4 Asparagus

Where: Gallery Overlook Room C & D
MI re-certification credits: 2 (1B, COMM CORE, PRIV CORE)
OH re-certification credits: 1.5 (presentations as marked)
CCA Credits: NM (0.5) PM (1.5)
Moderator: Ben Werling, Michigan State University Extension

9:00 AM **Asparagus Fertility Update**
- Zachary Hayden, Michigan State University

9:30 AM **Weed Control Update (OH: 2C, 0.5 hr)**
- Bernard Zandstra, Michigan State University

10:00 AM **A Refresher on Common Asparagus Beetle Biology (OH: 2B, 0.5 hr)**
- Zsofia Szendrei, Michigan State University
- Ben Werling, Michigan State University Extension

10:30 AM **Asparagus Pathology Update (OH: 2B, 0.5 hr)**
- Mary Hausbeck, Michigan State University

11:00 AM **Session Ends**

Asparagus Pathology Research − Results of 2018 Trials

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Michigan State University, Department of Plant, Soil & Microbial Sciences

Asparagus is a perennial crop that should be in production for many years with proper horticultural and pest management. Michigan is ranked second nationally in asparagus production. With an average of 9,200 acres harvested, Michigan asparagus growers produced 12,880 tons of spears at a value of $20.2 million in 2017. These totals are similar to previous years. Major asparagus-producing counties in Michigan include Mason and Oceana in the northwest. Asparagus is also produced in Cass and Van Buren counties in the southwest.

Unlike annual crops where an epidemic in one year will not necessarily influence yields in subsequent years, premature defoliation of the asparagus fern from a plant pathogen may reduce plant vigor. Consecutive years of premature defoliation have been shown to critically reduce subsequent yields. The primary pests of asparagus include both foliar and soilborne pathogens that are currently managed in seedbed and production fields with the help of fungicides. The goal of our 2017 and 2018 field research was to survey asparagus crowns for soilborne pathogens and to test new tools and strategies for managing diseases in asparagus.

Foliar Diseases. Fungicides are applied to asparagus fern to manage rust and purple spot, which are the most important foliar fungal diseases of asparagus in Michigan. Purple spot (caused by *Stemphylium vesicarium*) occurs on both the fern and the edible spears. Purple spot lesions may result in spears being rejected for the fresh market. Rust (caused by *Puccinia asparagi*) only affects the fern. Both rust and purple spot can develop on the main stem, secondary branches, and cladophylls and can be present together, exacerbating defoliation. Premature defoliation decreases carbohydrate stores in the crown, which can limit yield in subsequent years and cause plant stress that may increase susceptibility to soilborne pathogens such as *Fusarium*.

Soilborne Diseases. *Fusarium* spp. cause stem, crown, and root rot of asparagus (Figures 1 and 2). While this pathogen may infect asparagus seedlings in the nursery and crowns after establishment in production fields, *Fusarium* is a common problem throughout perennial systems, such as asparagus. Since asparagus is a perennial crop, crown rot may progress unnoticed initially. High heat and drought stress favor *Fusarium*, and may weaken the plant, allowing the pathogen to enter the vascular system. Control of *Fusarium* root and crown rot is challenging as this pathogen may persist in the soil for many years and control options are limited. Treating crowns with fungicides before planting and fumigating crown nurseries and production fields have been used in recent years to improve crown health and enhance the longevity and productivity of the asparagus planting. Soil applications of fungicides for direct-seeded crown nurseries may improve crown health and vigor by reducing soilborne diseases and has been the focus of our recent research.

Evaluation of fungicides for control of *Fusarium* root rot on asparagus seedlings. Asparagus 'Millennium' was seeded into 128-cell flats on 30 June. Fungicides (Table 1) were applied as a drench to the seeded flats on 30 June and 24 August. The seeds were transplanted into 72-cell packs containing a soilless media on 28 August. Twenty-four plants per treatment were placed into a completely randomized design. Plants were inoculated on 30 August and 13 and 22 September by injecting 10 ml of *Fusarium* inoculum into the soil at the base of the plant with a syringe. To inoculate the asparagus plants on 18 October, the plants were removed from the cell packs, rinsed with water, and the roots were dipped into the inoculum and transplanted into 5-inch pots.

