

Powdery mildew of field peas: Optimizing fungicide selection and application timing

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Management of powdery mildew in field peas Methods

Market class = testing was conducted on yellow and green dry peas

Row spacing = 7 inches

- **Seeding rate** = 330,000 viable seeds/ac
- Fungicide spray volume = 15 gal/ac.

Fungicides applied with a hand-held boom pressurized by CO_2 .

Fungicide spray droplet size: fine.

Number of fungicide applications: one

Application timing in fungicide efficacy studies: Full bloom and first pods full-length and flat to partially or fully filled. When first pods were fully filled, up to 1 pod/plant was fully filled. **Number of experimental replicates** = 3, 4, or 5 (depending on the study or the variety)

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Disease development occurred due to natural infection. No pathogen inoculum was applied.

Powdery mildew assessment: The percent of the canopy exhibiting symptoms of powdery mildew was estimated visually at late pod-fill.

Yield: Grain yields were calculated on the basis of the measured plot length at harvest and the grain moisture at harvest and are reported at a standard 13.5% moisture level.

Management of powdery mildew in field peas Methods

	E	E 1.1.1 (C)	• · · · · · · · ·		
	Fungicide efficacy	Fungicide efficacy	Fungicide application timing		
	2024	2023	2023		
g date:	May 28	May 25-26	May 25 330,000 viable seeds/ac		
ng rate:	330,000 viable seeds/ac	330,000 viable seeds/ac			
pacing:	7 inches	7 inches	7 inches		
ite:	July 26	July 20	see data summary		
zzle, pressure:	DG110015, 40 psi	XR11002, 30 psi	XR11002, 30 psi		
ray volume:	15 gal/ac	15 gal/ac	15 gal/ac		
oplet size:	fine	fine	fine		
	'Empire' : full bloom, first pods full-length and partially filled	'Empire' peas: full bloom, first pods not yet full length			
eld pea growth age when	'Shamrock' peas: full bloom, first pods full-length and flat	'Arcadia' peas: full bloom, first pods full-length and flat	see data summary for the growth		
fungicides were applied: 'Salamanca' peas: full first pods fully filled	'Salamanca' peas: full bloom, first pods fully filled	'Salamanca' : full bloom, 1st pods full-length and partially to fully filled	applied		
		'Navarro' peas: full bloom, first pods full-length and partially filled			
wdery mildew verity:	Powdery mildew at trace levels (< 0.1% of canopy)	None. Powdery mildew did not develop until 2 nd week of August.	Powdery mildew did not develop until second week of August.		
e assessment -	Aug. 20, 21, 22, 24	Aug. 18	Aug. 18		
nd growth stage:	late pod-fill	late pod-fill	late pod-fill		
st date:	Sept. 5	Sept. 2	Aug. 30		
sted plot size:	5 ft x ave. 22.8 ft	5 ft x ave. 17.9 ft	5 ft x ave. 18.7 ft		
mental replicates:	5	4	Navarro, Arcadia peas: 4 reps		
	g date: g rate: bacing: te: zzle, pressure: ray volume: oplet size: Id pea growth ge when ogicides were olied: wdery mildew verity: e assessment - nd growth stage: it date: sted plot size: mental replicates:	Fungicide efficacy 2024g date:May 28g rate:330,000 viable seeds/acvacing:7 incheste:July 26zzle, pressure:DG110015, 40 psiray volume:15 gal/acoplet size:fine'Empire':full bloom, first pods full-length and partially filled'Shamrock' peas:full bloom, first pods full-length and flat'Salamanca' peas:full bloom, first pods fully filledwdery mildew /erity:Powdery mildew at trace levels (< 0.1% of canopy)	Fungicide efficacy 2024Fungicide efficacy 2023g date:May 28May 25-26g rate:330,000 viable seeds/ac330,000 viable seeds/acacing:7 inches7 incheste:July 26July 20zzle, pressure:DG110015, 40 psiXR11002, 30 psiray volume:15 gal/ac15 gal/acoplet size:finefine'Empire':full bloom, first pods full-length and partially filled'Empire' peas: full bloom, first pods not yet full lengthvid pea growth ge when olied:'Shamrock' peas: full bloom, first pods full-length and flat'Salamanca': full bloom, first pods full-length and flat'Salamanca' peas:full bloom, first pods full-length and partially to fully filled'Navarro' peas: full bloom, first pods full-length and partially to fully filledwdery mildew verity:Powdery mildew at trace levels (< 0.1% of canopy)		

