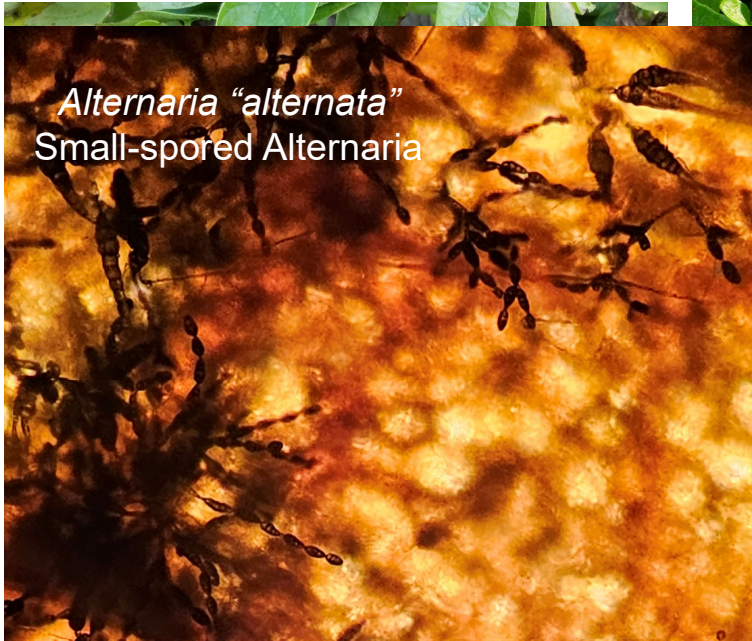
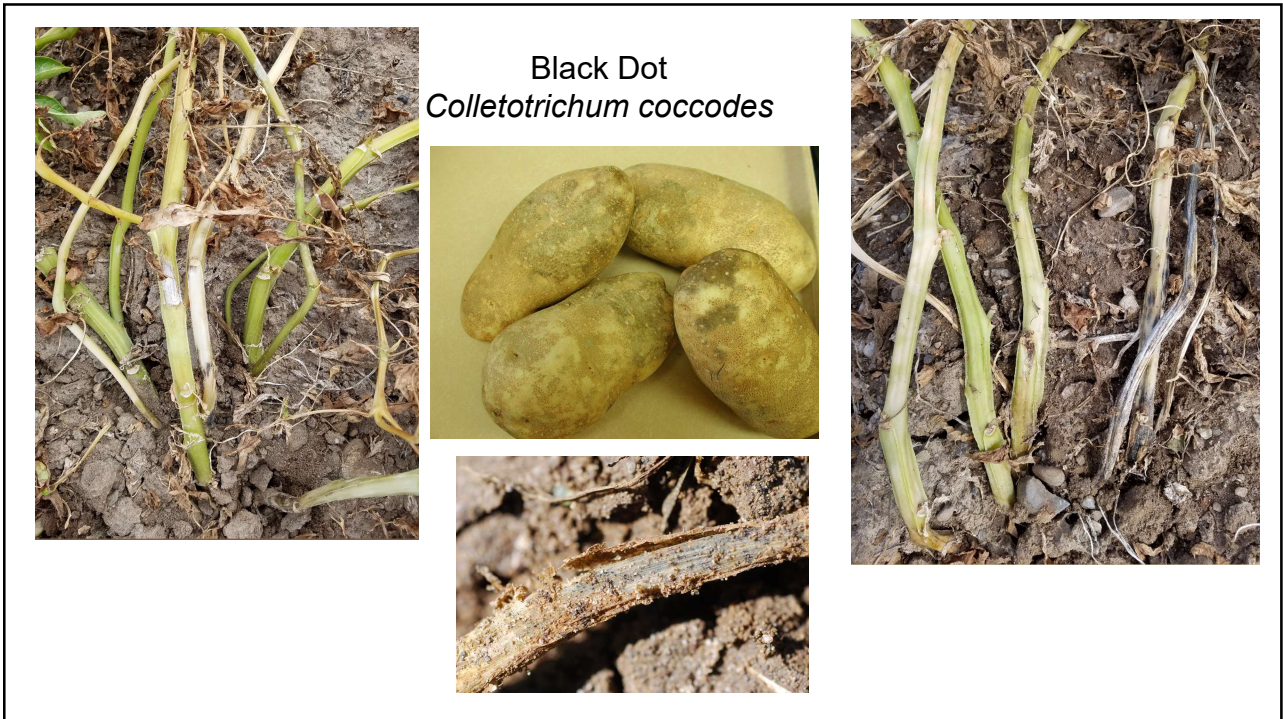


Fighting Foliar Foes with Fungicides



Trent Taysom





Gray Mold



Late Blight





Early Blight/Brown Spot Management

- Maintain adequate fertility
- Effect of variety
- Proper fungicide use
- Allow tuber skins to mature prior to harvest



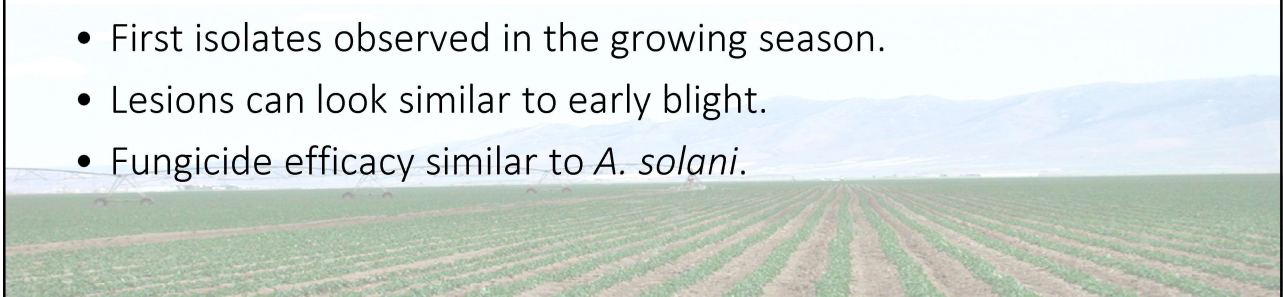
Proper Fungicide Use

- Use fungicides preventatively.
 - Use premium products early in the season.
 - Rotate products with different modes of action.
 - A back to back application of one mode of action may be most effective.
 - Then rotate to another chemistry.
 - No more than 2 of one FRAC group.
- Tank mix premium products with a protectant or another mode of action.



