conventional Fungicide  
Treatment of Cucumber to Control Downy Mildew**

LNE19-388R: Control of Cucumber Downy Mildew through Nighttime  
Application of Ultraviolet Light Before and After Infection

Mount Sinai Light and Health Research Center

April 2022

This material is based upon work supported by the National Institute of Food and Agriculture, U.S. Department of Agriculture, through the Northeast Sustainable Agriculture Research and Education program under subaward number LNE19-388R.

The following document contains an analysis which captures the costs associated with the various treatments evaluated in this research project. A quantitative survey of yield for the various conditions evaluated was deemed to be impractical; however, the producer noted that there was no discernable yield difference among the various treatments. Accordingly, the following analyses will focus solely on the costs associated with the various treatments on a per-acre basis up to 25 acres, which is the practical limit of a 2-row UV treatment attachment built to the specifications defined in subsequent sections. The table below summarizes the cost analysis data, which is calculated in the sections that follow.

### Summary of Per-Acre Costs for Various Treatments

| Acres Treated | UV Only  | Weekly Fungicide | UV + Weekly Fungicide | UV + Weekly DM Targeted Fungicide | UV + Fungicide Every-Other Week |
|---------------|----------|------------------|-----------------------|-----------------------------------|---------------------------------|
| 1             | \$243.59 | \$681.40         | \$924.99              | \$646.62                          | \$607.51                        |
| 5             | \$243.59 | \$541.22         | \$784.81              | \$506.44                          | \$529.63                        |
| 10            | \$243.59 | \$523.70         | \$767.29              | \$488.92                          | \$519.90                        |
| 25            | \$243.59 | \$513.18         | \$756.77              | \$478.40                          | \$514.06                        |

#### Costs Associated with UV Treatments:

The field trial conducted in 2020 investigated the efficacy of various UV-C doses. Statistical analyses of the data from that trial showed no reliable differences among 120, 240, and 480 J·m<sup>-2</sup> UV-C doses. Accordingly, the following analysis utilizes a dose of 240 J·m<sup>-2</sup>. Entries marked with an asterisk (\*) are based on assumptions explained below.

#### Cost Analysis of UV Treatment

|   |                   |
|---|-------------------|
| Ground speed to achieve dose (240 J·m <sup>-2</sup> ) | 1.25 MPH          |
| Row unit width  | 5 ft width        |
| UV treatment rate (240 J·m <sup>-2</sup> )            | 1.32 hr/acre      |
| Generator Fuel consumption per hour *                 | 0.33 gallons/hr   |
| Fuel use  | 0.44 gallons/acre |
| Average fuel cost *                                   | 4.26 \$/gallon    |
| Average hourly rate for equipment operator *          | \$17.44           |

#### Per acre cost to apply UV using *Single* row UV Unit

|                               |         |
|-------------------------------|---------|
| Fuel cost                     | \$1.86  |
| Labor cost                    | \$23.02 |
| Total cost per acre/treatment | \$24.88 |

#### Per acre cost to apply UV using *Double* row UV Unit

|                               |         |
|-------------------------------|---------|
| Fuel cost                     | \$3.71  |
| Labor cost                    | \$11.51 |
| Total cost per acre/treatment | \$15.22 |

#### Total cost of UV application for a planting

|   |                          |
|---|--------------------------|
| Treatments (8 weeks, 2x/week)           | 16                       |
| <b>Total cost using SINGLE row unit</b> | <b>\$398.04 per acre</b> |
| <b>Total cost using DOUBLE row unit</b> | <b>\$243.59 per acre</b> |



Conventional fungicide labor assumptions and notes:

- Spraying speed and time to mix, clean spray equipment, and make proper documentation provided by cooperating producer.
- Variable labor cost analysis assumes enough fungicide material to treat the acrages listed can be mixed in one batch (taking 1 hour of labor).
- National average hourly rate for *pesticide applicator* provided by the US Bureau of Labor Statistics report dated May 2021: <https://www.bls.gov/oes/current/oes373012.htm>

Conventional Fungicide Material Costs:

**Conventional Fungicide Materials Used in 2021 Field Trial**

| Product       | Rate Per Acre | \$/Unit | \$/Acre | Full Program      |            | DM Only Program   |            |
|---------------|---------------|---------|---------|-------------------|------------|-------------------|------------|
|               |               |         |         | Applications      | Total Cost | Applications      | Total Cost |
| Gatten        | 6.4 oz        | \$4.53  | \$29.00 | 2                 | \$58.00    | 0                 | \$0.00     |
| Initiate 720  | 2 pt          | \$9.38  | \$18.75 | 1                 | \$18.75    | 1                 | \$18.75    |
| Kocide 3000   | 1 lb          | \$11.25 | \$11.25 | 1                 | \$11.25    | 1                 | \$11.25    |
| Luna Senation | 6.4 oz        | \$7.56  | \$48.40 | 1                 | \$48.40    | 0                 | \$0.00     |
| Microthiol    | 6 lb          | \$1.73  | \$10.40 | 2                 | \$20.80    | 0                 | \$0.00     |
| Nordox 75WG   | 1.1 lb        | \$8.48  | \$9.33  | 1                 | \$9.33     | 1                 | \$9.33     |
| Omega 500F*   | 1 pt          | \$61.65 | \$61.65 | 1                 | \$61.65    | 1                 | \$61.65    |
| OxiDate 5.0   | 2 pt          | \$5.35  | \$10.70 | 1                 | \$10.70    | 1                 | \$10.70    |
| Previcur Flex | 1.2 pt        | \$11.25 | \$13.50 | 2                 | \$27.00    | 2                 | \$54.00    |
| Procure 480SC | 6.4 oz        | \$3.91  | \$25.00 | 1                 | \$25.00    | 0                 | \$0.00     |
| Rampart*      | 2 pt          | \$3.60  | \$7.20  | 1                 | \$7.20     | 1                 | \$7.20     |
| Ranman        | 2.4 oz        | \$8.50  | \$20.40 | 3                 | \$61.20    | 0                 | \$0.00     |
| Rhyme         | 7 oz          | \$3.98  | \$27.86 | 1                 | \$27.86    | 0                 | \$0.00     |
| Tanos         | 10 oz         | \$3.08  | \$30.83 | 1                 | \$30.83    | 1                 | \$30.83    |
| Torino        | 3.2 oz        | \$8.71  | \$27.86 | 1                 | \$27.86    | 0                 | \$0.00     |
| Vivando       | 16 oz         | \$2.27  | \$36.25 | 1                 | \$36.25    | 0                 | \$0.00     |
|               |               |         |         | \$482.08 per acre |            | \$203.71 per acre |            |

Fungicide material assumptions and notes:

- Product pricing sourced by averaging various online vendors' pricing as of April 2022.
- Online pricing for Omega 500F and Rampart could not be found online, so pricing for other products with the same percentage of active ingredient(s) was substituted for this analysis.

**Total Cost of Conventional Fungicide Treatments:**

| Total Cost for Weekly Applications<br>(9 total applications) |             |          |             |          | Total Cost for for Every-Other Week Applications<br>(5 total applications) |            |          |            |          |
|--|-------------|----------|-------------|----------|--|------------|----------|------------|----------|
| Acres treated  | Material    | Labor    | Total       | Per acre | Acres treated  | Material   | Labor    | Total      | Per acre |
| 1  | \$482.08    | \$199.32 | \$681.40    | \$681.40 | 1  | \$253.19   | \$110.74 | \$363.92   | \$363.92 |
| 5  | \$2,410.40  | \$295.70 | \$2,706.10  | \$541.22 | 5  | \$1,265.94 | \$164.28 | \$1,430.22 | \$286.04 |
| 10   | \$4,820.80  | \$416.17 | \$5,236.97  | \$523.70 | 10   | \$2,531.88 | \$231.21 | \$2,763.09 | \$276.31 |
| 25   | \$12,052.00 | \$777.58 | \$12,829.59 | \$513.18 | 25   | \$6,329.70 | \$431.99 | \$6,761.69 | \$270.47 |

**Total Cost for Weekly Application of DM Materials Only  
(9 total applications)**

| Acres treated | Material   | Labor    | Total      | Per acre |
|---------------|------------|----------|------------|----------|
| 1             | \$203.71   | \$199.32 | \$403.03   | \$403.03 |
| 5             | \$1,018.55 | \$295.70 | \$1,314.25 | \$262.85 |
| 10            | \$2,037.10 | \$416.17 | \$2,453.27 | \$245.33 |
| 25            | \$5,092.75 | \$777.58 | \$5,870.33 | \$234.81 |

**Cost of Combination Approaches:**

The 2021 field trial tested two combination approaches: UV-C plus the full conventional fungicide program (weekly application), and UV plus conventional fungicide applied every two weeks. The full combination of UV-C and fungicide produced better control than conventional alone when applied on black mulch, and equivalent control on reflective mulch. The second combination approach of every-other-week fungicide application demonstrated better control than UV alone, but not as good as the full fungicide-only program.

