

Weed Control Options for Strawberries

2024 New England Vegetable and Fruit
Conference

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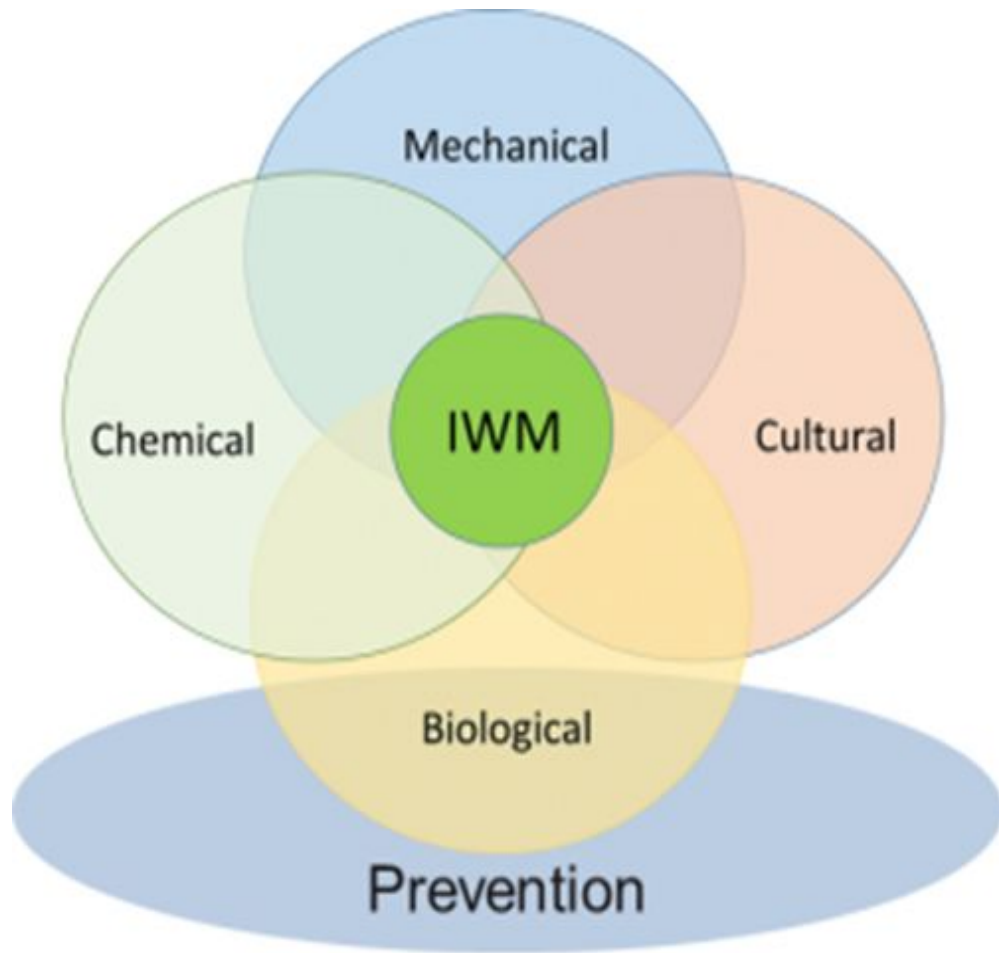
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Integrated Weed Management (IWM)



The IWM toolbox

Combining multiple methods and practices to manage weeds

- When current chemical strategies are no longer effective
- When a new weed species enters a field
- Increased societal demand for less pesticides



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Strategies in your Integrated Weed Management toolbox?