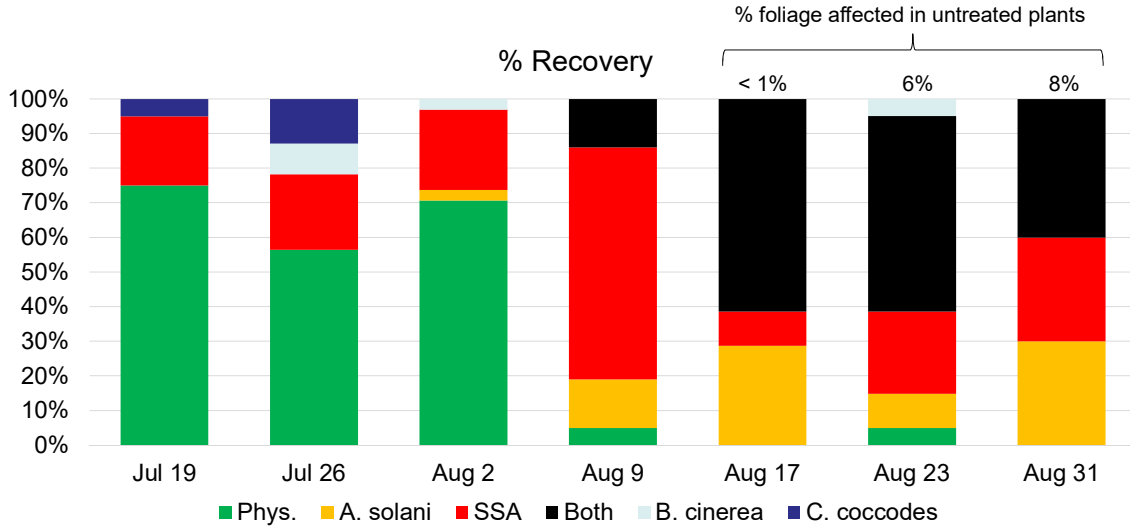
Brown Spot

- Caused by small-spored *Alternaria* species (SSA)
 - *Alternaria alternata*
 - *Alternaria tenuissima*
 - *Alternaria arborescens**
 - *Alternaria arbusti*
- First isolates observed in the growing season.
- Lesions can look similar to early blight.
- Fungicide efficacy similar to *A. solani*.



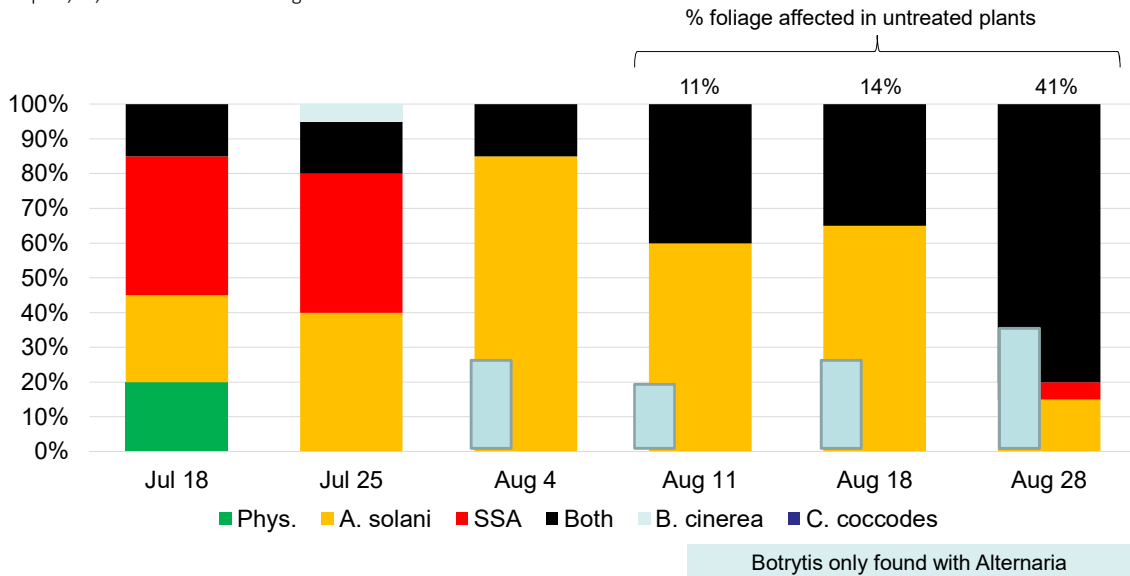
What was causing lesions in 2022?

Rupert, ID; Miller Research – Ranger Russet



What is causing lesions in 2023?

Rupert, ID; Miller Research – Ranger Russet



Chemical Management

- Pesticides = Crop Medicines
- Protectant
 - Protects where it is applied
 - Interfere with infection
 - Apply preventatively
 - Low risk of resistance development
- Systemic
 - Absorbed and moved in plant
 - May cure infections
 - Best applied preventatively
 - Risk of resistance development