A third combination approach could involve the removal of materials specifically targeting powdery mildew (PM) from weekly fungicide applications. While this combination was not tested in either field trial, UV-C has been demonstrated in lab studies to control PM. Additionally, PM was very well controlled in the 2021 trial UV-only plots, suggesting that the application of PM targeting materials can successfully be replaced with UV-C treatment. A cost analysis for this approach is also included below.

| Total Cost for Weekly Applications |             |            |             |          | Total Cost for for Every-Other Week Applications |            |            |             |          |
|------------------------------------|-------------|------------|-------------|----------|--|------------|------------|-------------|----------|
| Acres treated                      | Fungicide   | UV         | Total       | Per acre | Acres treated                                    | Material   | Labor      | Total       | Per acre |
| 1                                  | \$681.40    | \$243.59   | \$924.99    | \$924.99 | 1  | \$363.92   | \$243.59   | \$607.51    | \$607.51 |
| 5                                  | \$2,706.10  | \$1,217.95 | \$3,924.05  | \$784.81 | 5  | \$1,430.22 | \$1,217.95 | \$2,648.16  | \$529.63 |
| 10                                 | \$5,236.97  | \$2,435.89 | \$7,672.86  | \$767.29 | 10   | \$2,763.09 | \$2,435.89 | \$5,198.98  | \$519.90 |
| 25                                 | \$12,829.59 | \$6,089.73 | \$18,919.32 | \$756.77 | 25   | \$6,761.69 | \$6,089.73 | \$12,851.42 | \$514.06 |

**Total Cost for Weekly Application of DM Materials Only**

| Acres treated | Material   | Labor      | Total       | Per acre |
|---------------|------------|------------|-------------|----------|
| 1             | \$403.03   | \$243.59   | \$646.62    | \$646.62 |
| 5             | \$1,314.25 | \$1,217.95 | \$2,532.20  | \$506.44 |
| 10            | \$2,453.27 | \$2,435.89 | \$4,889.16  | \$488.92 |
| 25            | \$5,870.33 | \$6,089.73 | \$11,960.06 | \$478.40 |

**Equipment Cost Comparison:**

The build cost estimate for a two-row UV treatment attachment is compared to a price estimate for a 30-foot towed sprayer. The build cost estimate for April 2022 is based on the actual build cost of the unit used for the study, adjusted for material price fluctuations.

(<https://fred.stlouisfed.org/categories/33537>)

**Cost to Build 2-Row UV Treatment Attachment**

| <b>Component</b>       | <b>Quantity</b> | <b>Each</b> | <b>Total</b>    |
|------------------------|-----------------|-------------|-----------------|
| Light Fixtures         | 10              | \$225       | \$2,250         |
| Lamps                  | 40              | \$45        | \$1,800         |
| Lamp Coating           | 1               | \$550       | \$550           |
| Electrical Supplies    | 1               | \$280       | \$280           |
| Generator              | 1               | \$450       | \$450           |
| Curtains               | 1               | \$125       | \$125           |
| Steel, Hitch           | 1               | \$1,140     | \$1,140         |
| Steel, Light Enclosure | 2               | \$800       | \$1,600         |
| Hardware               | 1               | \$510       | \$510           |
| <b>Material Total</b>  |                 |             | <b>\$8,705</b>  |
| Labor                  | 50              | \$50        | \$2,500         |
| <b>Unit Total</b>      |                 |             | <b>\$11,205</b> |

The cost of tow-behind sprayers with 30' nominal boom was estimated by taking a median price of new units of this type listed for sale nationally on [www.tractorhouse.com](http://www.tractorhouse.com) as of 4/15/2022.

**The median price for such a sprayer was: \$6100**

**UV Applicator Life:**

The UV lamps in the applicator unit have been life-tested to last in excess of 10,000 hours with >90% output. Generators like the one used to power the unit have an expected service life of approximately 3,000 hours. Items such as the lamps are more likely to require replacement due to accidental damage rather than degradation from to operation. The “Lamp Coating” specified in the component cost table in the provides a plastic coating that contains lamp fragments in the event of accidental damage.

The table below shows the expected life, in growing seasons, of these components for a double-row unit based on the number of acres treated assuming that no accidental breakage occurs.

| Acres Treated | Expected Life<br>(Growing Seasons) |           |
|---------------|------------------------------------|-----------|
|               | UV Lamps                           | Generator |
| 1             | 947                                | 284       |
| 5             | 189                                | 57        |
| 10            | 95                                 | 28        |
| 25            | 38                                 | 11        |