The number of spears and the fern height and width were measured on 25 September and 16 November. On 12 December, each crown was rated for disease severity by assigning it to one of five categories (1=healthy, marketable; 2=small, isolated lesions, marketable; 3=moderate sized lesions, non-

marketable; 4=severe infection of the crown and roots, non-marketable; 5=plant death). No significant differences occurred among the treatments for the number of spears/ferns or height (Table 2). Cannonball treatments produced seedlings with significantly increased fern weight compared to treatments of EndoMAXX or Actinovate (Table 2). Disease pressure was moderate in this trial with the untreated inoculated plants receiving a root severity category average of 3.0; these crowns would not be preferred to establish a healthy production field (Table 3). Industry standard treatment of Cannonball WP was the only treatment that resulted in statistically healthier crowns compared to the untreated control.

Table 1. Products tested to protect asparagus seedlings from infection by *Fusarium*.

Product	Active ingredient	FRAC*	Labeled
Actinovate SP	*Streptomyces lydicus* WYEC 108	--	no
Cannonball WP	fludioxonil	12	yes
EndoMAXX	*Glomus intraradices/Glomus mosseae/ Glomus aggregatum/Glomus etunicatum*	--	no
Mycostop	*Streptomyces griseoviridis*	--	no

*Numbers and letters are used to define the fungicide groups by their mode of action. Visit www.frac.info for more information about FRAC codes.

Table 2. The number of spears and the height and weight of seedlings inoculated with *Fusarium* and treated with biological control products or a fungicide.

Treatment/100 gal	# Spears/ferns		Height (cm)	Weight (g)
	25 Sep	16 Nov		
Untreated inoculated	7.1*	12.1	48.8	19.9 ab
EndoMAXX 10 g	7.1	11.9	48.4	18.6 a
Actinovate SP 6 oz	7.2	12.7	48.1	18.1 a
Mycostop 4 g	7.2	11.5	49.6	18.6 ab
Cannonball WP 7 oz	6.1	11.7	49.0	20.6 b

*Column means with a letter in common or with no letter are not significantly different (Fisher LSD Test; *P*=0.05).

Table 3. Disease severity on crowns when seedlings were treated with biological control products or a fungicide.

Treatment/100 gal	Crowns in disease severity categories (%) *			Avg. crown category
	2	3	4	
Untreated inoculated	25**	50	25 b	3.0 b
EndoMAXX 10g	33	50	16 ab	2.8 ab
Actinovate SP 6 oz	25	62	12 ab	2.8 ab
Mycostop 4 g	29	50	16 ab	2.9 ab
Cannonball WP 7 oz	45	50	4 a	2.5 a

*Disease severity was rated on a scale of 1-5; where 1=healthy, and 5=dead.
**Column means with a letter in common or with no letter are not significantly different (Fisher LSD Test; *P*=0.05).

Survey of *Fusarium* species in asparagus crowns

One-year-old asparagus crowns were sampled from three Michigan growers in April and May, 2018: One grower in Berrien County (Berrien 1) and two growers in Oceana County (Oceana 1 and 2). From Berrien 1, 100 crowns of 'Jersey Supreme' were sampled, from Oceana 1, 127 crowns of 'Guelph Millennium' were sampled, and from Oceana 2, 131 crowns of 'Guelph Millennium' and 133 crowns of 'Guelph Eclipse' were sampled. All crown fields were previously fumigated with the exception of those from Oceana 1.

Crowns were washed and tissue pieces were removed from the crown and roots and surface sterilized. They were plated onto a *Fusarium* selective medium to determine the quantity and diversity of *Fusarium* species.

Fig. 1. Asparagus stand showing symptoms of *Fusarium* infection.

Fig. 2. Asparagus roots (left) and crown (right) exhibiting symptoms of *Fusarium* infection.

Table 4. Asparagus crowns sampled by location and cultivar and percentage of crowns *Fusarium* was isolated from.