Effect of fungicides on late blight;
Bonners Ferry, ID

- Dangers of tank-mixing
- Application method













Two Analogies



























Timing



Dose

C. respiration	7	C2 complex II: succinate-dehydrogenase	SDHI (Succinate-dehydrogenase inhibitors)	phenyl-benzamides	benodanil flutolanil mepronil	<p>Resistance known for several fungal species in field populations and lab mutants. Target site mutations in <i>sdh</i> gene, e.g. H/Y (or H/L) at 257, 267, 272 or P225L, dependent on fungal species.</p> <p>Resistance management required.</p> <p>Medium to high risk</p> <p>See FRAC SDHI Guidelines for resistance management.</p>	7	           
				phenyl-oxo-ethyl thiophene amide	isofetamid			
				pyridinyl-ethyl-benzamides	fluopyram			
				furan- carboxamides	fenfuram			
				oxathiin-carboxamides	carboxin oxycarboxin			
				thiazole-carboxamides	thiifuzamide			
				pyrazole-4-carboxamides	benzovindiflupyr bixafen fluidapyr fluxapyroxad furametpyr inpyrfluxam isopyrazam penflufen penthiopyrad sedaxane			
				N-cyclopropyl-N-benzyl-pyrazole-carboxamides	isoflucypram			
				N-methoxy-(phenyl-ethyl)-pyrazole-carboxamides	pydiflumetofen			
				pyridine-carboxamides	boscalid			
pyrazine-carboxamides	pyraziflumid							

MOA	TARGET SITE AND CODE	GROUP NAME	CHEMICAL OR BIOLOGICAL GROUP	COMMON NAME	COMMENTS	FRAC CODE		
sterol biosynthesis in membranes	3	G1 C14- demethylase in sterol biosynthesis (<i>erg11/cyp51</i>)	DMI-fungicides (DeMethylation Inhibitors) (SBI: Class I)	piperazines	triforine	<p>There are big differences in the activity spectra of DMI fungicides.</p> <p>Resistance is known in various fungal species. Several resistance mechanisms are known incl. target site mutations in <i>cyp51</i> (<i>erg 11</i>) gene, e.g. V136A, Y137F, A379G, I381V; <i>cyp51</i> promoter, ABC transporters and others.</p> <p>Generally wise to accept that cross resistance is present between DMI fungicides active against the same fungus.</p> <p>DMI fungicides are Sterol Biosynthesis Inhibitors (SBIs), but show no cross resistance to other SBI classes.</p> <p>Medium risk.</p> <p>See FRAC SBI Guidelines for resistance management.</p>	3	            
				pyridines	pyrifenox pyrisoxazole			
				pyrimidines	fenarimol nuarimol			
				imidazoles	imazalil oxpoconazole pefurazoate prochloraz triflumizole			
				triazoles	azaconazole bitterantol bromuconazole cyproconazole difenoconazole diniconazole epoxiconazole etaconazole fenbuconazole fluquinconazole flusilazole flutriafol hexaconazole imbenconazole ipconazole mefentrifluconazole metconazole myclobutanil penconazole propiconazole simeconazole tebuconazole tetraconazole triadimefon triadimenol triticonazole prothioconazole			
				triazolinthiones	prothioconazole			

MOA	TARGET SITE AND CODE	GROUP NAME	CHEMICAL OR BIOLOGICAL GROUP	(ISO) COMMON NAME	
C. respiration	11 C3 complex III: cytochrome bc1 (ubiquinol oxidase) at Qo site (cyt b gene)	QoI-fungicides (Quinone outside Inhibitors)	methoxy-acrylates	azoxystrobin coumoxystrobin enoxastrobin flufenoxystrobin picoxystrobin pyraoxystrobin	   
			methoxy-acetamide	mandestrobin	
			methoxy-carbamates	pyraclostrobin pyrametostrobin triclopyricarb	 
			oximino-acetates	kresoxim-methyl trifloxystrobin	
			oximino-acetamides	dimoxystrobin fenaminstrobin metominostrobin orysastrobin	
			oxazolidine-diones	famoxadone	
			dihydro-dioxazines	fluoxastrobin	
			imidazolinones	fenamidone	
			benzyl-carbamates	pyribencarb	
					QoI-fungicides (Quinone outside Inhibitors; Subgroup A)