Management of powdery mildew in field peas: Fungicide application timing

Carrington, ND (2023) A single application of Proline (5.7 fl oz/ac) when plants averaged 1 pod/plant fully filled conferred season-long Powdery mildew control

Growth stage at which fungicide was applied:	FIELD PEA VARIET	Y: ARCADIA	SALAMANCA	EMPIRE
Non-treated	25	c 28 b	50 •	° 72 ∘
43-93% of plants in bloom	[₽] 13 α	b 12 b	¹⁵ b	c 1 S bc
68-100% of plants in bloom	16 c	d 16 b	20 b	oc 🗄 9 abc
20-60% of plants with full- length pods			Date Jul 17 d p	
90-100% of plants with full- length pods	de 0 Iul 20	a D III 20	d 4	de B
1 pod/plant fully filled	APPLI Jul 23 Jul 23 a	APPLI	APPLI Jul 23 Jul 23	a D a
2-4 pods/plant fully filled	10 a	17 Inf	17 D a	NOT ASSESSED
Initial appearance of disease	Aug 14 Pug 14	⁴¹ 5 ab	aug 14	^{41 Bhg} bc
CV:	102.4 Within-column mea	127.4 ns followed by different letters are si	25.1 anificantly different ($P < 0.05$)	33.6 : Tukey multiple comparison procedure)

Powdery mildew severity (% of canopy)

XR11002 nozzles at 30 psi (fine droplets); 15 gal/ac. Powdery mildew developed so late in crop development that the disease no impact on yield.

Improving crop disease management: Fungicide application timing – fundamental concepts

Penalty to applying too late:

Fungicide applications must be made prior to pathogen infection.

- You cannot eradicate existing disease.
- Some, but not all, modern fungicides exhibit some degree of curative activity, but this curative activity is limited to the first few hours after pathogen infection – when pathogen infection can be seen only with a microscope and before disease lesions are present.

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Improving crop disease management: Fungicide application timing – fundamental concepts

Penalty to applying too early: New growth is not protected by the fungicide.

- Only the biomass that exists at the time that the fungicide is applied is protected.
- This is a problem for powdery mildew management in field peas when fungicide applications are made during early bloom because peas continue exhibiting upward growth during bloom.

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Improving crop disease management: Fungicide application timing – fundamental concepts

New growth is not protected by the fungicide.

- These peas were treated with a fungicide at bloom initiation
- Growth that occurred after bloom initiation was unprotected and became diseased with powdery mildew.
 - This is why (in the picture at the right) the upper ~ 1/5 of the canopy is diseased and the lower ~ 4/5 of the canopy is healthy.



Management of powdery mildew in field peas: Fungicide efficacy

Carrington, ND (2023)

Powdery mildew (% of canopy)

	Assessed at late pod-fill (Aug. 18)					
field pea variet	ty: Navarro	Salamanca	Arcadia	Empire	Combined analysis	
Non-treated control	76 g	65 c	78 h	88 d	77 g	
Drexel Sulfur 80WDG 5 lbs/a	ac 55 efg	29 bc	36 e-h	68 cd	47 fg	
Azoxystar 6 fl oz/ac	58 fg	16 bc	51 fgh	42 bcd	42 efg	
Provysol 3 fl oz/ac	40 d-g	27 bc	41 e-h	47 bcd	39 efg	
Endura 6 oz/ac	55 efg	13 bc	48 fgh	28 bcd	36 d-g	
Headline 6 fl oz/ac	20 b-g	15 bc	30 d-h	43 bcd	27 def	
Priaxor 4 fl oz/ac	14 c-g	30 bc	14 c-f	48 bcd	27 def	
Provysol 5 fl oz/ac	16 c-g	12 abc	21 c-g	23 bc	18 c-f	
Veltyma 7 fl oz/ac	11 b-f	12 abc	23 c-f	22 bc	17 cde	
Miravis Top 13.7 fl oz/ac	8 a-d	11 bc	11 cde	37 bcd	17 cd	
Revytek 8 fl oz/ac	9 b-e	8 abc	10 cde	30 bcd	14 cd	
Proline 5.0 fl oz/ac	4 abc	9 bc	7 bc	16 bc	9 bc	
Miravis Neo 13.7 fl oz/ac	5 a-d	8 abc	8 bcd	12 b	8 bc	
Proline 5.7 fl oz/ac	2 ab	5 ab	2 ab	10 b	4 b	
Delaro 12 fl oz/ac	0 a	0 a	0 a	0 a	0 a	
F, P	>F: 12.69, < 0.0001 CV: 28.8	5.37, < 0.0001 29.8	5.37, < 0.0001 29.8	11.94, < 0.0001 16.9	36.11, < 0.0001 12.6	