County	Crowns sampled	Cultivar	Crown isolated Fusarium (%)
Berrien 1	100	Jersey Supreme	39%
Oceana 1	127	Guelph Millennium	25%
Oceana 2	131	Guelph Millennium	36%
Oceana 2	133	Guelph Eclipse	47%
Total	491		

Preliminary results showed that *Fusarium* was isolated from Guelph Eclipse cultivar (47%) crowns and Guelph Millennium (35%) (Table 4, Figure 3A). *Fusarium* was isolated from crowns grown in previously fumigated fields and those grown in unfumigated fields (Table 4, Figure 3B). In addition to fumigation, other factors influence *Fusarium* infection including previous crop, grower practices, crop stress, and weather. Differences were not noted between fields in the northern part of the state (Oceana County) and fields in the southern part of the state (Berrien County) (Table 4, Figure 4A). A higher percentage of *Fusarium* was isolated from the root (45%), than from the crown (28%) (Table 4, Figure 4B). Further studies will be conducted to determine whether or not these *Fusarium* species are capable of causing disease in asparagus through pathogenicity testing which will help us to develop effective management strategies

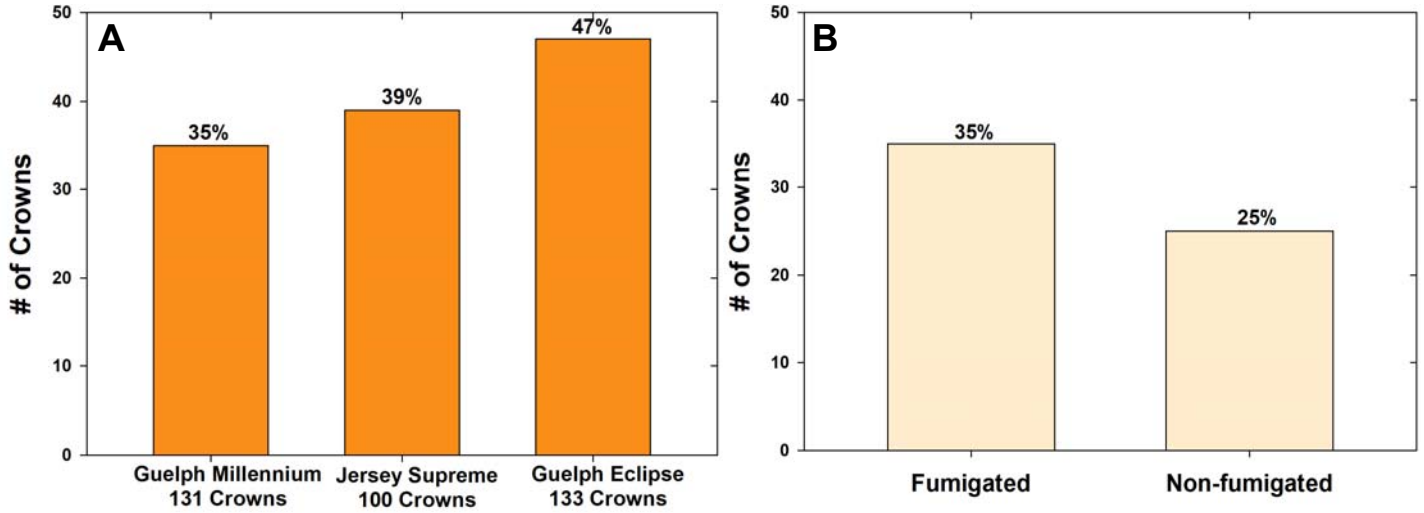


Fig. 3. *Fusarium* incidence by (A) cultivar and (B) fumigation.