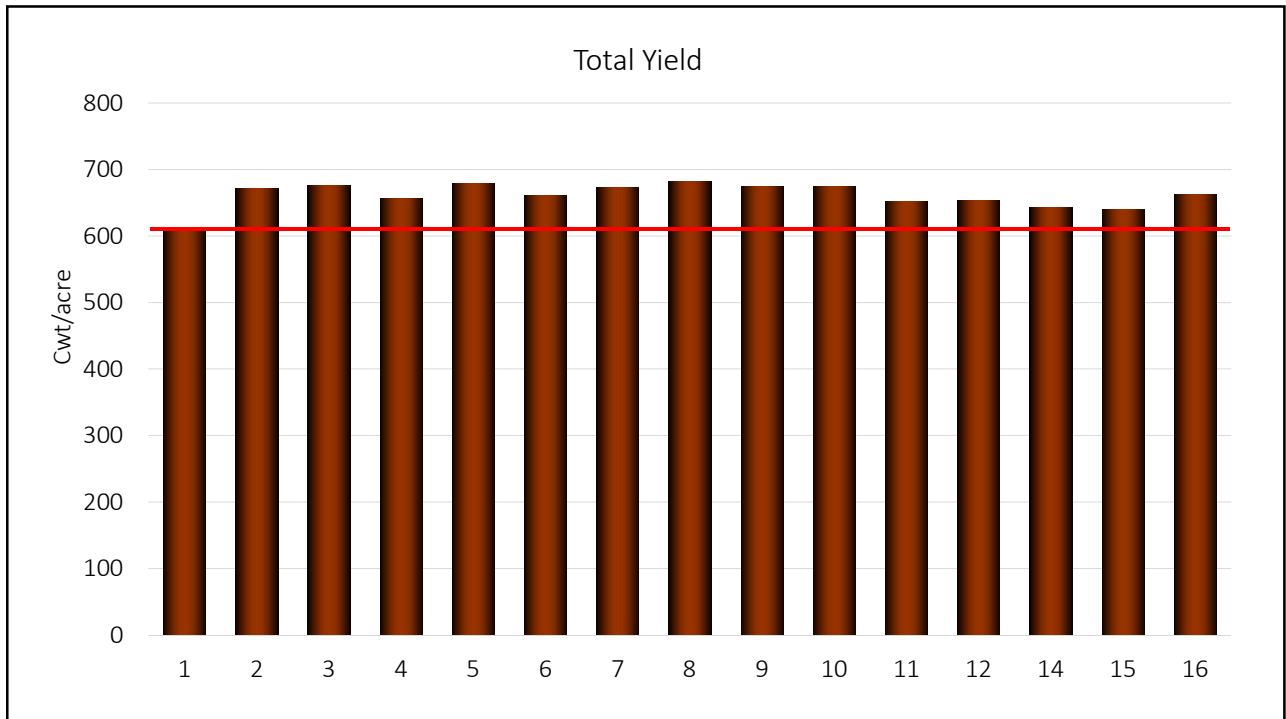
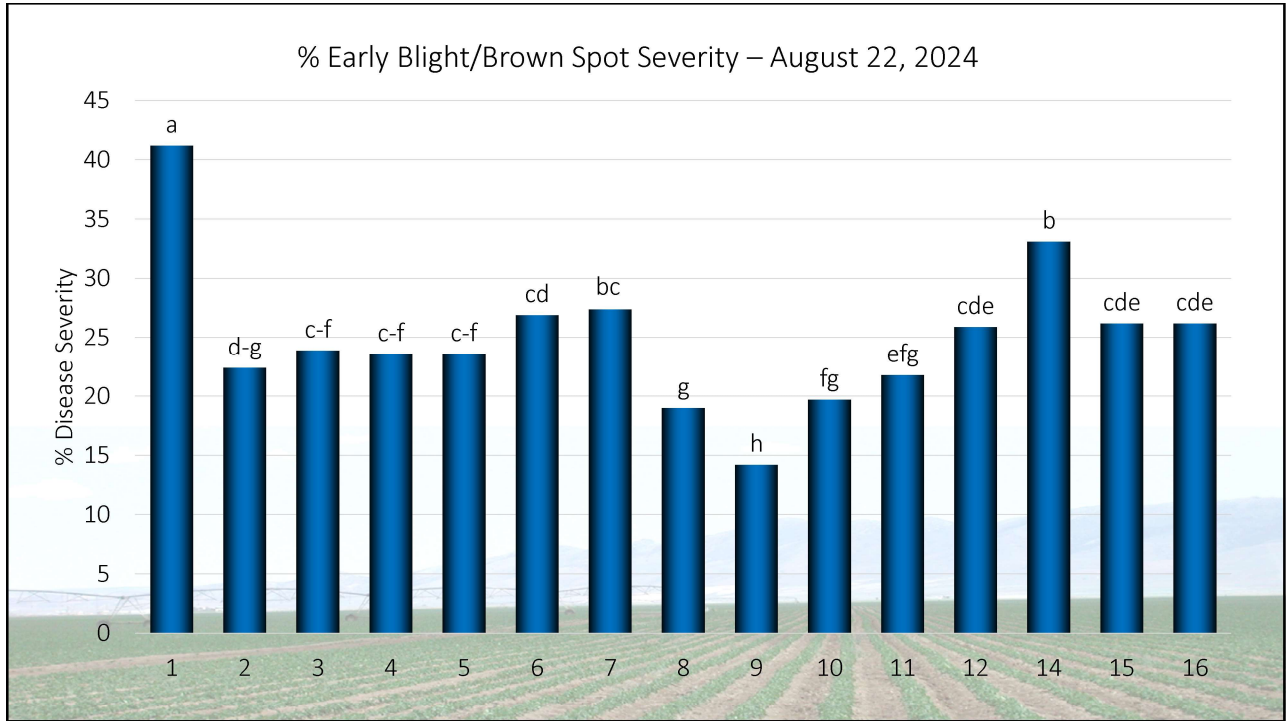
Products Tested in Public Foliar Disease Trials

Amistar Top	Endura Pro	Omega Top	Scala
Aproach	Gavel	Penncozeb	Serenade
AZterknot	Gem	Polyram	Super Tin
Badge SC	Headline	Priaxor	Tanos
Bravo WS	Innliven Elite	Propulse (Luna Pro)	Veltyma
Cabrio Plus	Inspire	Provysol	Velum Prime
Cupridyne	Luna Privilege	Quadris	Vertisan/Fontelis
Delaro	Luna Tranquility	Quadris Top	Wetcit
Dithane F45 and DF	Manzate	Quash	Zing!
Double Nickel	Miravis Prime	Reason	Zoxium
Echo DF and ZN	Omavo Elite	Revus Top	
Endura	Omega	Rovral	

How should I use my fungicides?

- Start at or just before row closure
 - Applications before that are not cost effective
- Apply every 10-14 days
 1. Premium product (EB/BS, WM) + protectant (EB/BS, LB)
 2. Premium product (EB/BS, WM) + protectant (EB/BS, LB)
 3. Protectant
 4. Protectant

JUNE							JULY							AUGUST						
S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S
			1	2	3	4	3	4	5	6	7	8	9	7	8	9	10	11	12	13
5	6	7	8	9	10	11	10	11	12	13	14	15	16	14	15	16	17	18	19	20
12	13	14	15	16	17	18	17	18	19	20	21	22	23	21	22	23	24	25	26	27
19	20	21	22	23	24	25	24	25	26	27	28	29	30	28	29	30	31			
26	27	28	29	30																