A single fungicide application was made July 20, approximately 3 weeks before first symptoms of powdery mildew, when peas were at the following growth stages: Empire, full bloom with first pods not yet full length; Arcadia, full bloom with first pods full length and flat; Salamanca, full bloom with first pods full-length and partially to fully filled; Navarro, full bloom with first pods full-length and partially filled. XR11002 nozzles at 30 psi (fine droplets); 15 gal/ac. Powdery mildew developed so late in crop development that the disease no impact on yield.

Management of powdery mildew in field peas: Fungicide efficacy

Carrington, ND (2024)

Powdery mildew (% of canopy)

Assessed at late pod-fill (Aug. 20-22)

	field pea variety:	Salamanca	Shamrock	Empire	Combined analysis
A single fungicide application was made July 26 when powdery mildew severity was at trace levels (< 0.1% severity)	Non-treated	19 de	25 def	30 cde	25 gh
	Azoxystar 6 fl oz/ac	23 е	30 f	46 f	33 h
	Endura 6 oz/ac	15 de	21 ef	35 ef	24 gh
	Headline 6 fl oz/ac	13 de	19 def	32 def	21 fgh
and peas were at the following	Priaxor 4 fl oz/ac	14 de	21 ef	28 cde	21 fgh
growth stages: Empire, full bloom with first pods full- length and	Provysol 3 fl oz/ac	6 b-e	16 c-f	27 cde	16 efg
	Miravis Top 13.7 fl oz/ac	8 b-e	16 c-f	21 b-e	15 efg
partially filled; Shamrock, full	Provysol 5 fl oz/ac	8 bcd	16 c-f	21 b-e	15 efg
bloom with first pods full length and flat; Salamanca , full bloom with first pods fully filled (1 pod/plant fully filled). DG110015 nozzles at 40 psi (fine droplets) 15 gal/ac spray volume	Revytek 8 fl oz/ac	8 cde	12 cde	24 b-e	15 efg
	Veltyma 7 fl oz/ac	6 bcd	13 c-f	24 b-e	14 efg
	Miravis Neo 13.7 fl oz/ac	4 a-d	12 c-f	19 a-d	12 cde
	Proline 5.0 fl oz/ac	3 abc	8 bcd	14 abc	8 cd
	Proline 5.7 fl oz/ac	1 ab	8 bc	10 ab	6 bc
	Delaro 10 fl oz/ac	0 a	4 ab	4 a	3 ab
	Delaro 12 fl oz/ac	0 a	1 a	3 а	1 a
	F, P>F: CV [:]	10.85 ,<0.0001 38	14.75, <0.0001 17.7	13.3, <0.0001 31.5	34.67, < 0.0001 9.2

Within-column means followed by different letters are significantly different (P<0.05; Tukey multiple comparison procedure)

Management of powdery mildew in field peas: Fungicide efficacy

In 2024, powdery mildew developed sufficiently early that yield data were informative, but powdery mildew and Ascochyta disease pressure drove yields