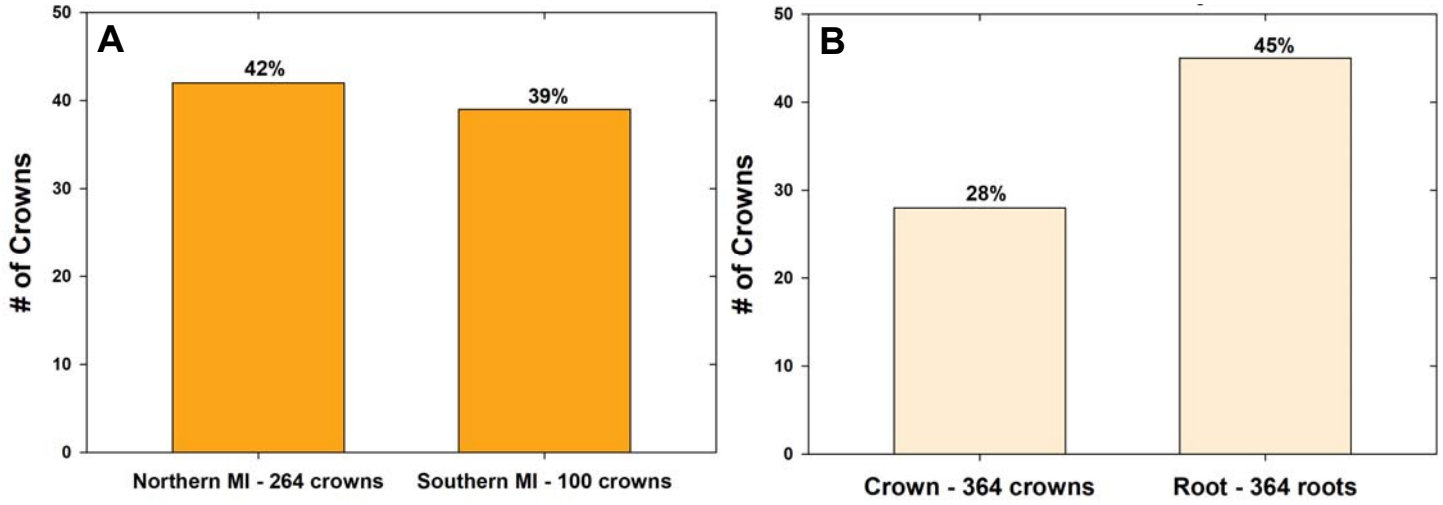


Fig. 4. *Fusarium* incidence by (A) location in Michigan and (B) plant part.

Acknowledgement. This research was supported by funding by the Michigan Asparagus Advisory Board and the Michigan Specialty Crop Block Grant 791AgDSC1807 awarded to the Michigan Asparagus Advisory Board.

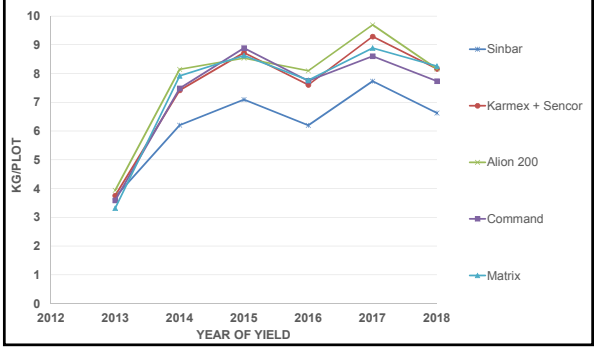
Asparagus Weed Control Now and Future

Bernard Zandstra
Michigan State University
Great Lakes Expo
Grand Rapids, MI
December 4, 2018

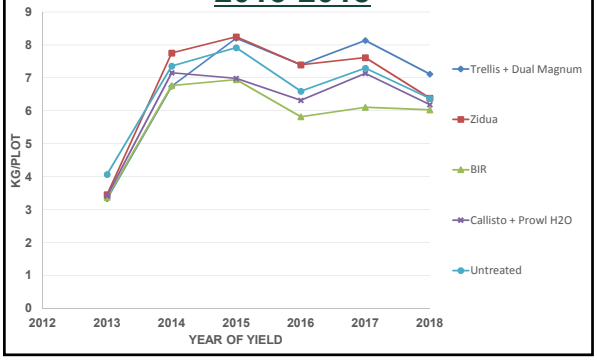
Hart Research Farm

1. 6 year repeated application
2. Soil: Spinks sand: 86% sand, 6% clay, 1% OM
3. One preemergence application per year