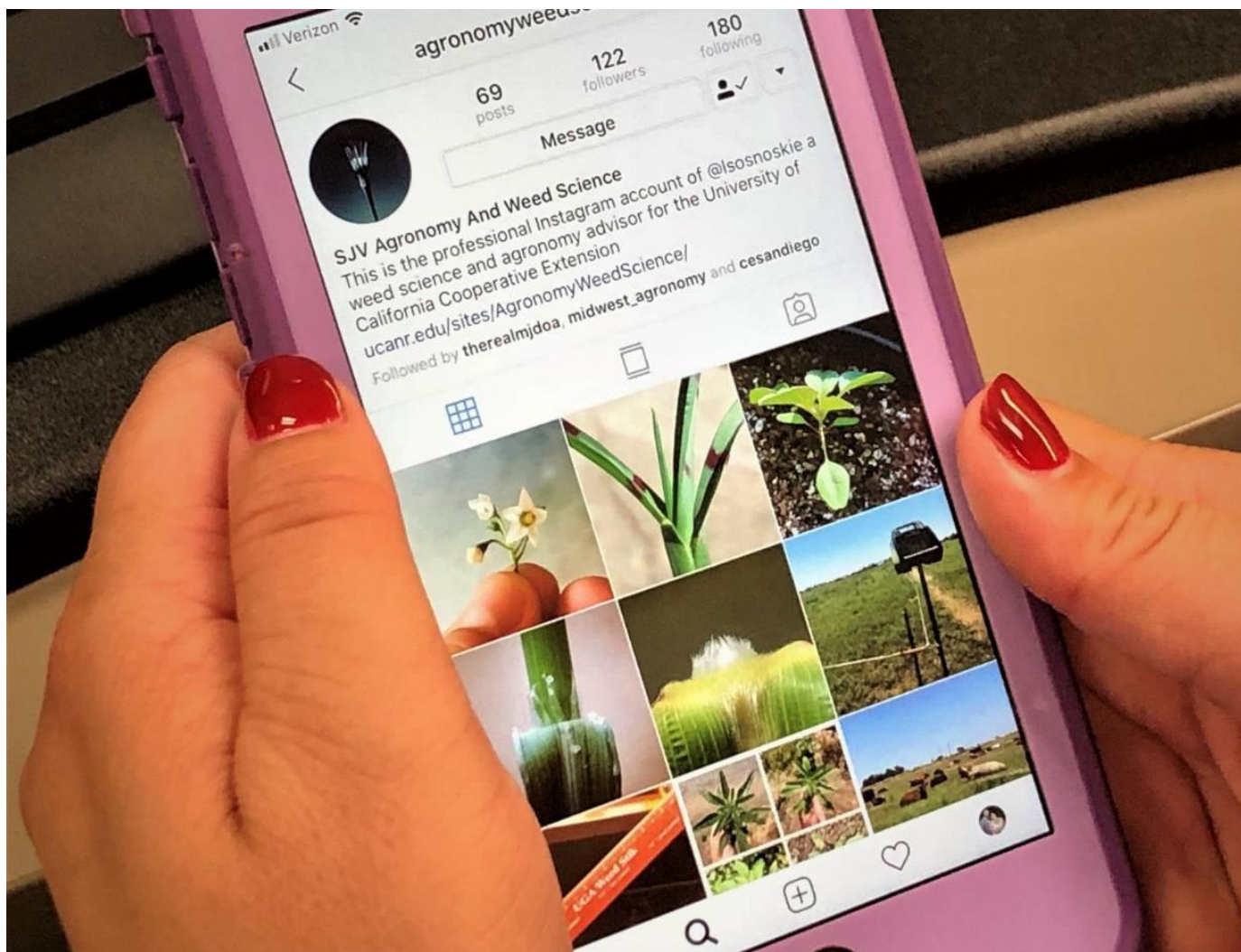
- **Weed identification:** phone apps
- **Prevention:** equipment cleaning, seed production...
- **Cultural practices:** cover cropping, crop rotation, planting dates, row spacing....
- **Herbicides:** update
- **The future of weed control:** Naio OZ...



⇒ Weed Identification

- Help to determine how species came to a field site (e.g. wind-dispersed seeds vs potential entry on equipment)
- Help to identify areas of the field favorable to weed infestation (e.g. nutsedges in wet places, compacted soil areas, weak crop coverage...)
- Help the development of a weed management program based on projected response to treatment (e.g. differential effects of herbicides across species)





Isn't there just a phone app where I can just take a picture, and a program tells me what I'm looking at?

Actually, yes...



