

Fungicide “Cheat Sheet” for Alternaria Leaf Spot and Head Rot in Broccoli and Other Cole Crops, 2023

Product and Rate/A	Active Ingredient	FRAC ¹ Group	Rating for Risk of Fungicide Resistance	PHI	Restricted Use ²	Maximum Use	Rotation Restrictions (No. of apps before rotate to another FRAC group)	Cole Crops on Label ³	Disease Control	
									Relative Control of ALS ⁴	Activity on DM ⁵
Bravo Weather Stik 1.5 pt (+ many other formulations)	chlorothalonil	M5	Very low	7 days	No	11.7 pts (= 7 apps)	none	ALL	Mediocre	Good
Quadris 6-15.5 fl oz (+ other formulations)*	azoxystrobin	11	High	0 days	No	90 fl oz (= 5-15 apps)	none	ALL	Good	Mediocre
Switch 10-14 oz	cyprodinil + fludioxonil	9 12	Medium	7 days	No	56 oz (= 4-5 apps)	2	ALL	Good	None
Alternity 11-14 oz	cyprodinil + fludioxonil	9 12	Medium	7 days	No	56 oz (= 4-5 apps)	2	ALL	Good*	None
Priaxor 6-8.2 fl oz	fluxapyroxad + pyraclostrobin	7 11	Medium-High High	3 days	Yes	24.6 fl oz (= 3 apps)	2	ALL	Excellent	Mediocre
Endura 6-9 oz	boscalid	7 11	Medium-High	0 days	No	18 fl oz (= 2 apps)	2	ALL	Caution! ⁶ Good	None
Luna Experience 6-8.6 fl oz	fluopyram + tebuconazole	7 3	Medium-High Medium	7 days	Yes	34 fl oz (= 4 apps)	2	Brassica leaf greens only	Excellent	None
Luna Sensation 5-7.6 fl oz	fluopyram + trifloxystrobin	7 11	Medium-High High	0 days	Yes	15.3 fl oz (= 2 apps)	2	ALL	Excellent	Mediocre
Miravis Prime 11.4 fl oz	pydiflumetofen + fludioxonil	7 12	Medium-High Low-Medium	7 days	Yes	34.2 fl oz (= 3 apps)	2	ALL	Excellent	None
Inspire Super 16-20 fl oz	cyprodinil + difenoconazole	9 3	Medium Medium	7 days	No	80 fl oz (= 4 apps)	2	ALL	Excellent	None
Vango Esq 14-20 fl oz	cyprodinil + difenoconazole	9 3	Medium Medium	7 days	No	80 fl oz (= 4 apps)	2	ALL	Excellent*	None
Quadris Top 12-14 fl oz	azoxystrobin + difenoconazole	11 3	High Medium	1 day	No	56 fl oz (= 4 apps)	1	ALL	Excellent	Not Labeled
Viathon 2 pt	tebuconazole + potassium phosphite	3 P07	Medium Low	7 days	No	8 pt (= 4 apps)	none	Brassica leaf greens only	Good	Good
Topguard EQ 5-8 fl oz	flutriafol + azoxystrobin	3 11	Medium High	7 days	No	32 fl oz (=4 apps)	rotation recommended	ALL	Good	Not Labeled
Organic OMRI Listed:										
Oso 5%SC 6.5-13 fl oz	polyoxin D zinc salt	19	Medium	0 days	No	78 fl oz (= 6 apps)	none	ALL	Mediocre	None
Kocide 3000-O 0.5-0.75 lb ⁷	copper hydroxide	M1	Low	0 days	No	8.8 lb (=11 apps)	none	ALL	Mediocre - Poor	Labeled**
Cueva 0.5% v/v	copper octanoate	M1	Low	0 days	No	13.25 qt (=2 apps)	rotation recommended	ALL	Mediocre - Poor	Labeled**

1 **FRAC:** Fungicide Resistance Action Committee group. Fungicides that belong to the same FRAC group are at risk for developing cross-resistance. For best fungicide resistance management practices, fungicides belonging to different FRAC groups should be rotated.

2 **Restricted Use:** DEC spray license required to use.

3 **ALL Cole crops** includes broccoli, cabbage, cauliflower and Brussels sprouts. Often, kale, collards, kohlrabi and mustard greens also on label (see labels for details). **Luna Experience** and **Viathon** are only labeled on Brassica leaf greens such as broccoli raab, Chinese cabbage (Bok Choy), collards, mizuna, etc. NOT broccoli, cauliflower, or cabbage (see label).

4 **ALS: Alternaria leaf spot and head rot.** Relative disease control based on 2018 (1 on-farm), 2021 (2 conventional & 1 organic at Cornell Agri-Tech, 1 on-farm) and 2022 (conventional & organic at Cornell AgriTech) fungicide trials (Smart *et. al.* 2021, Hoepting 2018, 2021, 2022).