Variety Resistance



Burbank

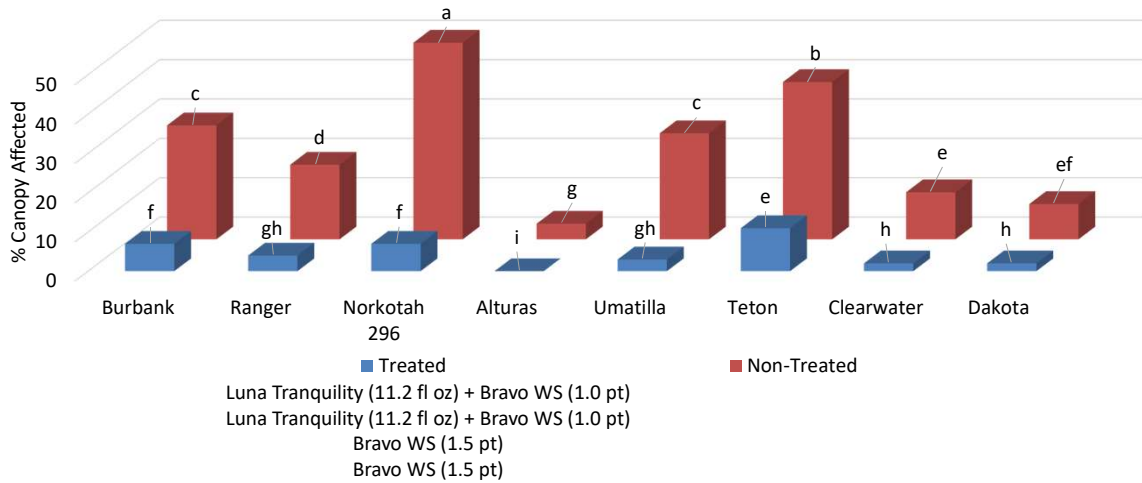
Ranger

Norkotah

Dakota

Early Blight/Brown Spot – Variety

% Disease Severity – August 18, 2020



Fungicide programs

Fungicide Timing	1. UTC	2. Standard	3. Reduced foliar	4. In-furrow
In-furrow	--	--	--	Velum Prime (6.5)
Row closure (RC) Late June	--	Luna Tranquility (11) Bravo WS (1.0)	Luna Tranquility (11) Bravo WS (1.0)	--
RC + 2 weeks Early July	--	Luna Tranquility (11) Bravo WS (1.0)	--	--
+ 2 weeks Late July	--	Bravo WS (1.5)	Bravo WS (1.5)	Bravo WS (1.5)
+ 2 weeks Early August	--	Bravo WS (1.5)	--	--
Active Ingredient (lb a. i./acre)	0	4.48	2.24	1.34
Estimated cost/acre	\$0	\$74	\$37	\$55
Difference			-\$37	-\$21
EQ	0	114.6	57.3	34.7

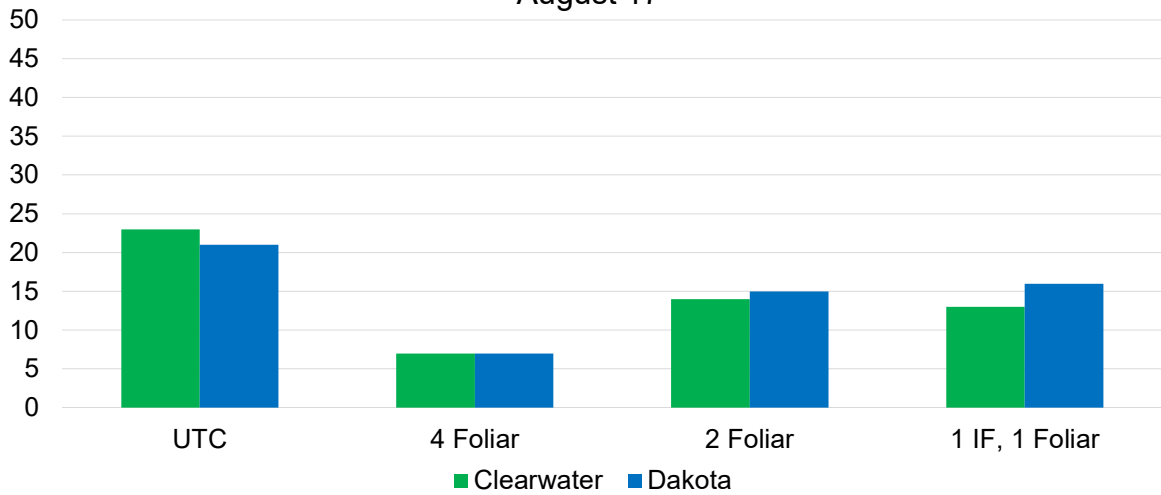
Variety – Reduced Fungicide (Clearwater)

- 2022 – Very little disease and fungicides not necessary?
- 2023 – High disease pressure, fungicides worked early



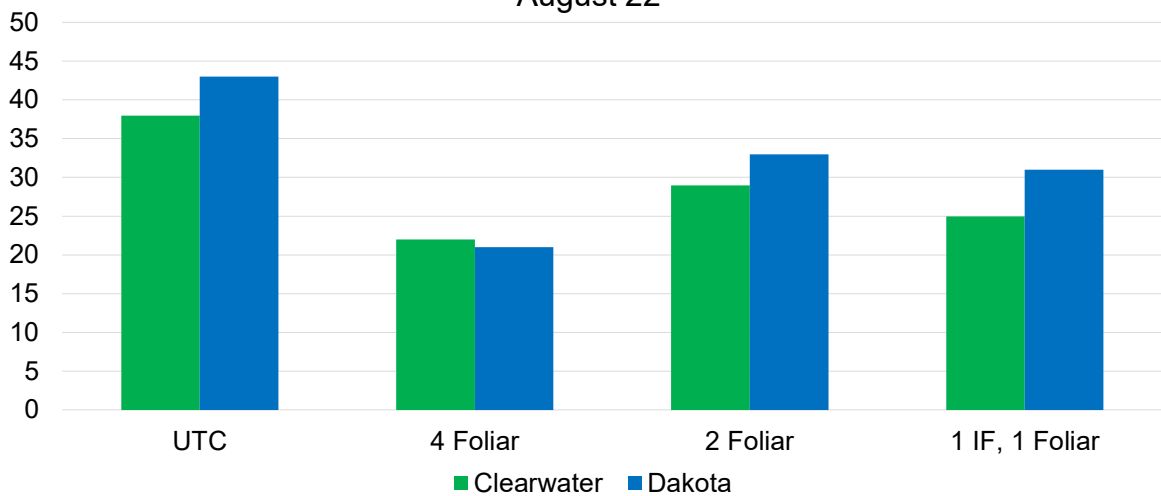
Variety Resistance = Reduced Fungicide? (EB, WM)

August 17



Variety Resistance = Reduced Fungicide? (EB, WM)