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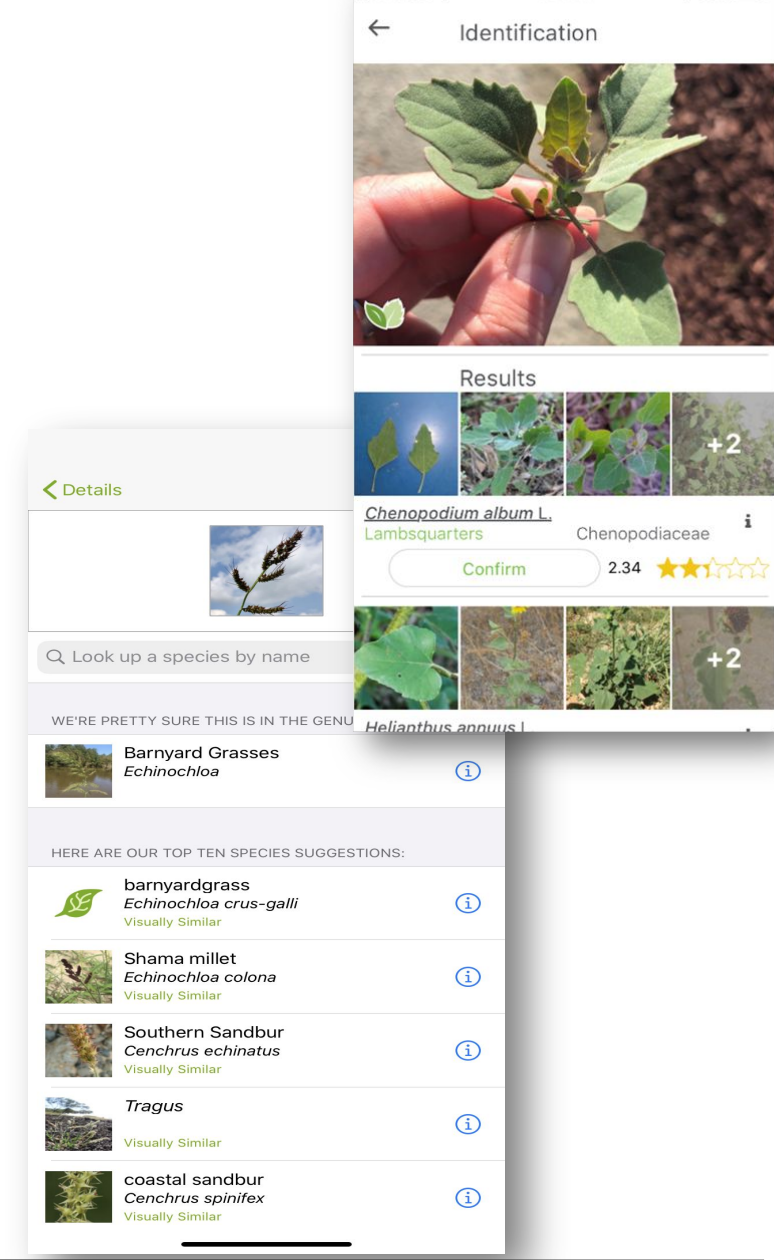
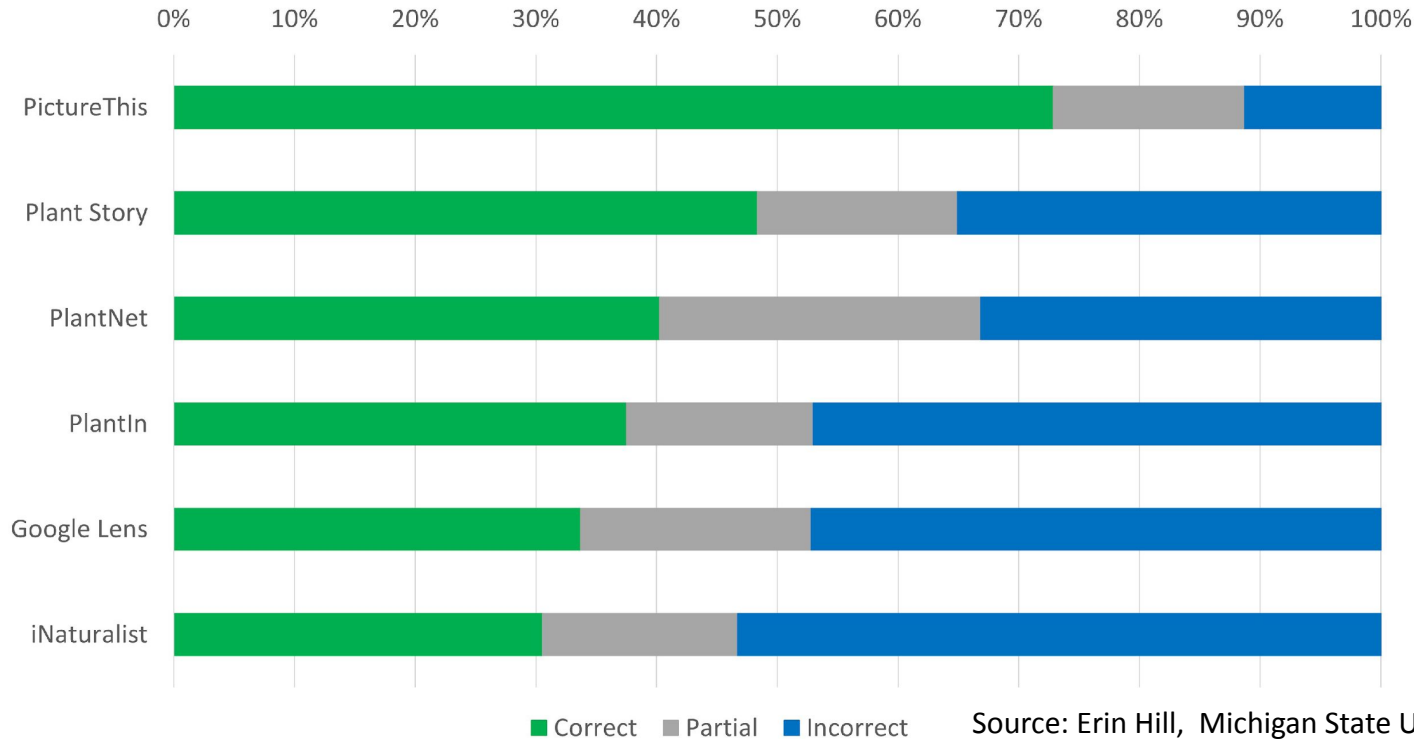
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Weed ID resources apps for your phone