Asparagus Yield Treatments 1-5 2013-2018



Asparagus Yield Treatments 6-10 2013-2018



6 Year Asparagus Yield, Hart (1) 2013-2018

	Treatment and Rate	Yield, kg/plot	
		2018	Average (2013-2018)
1	Sinbar 1	6.63*	6.27*
2	Karmex 1.6 + Sencor 1.6	8.17	7.50
3	Alion 0.085	8.17	7.77
4	Command 2	7.74	7.34
5	Matrix 0.063	8.26	7.47

6 Year Asparagus Yield, Hart (2) 2013-2018

	Treatment and Rate	Yield, kg/plot	
		2018	Average (2013-2018)
6	Trellis 1.5 + Dual Mag 1.9	7.12	6.82
7	Zidua 0.267	6.39*	6.81
8	BIR 0.045	6.03*	5.84*
9	Callisto 0.241 + Prowl H_2O 1.9	6.19*	6.20*
10	Untreated	6.38*	6.61

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Weed Control – Hart – 2018 (1)

		GROUP	POAM 6/8	POAM 9/7	RUTH 6/8	RUTH 9/7
1.	Sinbar 1	5	8.7	8	10	10
2.	Karmex 1.6 Tricor 1.6	7 5	8.3	5*	10	9.7
3.	Alion 0.085	29	10	10	10	10
4.	Command 2	13	9.3	7.7	10	8.3
5.	Matrix 0.063	2	9.7	9.3	9.7	2.3*
	LSD		2.1	3.8	3.6	5.4

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Weed Control – Hart – 2018 (2)

		GROUP	POAM 6/8	POAM 9/7	RUTH 6/8	RUTH 9/7
6.	Trellis 1.5 Dual Magnum 1.9	21 15	8	3.3*	2.3*	1*
7.	Zidua 0.267	15	10	10	10	7
8.	Bicyclopyrone 0.045	27	5*	9.3	7	7
9.	Callisto 0.241 Prowl H_2O 1.9	27 3	8.7	4.3*	10	1.7*
10.	Untreated		2*	7	4*	4*
	LSD		2.1	3.8	3.6	5.4

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Powell Amaranth Control Hart

1. Sprayed November 6, 2017
2. All treatments included glyphosate
3. 29 harvests from 5/12/18 – 6/18/18

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2017 Herbicide Resistance Screening Results

Weed species: Powell amaranth

Sample IDs: AMAPO-34 ; 20175970

Sample submitter(s): [redacted]

Other information: Oceana - Tom Oomen - OF1

Site of action (Group #)*	Product	Active ingredient	App. Rate (1x)	Susceptible	Somewhat resistant**	Resistant	Not tested
EPSPS (9)	Roundup	glyphosate	32 fl oz/a	X			
Auxin receptor (4)	2,4-D amine	2,4-D amine	1 pt/a	X			
ALS (2)	Sandea	halosulfuron	1 oz/A			X	
PSII (7)	Lorox	linuron	2 lb/A			X	
PPO (14)	Spartan	sulfentrazone	8 fl oz/A	X			

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Herbicide Resistance Summary

Redroot and Powell amaranth Resistance Results [redacted]