August 22



Variety Resistance = Reduced Fungicide? (Total Yield)

	Clearwater	Dakota
UTC	636	599
1 IF, 1 Foliar	643	634
2 Foliar	642	626
4 Foliar	659	640
	NS	NS

Variety – Reduced Fungicide (Clearwater)

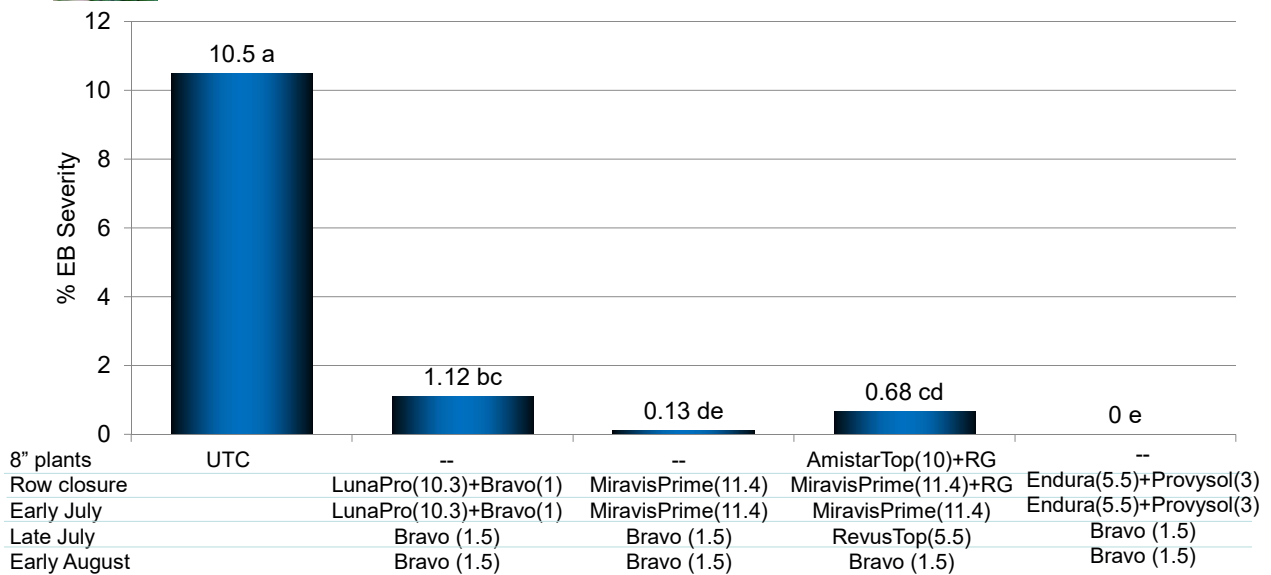
	“Light” EB/BS		“Moderate” EB/BS	
	2019	2020	2019	2020
	Total	Marketable	Total	Marketable
Treated (4 apps)	682	632	672	596
Untreated	652	607	649	582
Difference	+30	+25	+23	+14

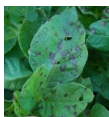
What does the fungicide program do for me?

Year	Untreated Check	Fungicide Program	% Control	+ cwt/acre (%)
2016	40	10	75	9 (1.3)
2017	27	8	70	31 (4.5)
2018-1	Burbank	2	88	35 (5.0)
2018-2		3	88	3 (0.4)
2019-1		3	89	5 (0.8)
2019-2		4	82	15 (2.4)
2020		3	86	28 (4.2)
2021	Ranger	14	58	33 (5.3)
2022		5	73	35 (5.1)
2023		22	47	65 (10.7)
			Average increase:	26 (4.0)



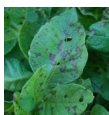
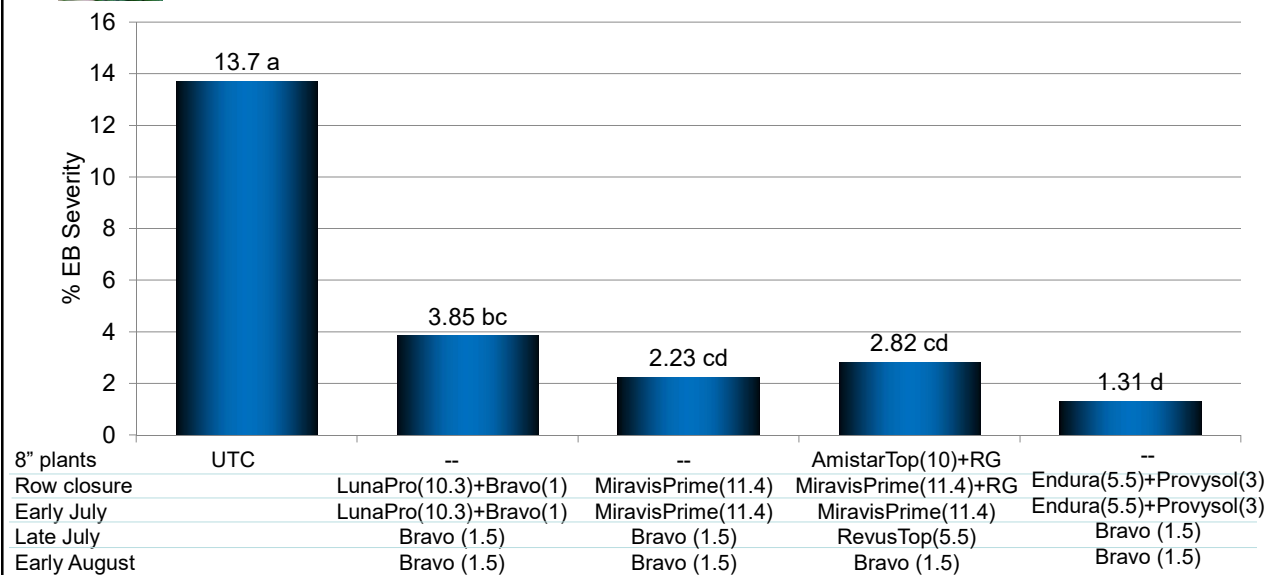
How did the new programs compare for early blight? August 9, 2023