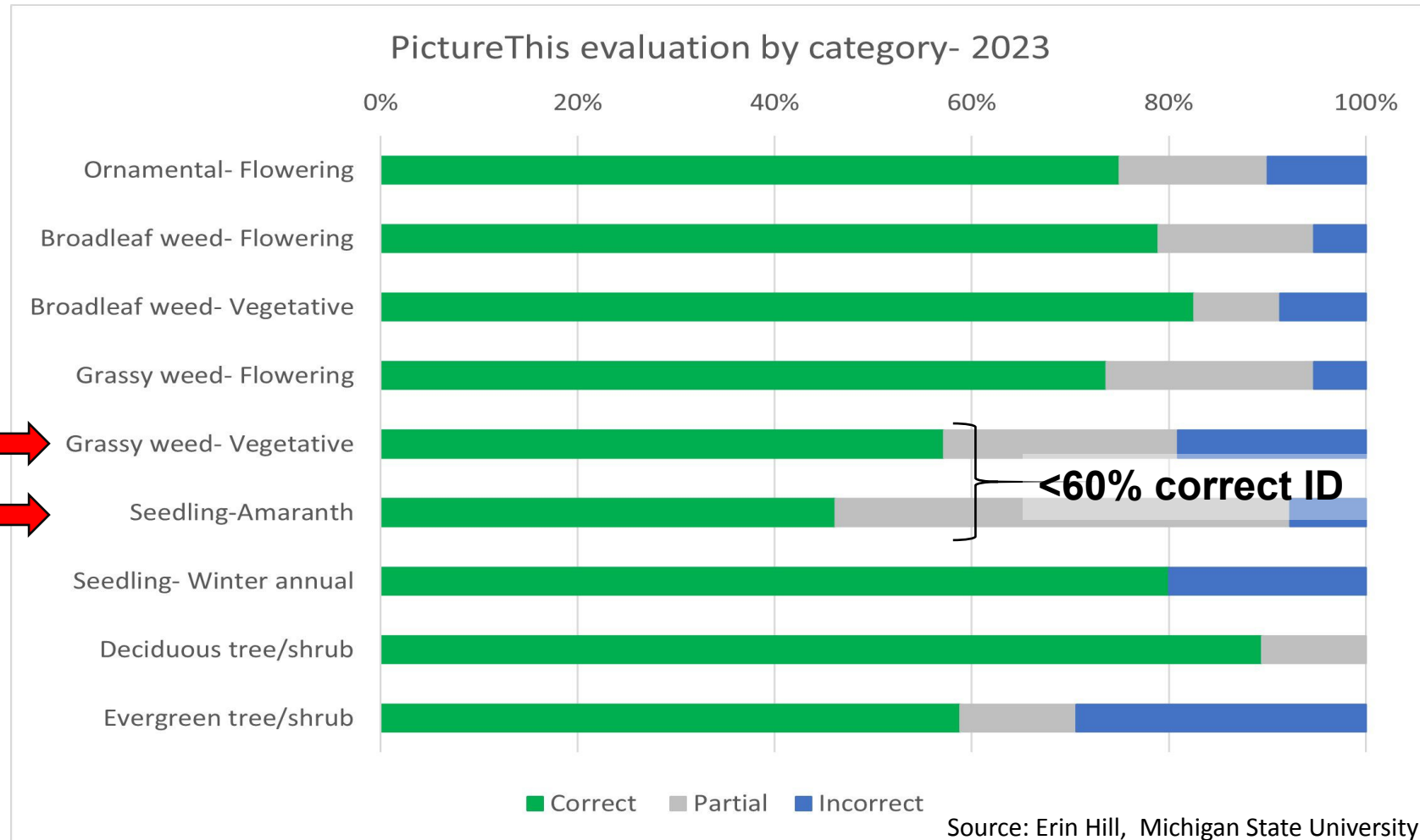
Uses recognition software to compare your pictures to image galleries to get an identification

- **PictureThis**
- **Pl@ntNet**

Overall evaluation of Plant ID apps-2023



Weed ID resources apps for your phone



- Lower identification accuracy for vegetative grassy weeds and weeds at the seedling stage...
- May be worth getting two apps on your phone for confirming ID
- Check the identification with a reputable source

⇒ Prevention

All the steps taken to prevent introduction, establishment, and spread of a weed species

Some Prevention Tactics



Cleaned brush mower (left) versus a brush mower covered in dandelion seed (right).