2017

		Product	Roundup PowerMax	2,4-D amine	Sandea	Lorox	Spartan	
		Active ingredient	glyphosate	2,4-D	halosulfuron	linuron	sulfentrazone	Height range at time of application
		Site of Action (Group)	EPSPS (Group 14)	Synthetic auxin (Group 4)	ALS (Group 2)	PSII (Group 7)	PPO (Group 14)	
		1x Rate	32 fl oz/A	1 pt/A	1 oz/A	1 oz/A	8 fl oz/A	
Sample #	DTS #	Location						(inches)
AMAPO-34	20175970	OF1 (Crystal Valley)	*	*	Resistant	Resistant	*	1.0-2.0
AMAPO-35	20175971	STO (Grant)	*	*	Resistant	Resistant	*	1.0-2.0
AMAPO-36	20175972	Young 35 (Golden)	*	*	Resistant	Resistant	*	1.0-2.0
AMAPO-37	20175973	2L Hole (Golden)	*	*	Resistant	Resistant	*	1.0-2.2
AMARE-12	20175974	MW11 (Platte)	*	*	Resistant (1x)	Resistant	*	1.0-2.4
AMARE-13	20175975	2-R (Riverton)		*			*	1.0-2.8
AMARE-14	20175976	Rick's 30 (Golden)	*	*	Resistant	Resistant	*	1.0-2.4
AMARE-15	20175977	MW38 (Elkridge)	*	*	Resistant	Resistant	*	2.0-2.8
AMARE-16	20175978	Sg5 (Hart)	*	*	Resistant	Resistant	*	1.0-2.8
AMARE-17	20175979	Sg2 (Hart)	*	*	Resistant	Resistant	*	1.2-2.4
AMARE-18	20175980	Sg10 (Hikson)	*	*	Resistant	Resistant	*	1.4-2.4
AMARE-19	20175981	CL (Bear Lake)	*	*	*	Resistant	*	1.4-2.2

*= Susceptible, killed by the 1x rate
Resistant= Resistant at both the 1x and 4x field rates
Resistant (1x)= Resistant to the 1x field rate, susceptible to the 4x rate
Survived= Plants survived application at both rates, however true resistance needs to be confirmed
Survived (1x)= Survived at the 1x rate, susceptible to the 4x rate, true resistance needs to be confirmed
NC= Not controlled, this product is not labeled for control of this weed and was ineffective

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POAM Control and Asparagus Yield – 2018 (1)

		GROUP	POAM 6/8	POAM 9/7	ASPA KG/PLOT
1.	Alion 0.046	29	9.3	10	8.1
2.	Alion 0.065		9.7	10	7.4
3.	Alion 0.085		9.7	9	7.7
4.	Chateau 0.192	14	6.3*	1.7*	7.9
	LSD		2.7	3.1	NS

POAM Control and Asparagus Yield – 2018 (2)

		GROUP	POAM 6/8	POAM 9/7	ASPA KG/PLOT
5.	Karmex 3	7	2.7*	2*	8.1
6.	Solicam 4	12	2.7*	1.3*	7.5
7.	Sinbar 1	5	2.3*	3*	8
8.	Command 1	13	5.7*	3.3*	8
9.	Spartan 0.375	14	1.7*	3.7*	8.2
10.	Roundup 1	9	1.7*	1.7*	7.4
	LSD		2.7*	3.1	NS

Fall and Spring Weed Control at MSU – 2018 (1)

		App. Timing	Total Good No./Plot	Total Good KG/Plot	Total Cull No./Plot	Total Cull KG/Plot
1.	Alion 0.046 Roundup PM 1	FALL	456.0*	9.83*	23	0.48
2.	Alion 0.065 Roundup PM 1	FALL	599.3	13.60	30	0.64
3.	Alion 0.085 Roundup PM 1	FALL	569.0	12.74	43	0.93*
4.	Alion 0.13 Roundup PM 1	FALL	540.3	12.37	54*	1.17*

Fall and Spring Weed Control at MSU – 2018 (2)

		App. Timing	Total Good No./Plot	Total Good KG/Plot	Total Cull No./Plot	Total Cull KG/Plot
5.	Alion 0.026 Roundup PM 1	EPRE	487.0	10.95	28.3	0.63
6.	Alion 0.046 Roundup PM 1	EPRE	572.7	13.08	30.0	0.63
7.	Alion 0.065 Roundup PM 1	EPRE	482.0	11.54	21.0	0.50
8.	Alion 0.065 Roundup PM 1	PRE	542.7	11.50	37.7	0.74

Fall and Spring Weed Control at MSU – 2018 (3)