Carrington, ND (2024)	Powdery mildew (% of canopy)			Yield (bu/ac)				
	Assessed at late pod-fill (Aug. 20-22)			Ascochyta and powdery mildew were constraints on yield.				
field pea variety:	Salamanca	Shamrock	Empire	Combined analysis	Salamanca	Shamrock	Empire	Combined analysis
Non-treated	19 de	25 def	30 cde	25 gh	66 a	66 d	66 a	66 c
Azoxystar 6 fl oz/ac	23 е	30 f	46 f	33 h	74 a	73 a-d	66 a	71 bc
Endura 6 oz/ac	15 de	21 ef	35 ef	24 gh	78 a	67 cd	65 a	70 bc
Headline 6 fl oz/ac	13 de	19 def	32 def	21 fgh	77 a	73 a-d	70 a	73 abc
Priaxor 4 fl oz/ac	14 de	21 ef	28 cde	21 fgh	75 a	76 abc	72 a	74 ab
Provysol 3 fl oz/ac	6 b-e	16 c-f	27 cde	16 efg	77 a	72 a-d	64 a	71 bc
Miravis Top 13.7 fl oz/ac	8 b-e	16 c-f	21 b-e	15 efg	82 a	73 a-d	70 a	75 ab
Provysol 5 fl oz/ac	8 bcd	16 c-f	21 b-e	15 efg	69 a	69 bc	67 a	69 bc
Revytek 8 fl oz/ac	8 cde	12 cde	24 b-e	15 efg	76 a	80 a	72 a	76 ab
Veltyma 7 fl oz/ac	6 bcd	13 c-f	24 b-e	14 efg	76 a	76 abc	70 a	74 ab
Miravis Neo 13.7 fl oz/ac	4 a-d	12 c-f	19 a-d	12 cde	78 a	73 a-d	67 a	73 abc
Proline 5.0 fl oz/ac	3 abc	8 bcd	14 abc	8 cd	79 a	75 a-d	68 a	74 ab
Proline 5.7 fl oz/ac	1 ab	8 bc	10 ab	6 bc	79 a	75 a-d	67 a	74 ab
Delaro 10 fl oz/ac	0 a	4 ab	4 a	3 ab	77 a	77 ab	71 a	75 ab
Delaro 12 fl oz/ac	0 a	1 a	3 а	1 a	83 a	81 a	73 a	79 a
F, P>F: CV:	10.85 ,<0.0001 38	14.75, <0.0001 17.7	13.3, <0.0001 31.5	34.67, < 0.0001 9.2	1.8, 0.0612 9.5	4.88, <0.0001 5.8	1.17, 0.3208 8.3	5.04, 0.0001 3.5

Within-column means followed by different letters are significantly different (P<0.05; Tukey multiple comparison procedure)

A single fungicide application was made July 26 when powdery mildew severity was at trace levels (< 0.1% severity) and peas were at the following growth stages: Empire, full bloom with first pods full-length and partially filled; Shamrock, full bloom with first pods full length and flat; Salamanca, full bloom with first pods fully filled (1 pod/plant fully filled).

DG110015 nozzles at 40 psi (fine droplets); 15 gal/ac spray volume

Application timing: prior to disease development; peas in full bloom with an average 1 fully filled pod/plant.

- In 2023, season-long 100% management of powdery mildew was achieved with a single application of Proline (5.7 fl oz/ac) made when peas were in full bloom with an average of 1 fully filled pod/plant.
- These are results from a single study but results were consistent across field pea varieties that reached this growth stage on different dates.
- This is a preliminary recommendation from an ongoing project.
- This application timing is likely a bit late for fungicide applications targeting Ascochyta. For Ascochyta, a fungicide application is recommended at full bloom and first pods full-length and flat.
- Results from the fungicide efficacy testing suggest that applications of Delaro (10 or 12 fl oz/ac) may perform better than Proline against powdery mildew when applied when first pods are full-length and flat. Delaro is also effective against Ascochyta.

The most effective fungicides: Delaro @ 12 fl oz/ac and Proline @ 5.7 fl oz/ac.

- Applied as a single application (prior to disease development or at trace levels of powdery mildew when peas were in full bloom with the first pods full-length and flat or partially to fully filled, with a maximum 1 fully filled pod/plant), Delaro and Proline provided excellent management of powdery mildew in field peas.
- Delaro was slightly more effective than Proline against powdery mildew in field peas.
- Both Delaro and Proline exhibited rate responses; higher application rates were more effective than lower application rates.
- Registered fungicides differed significantly in their efficacy against powdery mildew. Many products were much less effective than Delaro and Proline.
- Delaro and Proline are also effective against Ascochyta blight.



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