Photo credit: Flessner 2016.

- Weed-free irrigation water.
- Reduce weed seed viability through composting process of natural mulches (check humidity and moisture).
- Preventing seed production on field borders (mowing or planting of a boundary strip).
- Equipment cleaning.



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⇒ Prevention



After 38 years of burial, the following weeds species germinated.

| Weed species | % seed germinated |
|----------------------|-------------------|
| Jimsonweed | 91 |
| Common mullein | 48 |
| Velvetleaf | 38 |
| Evening primrose | 17 |
| Common lambsquarters | 7 |
| Green foxtail | 1 |
| Curly dock | 1 |

Conclusion: never let weeds go to seed...



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⇒ Cultural Practices

- Appropriate rate, timing, and placement of fertilization. **Feed the crop, not the weeds!**
- Optimize disease and insect control
- Variety selection – prefer cultivars that can quickly vine and shade the ground (leaf shape, soil shading...)
- Reduced row spacing and increased planting density = more uniform plant distribution across the field



Enhancing the crop's capacity to suppress and outcompete

⇒ Cultural Practices

Living mulch – Annual rye



Advantages

- Cleaner fruit
 - Disease
 - Dirt
- Moisture conservation
- Weed control
- Soil health

Disadvantage

- Planting
- Additional management
 - Fertility CC
 - Fertility crop
- Pre-plant moisture loss
- Cultivation

⇒ **Herbicides – General Note**

- **Dacthal is no longer labeled for any crop use**
- EPA issued “Stop Use” of Dacthal (DCPA) for all uses on August 6th, 2024. This is for all uses of Dacthal. No application, sale, distribution or transportation of Dacthal is permitted. More information can be found at <https://www.epa.gov/newsreleases/epa-issues-emergency-order-stop-use-pesticide-dacthal-address-serious-health-risk-4>
- Check with your state agency responsible for pesticides to determine appropriate procedures for disposal of remaining stocks.

⇒ Herbicides – row middles with rye living mulch

- NO preemergence herbicide – risk of injury to living mulch
- Limited options for postemergence weed control –of broadleaf weeds:

| WSSA Group | A.I. | Formulated Product | Notes |
|--------------------------------------|------------|---------------------------------------|--|
| WSSA 4 Synthetic auxins | clopyralid | Spur ^{Restricted Use} | <ul style="list-style-type: none">• Only labeled for postharvest use in perennial strawberries• <i>Clopyralid</i> controls composite (ragweed, galinsoga, cocklebur, groundsel) and leguminous (clover, vetch). Suppresses perennial composites (Canada thistle, goldenrod, mugwort). |
| WSSA 4 Synthetic auxins | 2,4-D | Weedar 64 | <ul style="list-style-type: none">• Do not apply between mid-August and winter dormancy. |



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NEW PLANTING WEED CONTROL

⇒ In-Row Herbicides – New Planting - preemergence

| WSSA Group | A.I. | Formulated Product | Notes |
|--|-------------|------------------------------|---|
| WSSA 5 Inhibition of photosynthesis (PSII) | terbacil | Sinbar 80 WDG | <ul style="list-style-type: none"> • Apply after transplanting but before new runner plants start to root. Apply before mulching in late fall! • Do not apply if transplants have developed new foliage / OM < 0.5% • Higher injury potential on sandy soils! • Control of annual broadleaf weeds but weak on pigweeds. |
| WSSA 15 Mitosis Inhibitor | napropamide | Devrinol DF-XT / 2-XT | <ul style="list-style-type: none"> • Labeled for preplant incorporated application with plastic mulch production (prior to laying plastic). • Do not apply from bloom through harvest • Subject to photodegradation. About 50% is lost after 4 days on the soil surface in the summer... Activate with ½ inch sprinkler irrigation within 24 h after application • Controls annual grasses and small seeded broadleaf weeds. |