***Aframe** is a generic version of Quadris, **Vango ESQ** is a generic version of Inspire Super, and **Alternity** is a generic of Switch.

5 **DM: downy mildew.** Best control of DM is provided by Orondis Opti/Ultra, Revus and Presidio. **Kocide 3000-O is labeled for downy mildew, but Cornell has not trialed this products on downy mildew.

6 Some strains of the ALS pathogen may be insensitive (e.g. not controlled by fungicide) to Endura in New York.

7 It is likely that other copper-based products have activity on Alternaria diseases of Cole Cops, but Kocide 3000-O is the only one that we have data on at this time.

Fungicide Recommendations for ALS in Broccoli

Fungicide “Cheat Sheet” provides a list of fungicides that are labeled in broccoli and other common Cole crops, for which Cornell research has shown to be effective for control of *Alternaria* leaf spot (ALS) and head rot. The relative control of ALS was based on results from: 1) On-farm trial conducted under severe ALS pressure (Hoepting, 2018); 2) Conventional and organic fungicide trials (1 of each) conducted at Cornell AgriTech research farm under severe ALS pressure (Smart *et al.*, 2021); 3) On-farm trial conducted under low ALS pressure (Hoepting *et al.*, 2021); 4) Conventional trial conducted at Agri-Tech research station under moderate-severe ALS pressure (Hoepting, 2021); and 5) Conventional and organic trial conducted at AgriTech research station under low pressure.

- Spray fungicides preventatively before disease establishes itself, because lower frame leaves serve as inoculum to infect heads. This is especially important when disease is present in the area/planting and when conditions are favorable for disease (e.g. leaf canopy is wet from rain, irrigation or dew for prolonged periods (20 hours or more), especially when temperatures are 75–82°F).
 - Bravo would be an economical choice at this timing.
- Once the canopy fills in, aeration is reduced and leaf wetness is prolonged, especially during late-August and into the fall. Begin application of systemic/translaminar fungicides with very good to excellent activity on ALS at this time, through head formation and harvest, especially when disease risk is high.
- All fungicides listed in the Cheat Sheet except Bravo (FRAC M5) and copper (FRAC M1), are at risk of ALS developing resistance.
 - See ALS Fungicide Cheat Sheet/labels for rotation restrictions and seasonal maximum use rates.
 - Be mindful of pre-mixes that have more than one FRAC group per fungicide that need to be managed for fungicide resistance. For example, there are a few products with FRAC 3 and 7 that are pre-mixes with FRAC 11, which makes it easy to apply 3-4 consecutive applications of FRAC 11 when rotating FRAC 3 with FRAC 7.
- For best fungicide resistance management practices:
 - Do not apply more than 1-2 applications before alternating to another FRAC group.
 - Do not use more than 2 applications per FRAC group per crop.
 - Some strains of the ALS may not be sensitive (= poor fungicide performance) to Endura in New York.
 - Bravo and copper are the exceptions to this, because their multi-site mode of actions reduce their risk for fungicide resistance and may be used several times.
- Use the highest labeled rates, especially for Quadris and when conditions are favorable for disease.
- Use a 7-day spray interval when disease pressure is high, especially for organic products.
- Use an adjuvant with fungicides that have translaminar or systemic activity (FRAC 3, 7, 9, 11, 12) for improved efficacy. Read labels for details.
 - Be careful about using adjuvants with copper bactericide or sanitizers, as excessive leaf burn injury may occur, especially with oil adjuvants when temperatures are >90°F, or during prolonged cool periods.
- Save products with 0 days (Endura, Quadris, Luna Sensation, organic products), 1 day (Quadris Top), or 3 days (Priaxor) PHI for close to and during harvest.
- Note that Luna Experience, Endura, Miravis Prime, Inspire Super/Vango ESQ, Switch/Alterity and Oso 5%SC have no activity on DM.
 - ALS fungicides with good DM activity include Bravo, those with FRAC 11 active ingredients (Quadris, Quadris Top, Priaxor, Luna Sensation), and FRAC P07 (Viathon).
 - Best control of DM is provided by Orondis Opti/Ultra, Revus and Presidio. Note that none of these fungicides have any activity on ALS.
- **Do your fungicide spray program “puzzle” ahead of time.** Although there are several fungicide options, it can be tricky to not exceed 2 apps per FRAC per crop, especially when most products contain premixes of two FRAC groups (e.g. Luna Sensation contains FRAC 7 and 11).
 - It is a good idea to design a 4-6 week program to use from full canopy fill through harvest. Prior to this, Bravo should suffice unless ALS pressure is high.
 - Start with the products that you want to use during harvest with 0 PHI and work backwards to avoid no more than 2 apps per FRAC.

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Updated by Christy Hoepting (September 2023)