		App. Timing	Total Good No./Plot	Total Good KG/Plot	Total Cull No./Plot	Total Cull KG/Plot
9.	Command 1 Roundup PM 1	FALL	458.7*	10.28*	23.0	0.47
10.	Karmex 3 Roundup PM 1	FALL	496.7	11.36	30.0	0.67
11.	Chateau 0.192 Roundup PM 1	FALL	519.7	12.28	37.7	0.82
12.	Chateau 0.192 Roundup PM 1	PRE	551.3	12.65	61.0	1.52*

New Herbicide Labels

1. **Quinstar** 4L 0.375 lb (12 fl oz)
   - Bindweed, Canada thistle, sowthistle, crabgrass, Russian thistle
   - 1 application after harvest
2. **Command** 1 lb (2.6 pt) Preemergence
   - Grasses, com. lambsquarters, com. ragweed, velvetleaf
   - Use with another preemergence herbicide

Future Label

1. **Alion** 1.67sc 0.065 lb (5 fl oz)
   - Fall or early spring
   - Most grasses & broadleaves
   - Long residual: 3-4 months
   - May be labeled for 2020 season

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Asparagus Postemergence Herbicides (1)

1.	Clarity: 0.25-0.5 lb in crop	Broadleaves 1 Day PHI
2.	2,4-D	Most broadleaves 3 Day PHI
3.	Spur: 0.19-0.25 lb	composites, legumes, smartweeds; 2 Day PHI
4.	Quinstar: 0.375 (12 oz)	LACG, BYGR, bindweeds after final harvest

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Asparagus Postemergence Herbicides (2)

5.	Lorox: 1-2 lb in crop	Broadleaves; 1 Day PHI
6.	Roundup: 1-4 lb	Spring before emergence Spot spray in crop for perennials 5 Day PHI
7.	Aim: 0.008-0.03	Directed between rows for small broadleaves 5 Day PHI
8.	Sandea: 0.023-0.047	Broadleaves, yellow nutsedge 1 Day PHI

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Asparagus Preemergence Weed Control in Soil < 1% Organic Matter (1)

Year 1 Spring
Karmex 2 lb/a
Prowl H_2O 2 qt
Gramoxone 1 qt
Post harvest
Chateau 4-6 oz
Sandea 1 oz
Fusilade 1 pt
Quinstar 12 oz

Year 2 Spring
Karmex 2 lb/a
Command 2.6 pt
Gramoxone 1 qt
Post harvest
Callisto 7 oz
Dual Mag. 1.3 pt
Poast 1 pt
NIS
Spur 8 oz

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Asparagus Preemergence Weed Control in Soil < 1% Organic Matter (2)

Year 3 Spring
Tricor 1.3 lb/a
Prowl H_2O 2 qt
Post harvest
Solicam 3 lb
Sandea 0.5 oz
Spur 8 fl oz

Year 4 Spring
Karmex 2 lb
Command 2.6 pt
Gramoxone 1 qt
Post Harvest
Karmex 2 lb
Solicam 3 lb
Select Max 1 pt
Aim 1.9 fl oz
Quinstar 12 oz

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Asparagus Preemergence Weed Control in Soil >1% Organic Matter (1)

Year 1 Spring
Karmex 3 lb/a
Command 2.6 pt
Roundup 1 qt
Post harvest
Chateau 4-6 oz
Prowl H2O 3 qt
Fusilade 1 pt
Quinstar 12 oz

Year 2 Spring
Tricor 1.3 lb
Spartan 12 oz
Gramoxone 1 qt
Post harvest
Solicam 5 lb
Sandea 0.5 oz
Spur 8 fl oz

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Asparagus Preemergence Weed Control in Soil >1% Organic Matter (2)

Year 3 Spring
Callisto 7 fl oz
Prowl H_2O 3 qt
Gramoxone 1 qt
Post harvest
Sinbar 1.5 lb
Solicam 4 lb
Clarity 0.5 pt

Year 4 Spring
Karmex 4 lb
Command 2.6 pt
Roundup 1 qt
Post harvest
Chateau 6 oz
Prowl H_2O 3 qt
Select Max 16 oz
Quinstar 12 oz