⇒ In-Row Herbicides – New Planting - postemergence

| WSSA Group | A.I. | Formulated Product | Notes |
|---|------------|---|---|
| WSSA 1 ACCase Inhibitor | sethoxydim | Poast 1.5EC | <ul style="list-style-type: none"> Require mixing surfactant – see label. Use of COC may increase the risk of crop injury when hot or humid conditions prevail. Annual and perennial grasses - Use high rate and sequential applications for perennial grasses (bermudagrass, quackgrass). Control may be reduced if grasses are large or under hot or dry weather conditions |
| | clethodim | Select Max ^{Restricted Use} | |
| WSSA 5 Inhibition of photosynthesis (PSII) | terbacil | Sinbar 80 WDG | <ul style="list-style-type: none"> Apply in late summer or early fall to dormant crop. Spray must be followed immediately by 0.5-1 inches of irrigation or rainfall to rinse the strawberry foliage. Winter annual broadleaf control |



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BEARING YEAR WEED CONTROL

⇒ In-Row Herbicides – Bearing Year - preemergence

| WSSA Group | A.I. | Formulated Product | Notes |
|-------------------------------------|-------------|------------------------------|---|
| WSSA 5 PSII inhibitor | terbacil | Sinbar 80 WDG | <ul style="list-style-type: none"> • Apply just prior to mulching in late fall t • Winter annual broadleaf control |
| WSSA 14 PPO Inhibitor | flumioxazin | Chateau 51 WDG | <ul style="list-style-type: none"> • <u>Matted row</u>: late winter or early spring application when strawberries are dormant. • <u>Plastic mulch</u>: shielded spray application between the rows of strawberries on plastic mulch before fruit set • Controls annual broadleaf weeds (cutleaf evening primrose, henbit, chickweed, pigweeds, wild radish). |
| WSSA 15 Mitosis Inhibitor | napropamide | Devrinol DF-XT / 2-XT | <ul style="list-style-type: none"> • Apply in late fall through early winter (not on frozen ground) or in early spring. Do not apply from bloom through harvest • Activate with ½ inch sprinkler irrigation within 24 h after application • Will not controlled emerged weeds |



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⇒ In-Row Herbicides – Bearing Year - preemergence

| WSSA Group | A.I. | Formulated Product | Notes |
|-----------------------------|---------------|--------------------|--|
| WSSA 14 PPO Inhibitor | sulfentrazone | Spartan 4F | <ul style="list-style-type: none"> • No regional data available • Not labeled for use in NY! • Do not apply to non-dormant strawberry (risk of severe injury). • Effective for preemergence control of annual broadleaf weeds (lambsquarters, pigweed, groundsel) and <u>suppression of yellow nutsedge</u>. |
| WSSA 3 Mitosis Inhibitor | pendimethalin | Prowl H2O | <ul style="list-style-type: none"> • No regional data available • Over-the-top application limited to fall and winter dormant strawberries. • In-season row middles application <u>ONLY</u>. • Will not controlled emerged weeds. • Annual grass + some small seeded annual broadleaf weeds. |

□ Acifluorfen (Ultra Blazer) not labeled for use in New England states...

⇒ In-Row Herbicides – Bearing Year - postemergence

| WSSA Group | A.I. | Formulated Product | Notes |
|--------------------------------|------------|---|--|
| WSSA 1 ACCCase Inhibitor | sethoxydim | Poast 1.5EC | <ul style="list-style-type: none"> • Use of COC may increase the risk of crop injury when hot or humid conditions prevail. • Sequential applications necessary for perennial grass control • PHI: fluazifop = 14 days sethoxydim = 7 days clethodim = 4 days |
| | clethodim | Select Max ^{Restricted Use} | |
| | fluazifop | Fusilade DX | |
| WSSA 4 Synthetic auxins | clopyralid | Spur ^{Restricted Use} | <ul style="list-style-type: none"> • Only labeled for postharvest use in perennial strawberries • Composite (ragweed, galinsoga, cocklebur, groundsel) and leguminous (clover, vetch) control • Suppresses perennial composites (Canada thistle, goldenrod, mugwort). • Risk of carryover.... |



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Clopyralid Carryover to Vegetable Crops

- Tomato and pepper
 - Crop injury on foliage.
 - Misshapen fruit.
 - Reduction in yield.
- Cantaloupe
 - No visual injury.
 - No effect on yield.



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⇒ Row Middles Herbicides – postemergence

| WSSA Group | A.I. | Formulated Product | Notes |
|-----------------------------|---------------|--|--|
| WSSA 9 EPSP inhibitor | glyphosate | Various commercial formulations | <ul style="list-style-type: none"> • Use limited to hooded sprayer or wiper applicator. • Avoid contact with any portion of the crop or plastic. • Strawberries are most susceptible to glyphosate damage in the fall. |
| WSSA 14 PPO Inhibitor | carfentrazone | Aim | <ul style="list-style-type: none"> • Apply to actively growing weeds up to 4 inches tall and rosettes less than 3 inches across. • Coverage is essential for satisfactory performance • Broadleaf weeds ONLY |
| WSSA 22 PSI inhibitor | paraquat | Gramoxone ^{Restricted Use} | <ul style="list-style-type: none"> • Directed shielded spray to control emerged weeds in row-middles ONLY! • Use NIS surfactant • Drift can cause crop injury. • Controls annual broadleaf and grassy weeds. • Required online training for certified applicators |



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**Herbicides Remain the #1 Solution
For Weed Management...
(266 M. acres treated in 2022)**

But This May Rapidly Change...