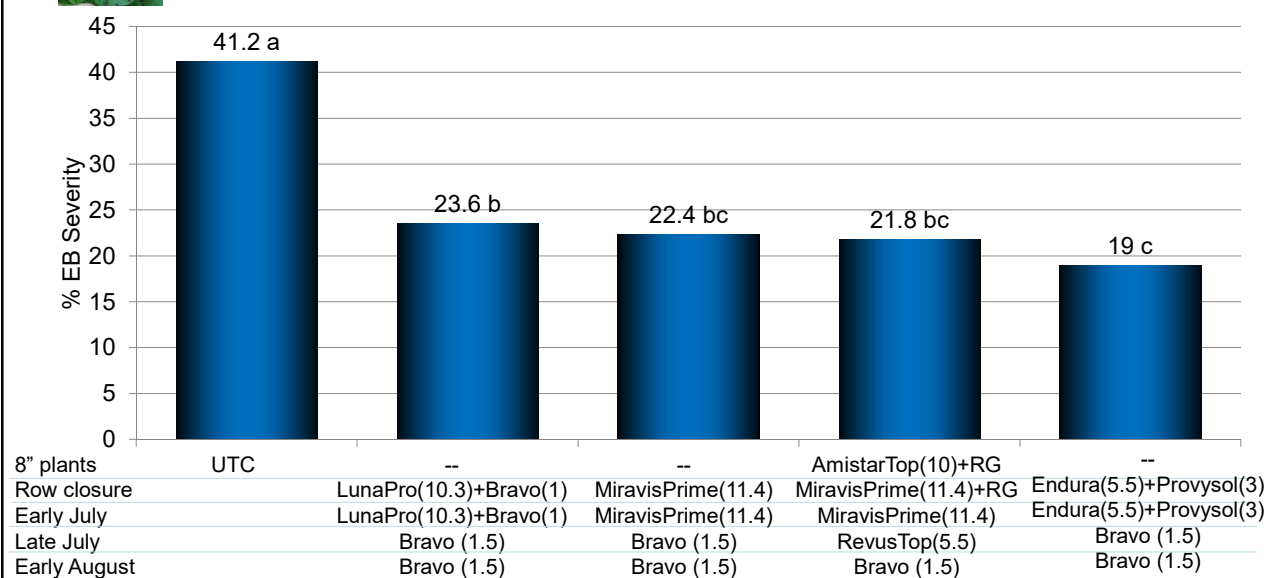
How did the new programs compare for early blight?

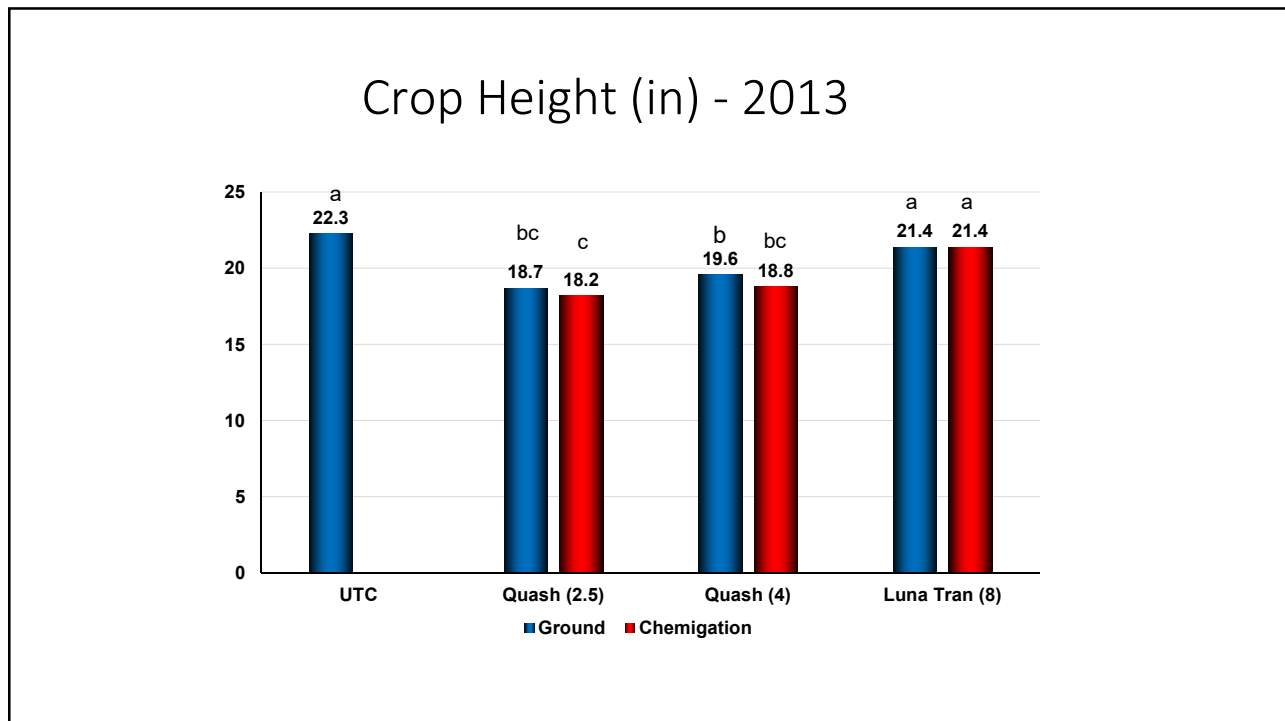
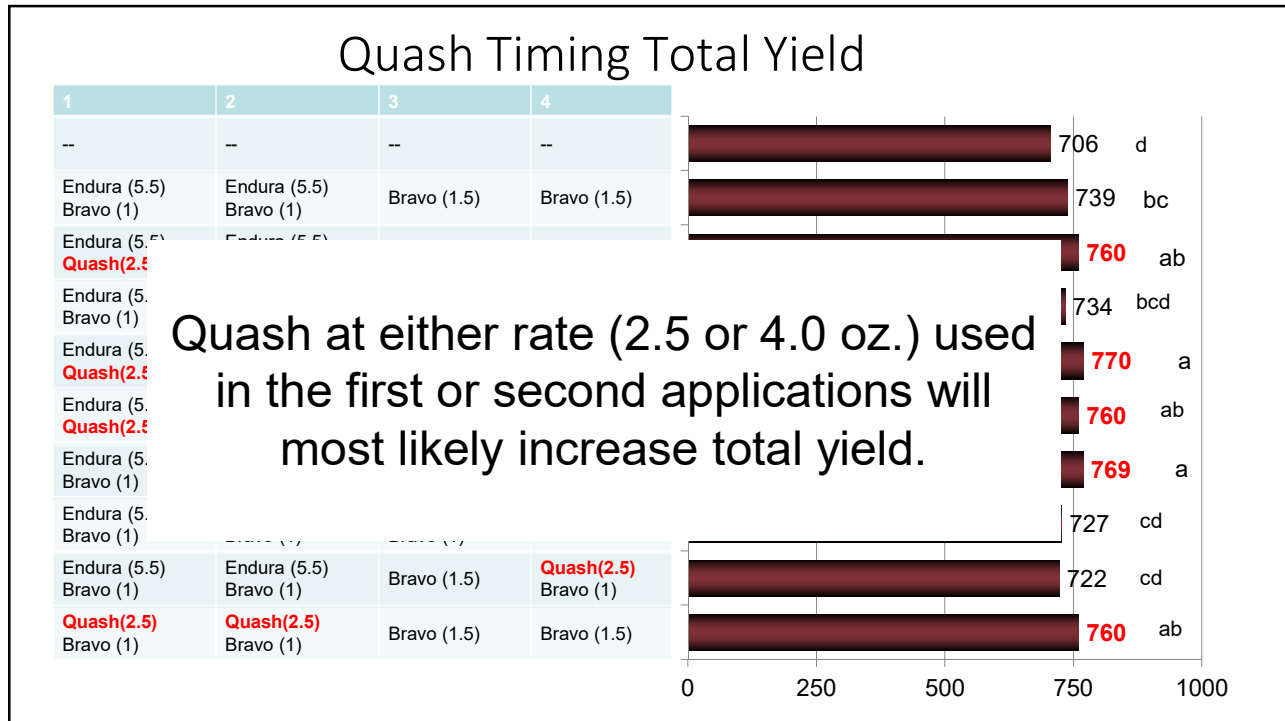
August 14, 2023