**533 unique cases of HR
to 168 herbicides**



Export Market Access



**Consumer
Perception**



**Worker Protection And Crop Injury
Concerns**

Weed Management in 2050: Perspectives on the Future of Weed Science

Westwood et al. (2018). Weed Management in 2050: Perspectives on the Future of Weed Science. Weed Science, 66(3):275-285. doi:10.1017/wsc.2017.78

Herbicides aren't going away but may change (e.g. *biopesticides*)

Biological control

Enhancing crop biology for improved competitive ability

Novel tools, precision agriculture, and robotics

Advantages of Robotic Weeders

- **Weed Prevention** - Early detection and removal before competition with crop occurs
- **Precision** - precise targeting/removal of weeds
- **Reduce Herbicide Usage**
- **Labor Efficiency** - autonomous operation
- **Scalability** - different sizes of equipment available
- **Cost savings** - high initial investment but reduced labor and pesticides cost, increased yield



Naio OZ – Versatile Farming Robot



Naio OZ autonomous seeder and weeder

In autonomous mode, Oz follows the crop rows of the plot and guides itself

- Work output: 0.25 acre/hour
- Weight: 330 lb
- Traction: 650 lb
- Energy: 100% electric
- Autonomy: Up to 8 hours



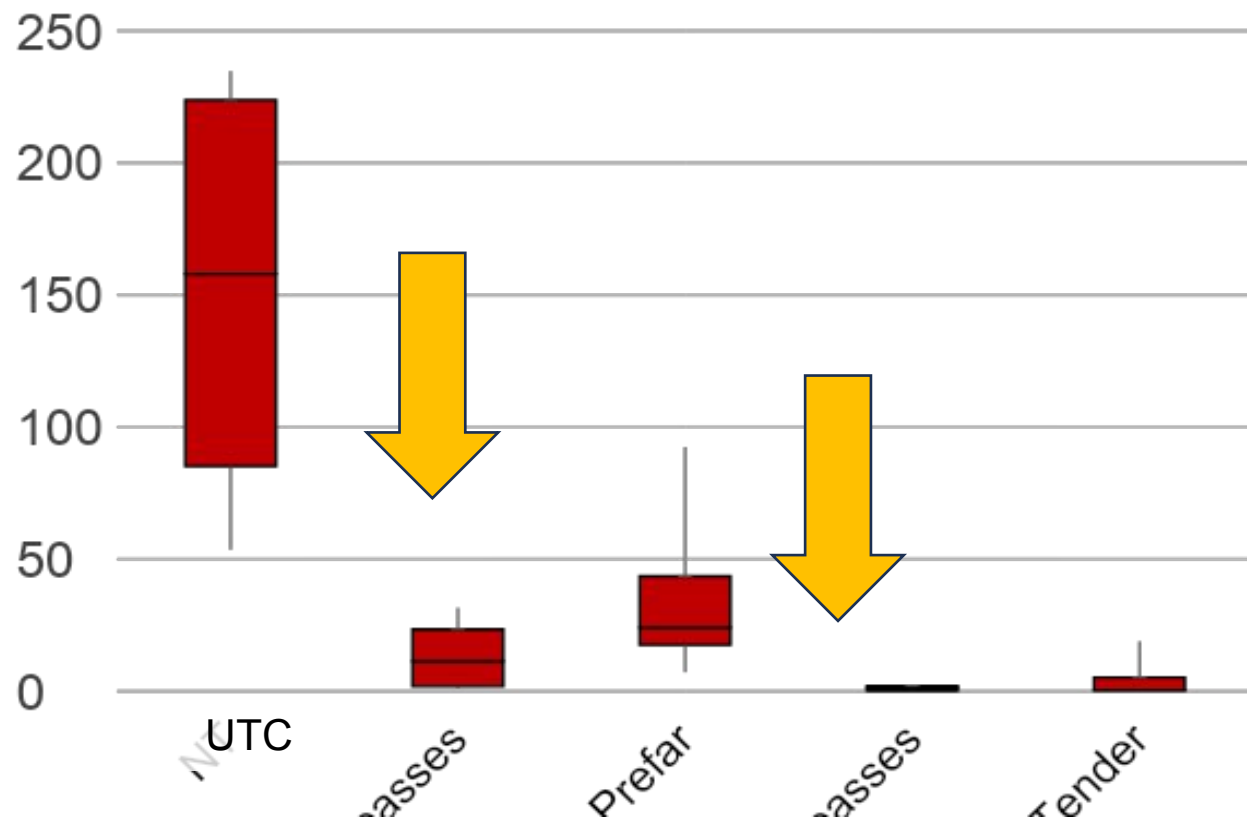
Trials conducted in 2023 and 2024 at Rutgers, Cornell and Univ. of Arkansas