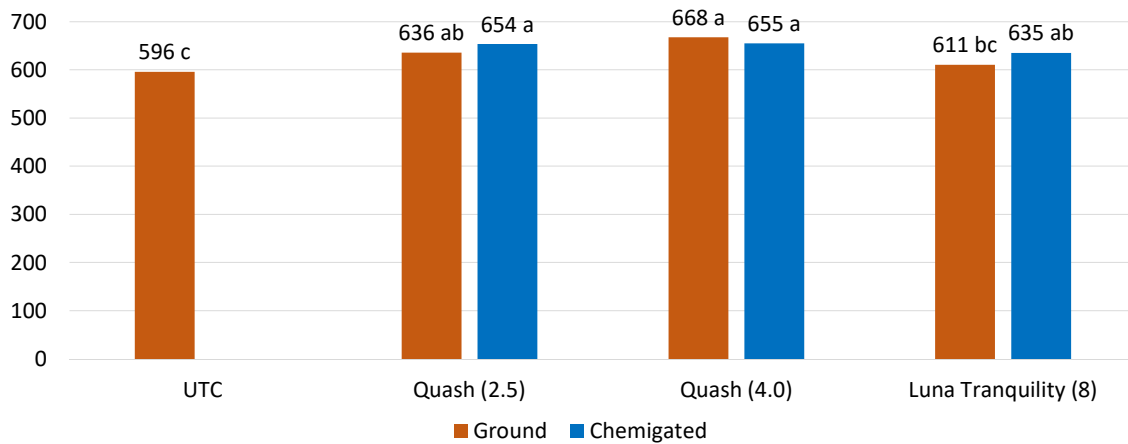
How did the new programs compare for early blight?

August 22, 2023





Effect of Fungicides on Yield, 2012



Other Effects of Metconazole

- Deep Green Coloring of leaves
- Settling of Canopy
 - Plants are shorter



Relative Efficacy of Selected Early Blight Products

	Product	Other Targets
1	Luna Tranquility	White mold, gray mold
	Luna Pro	White mold, gray mold
	Miravis Prime	White mold, gray mold
	Provysol	
	Velum Prime, Velum Rise	White mold
2	Amistar Top	Black dot, powdery mildew
	Revus Top	Late blight
	Quash (commonly increases yield)	White mold (?)
	Priaxor*	Black dot
	Super Tin	Late Blight
3	Endura*	White mold, gray mold
	Quadris*, Headline*	Black dot, powdery mildew
	Rovral	White mold
	Protectants (chlorothalonil, EBDC)	Late blight
	Scala	Gray mold



*Fungicide resistance issues

Protectants critical for resistance management

Relative Efficacy of Selected White Mold Products

	Product	Other Targets
1	Endura	Early blight
	Luna Pro	Early blight
	Luna Tranquility	Early blight, gray mold
	Miravis Prime	Early blight, gray mold
	Omega	Late blight
	Velum Prime, Velum Rise	Early blight
2	Quash	Early blight
	Rovral	Early blight
	Topsin	



No known resistance issues for white mold.

Early Blight/Brown Spot Fungicides

- Use fungicides preventatively.
 - Use premium products early in the season.
 - A back to back application of one mode of action is most effective.
 - Then rotate to a different mode of action.
 - No more than 2 of one group in southern Idaho!
- Tank mix premium products with a protectant or another mode of action.
 - Improves program performance
 - Protection against late blight

Once I became a parent I finally understood the scene where Yoda gets so tired of answering Luke's questions he just dies.



Questions?