- Seeded sweet corn (NJ and AR)
- Transplanted cabbage (NJ and NY)

Naio Oz mechanical cultivation – Cabbage 2023

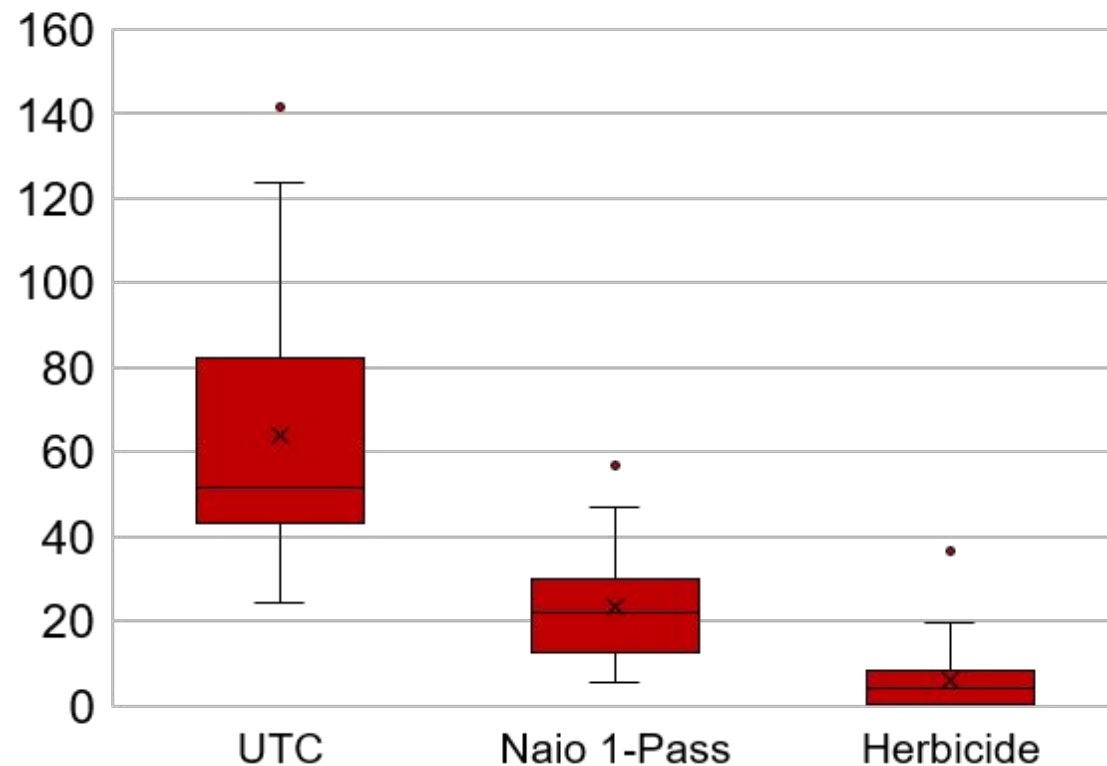
Cabbage (Rutgers)

Weed biomass (g m⁻²)



Cabbage (Cornell)

Weed biomass (g per 0.25 m²)



Using AI for weed management



Credit: Nathan Boyd, UF/IFAS.

EZ Ag Innovations

Uni. of Florida – Nathan Boyd

- Using artificial intelligence (AI) to detect and identify weeds within a crop canopy.
- AI sends signal to spray the herbicide only on the weeds

Using AI for weed management



Credit: Nathan Boyd, UF/IFAS.

EZ Ag Innovations

Deep learning AI machine vision

- Detection of objects of interest with cameras.
- Training of AI models with the HiPerGator supercomputer.



NVIDIA GPU-accelerated computing for fast real-time image processing.

Carbon Robotics LaserWeeder™



- High-resolution, real-time cameras to scan the ground and identify weeds and crops.
- Weed detection and identification through advanced deep learning algorithms (AI).
- 150W carbon dioxide (CO₂) laser with 3 mm precision accuracy.





Questions ?

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Cornell **AgriTech**

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