Copper Fungicides – A Comprehensive List of Products Used for Vegetable Disease Control

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Copper was one of the first elements used as a plant fungicide (the other was Sulfur). Its discovery can be traced back to the famous origin of Bordeaux mixture, containing a mixture of copper sulfate ($CuSO_4$) and slaked lime, and used for downy mildew control in French vineyards.

Copper compounds, 16 are detailed in this report as registered (all are underlined) in NYS, are still widely used for disease control in both conventional and organic production (6 products as listed by the OMRI are indicated in this report in green). Coppers are assigned to Group M1 by Fungicide Resistance Action Committee (FRAC), with the "M" indicating multisite activity. One product, $^{M1 + M3}$ ManKocide, is a combination of ^{M1} *copper hydroxide* and ^{M3} *mancozeb* (MZ) to capitalize on the benefit of the mancozeb component to increase the release of Cu^{2+} ions to provide better control of bacterial diseases like speck, spot and canker of tomato. Note that this product is approved for use on Tomato, but not on Pepper or Eggplant. As long as mancozeb is labeled for a given crop, conventional growers can make their own tank-mixture of mancozeb with the copper product of their choice. Begin by choosing a copper product with at least 20% or more copper as the active ingredient to insure the greatest release of Cu^{2+} ions.

Not all copper fungicide products are created equal, as indicated by the differences in the percent of active ingredient and the formulation of copper used. A quick review of the table reveals that there can be major differences between the products and the diseases labeled by crop. Language can also be vague as to which diseases are actually meant, but by reviewing all of the labels some clues are provided. For example, although basic copper sulfate (Albaugh and Old Bridge) have pretty broad labels across the crops listed, under crucifers they list leaf spots (**LeafS**) along with downy mildew (**DM**), leaving us to assume that the leaf spots they mean are for Bacterial black rot (**Blkrot**) and Alternaria black leaf spot (**Alt LS**), as these diseases are shown on all other labels. For cucurbits, 2ee labeling exists for some coppers registered in New York specifically for Phytophthora blight (**PhyBlt**) as indicated. The straight copper products are all labeled for **TEP**, = **T**omato, **E**ggplant and **P**epper. In the table, only the diseases for tomato = **T** are listed (because of space limitations), but in the footnote the diseases are covered for eggplant and pepper. Another clarification for tomato is for leaf mold caused by *Fulvia fulva*. This appears on the labels as either leaf mold (**LefMo**) or gray leaf mold (**GyLM**). The footnotes provide information on the other abbreviations. I call your attention to two additional factors summarized in the Table. Some of the more recently revised copper labels have shifted to 48 hrs as the time for re-entry (REI), while the older labels maintain 24 hrs, but a few have even shorter intervals. Most products are listed for use in the greenhouses on the label, and indicated in the next to last column as Yes or No.

Note: Most of the copper labels are from the PIMS web site (http://pims.psur.cornell.edu/), or in a few cases the latest label was found on the Crop Data Management System site (CDMS) (http://www.cdms.net/LabelsMsds/LMDefault.aspx?ms=1). My advice is to carefully check the label before you purchase any product to make sure it clearly lists the crops and diseases for your intended use. As always, "the label is the law".

Listing of Copper Compounds (NYS Reg.) for **Vegetables By Disease** © T. A. Zitter April 2012

Trade Name (OMRI in Green)	Source	Active ingredients	% Metallic Cu	REI (Hrs.)[a]	Beans Dry or Green	Crucifers[c]	Ca, Cel, Be[d]	Cucurbits[e]	Let, En, Es, Sp[f]	On, Gar, Le[g]	Tom, Egg, Pep[h]	Potato[i]	GrHs On Label[j]	Miscl. Wa, Ch, Di, Pa[k]
Badge SC EPA 80289-3	Isagro	**17.6% copper oxychloride + 16.4% copper hydroxide**	20	24	Dr, Gr BwnSp. ComBlt HaloBlt	Blkrot Alt LS DM	All 3 see label	AngLS Alt LS DM PM GSB	Sp Anth DM CerLS WhRst	On,G BacBlt DM PurBlo	TEP BacSe BacSp Anth EB LB SepLS GyLM	EB LB	Yes	All see label
Badge X_2 EPA 80289-12	Isagro	**23.8% copper oxychloride + 21.5% copper hydroxide**	28	48	Dr, Gr Broader label	Same as above	All 3 Broader label	Same as above	Let. Sp. Broader label	On, G Same as above	TEP Same as above	EB LB	Yes	All see label
Basic Copper 53 EPA 45002-8	Albaugh	**98% basic copper sulfate**	53	24	Gr, Dr AngLS BacBlt Anth DM PM	DM LeafS	All 3 see label	AngLS Anth Alt LS DM PM GSB **Scab**	All 4 Anth DM CerLS WhRst	On DM PurBlo	TEP BacSe BacSp BacCa Anth EB LB LefMo SepLS StemLS	EB LB	No	No
Basic Copper Sulfate EPA 46923-9	Old Bridge	**99% basic copper sulfate**	53	24	Gr, Dr AngLS BacBlt Anth DM	DM LeafS	All 3 see label	AngLS Anth Alt LS DM PM GSB **Scab**	Le, Sp Anth DM CerLS WhRst	On DM PurBlo	TEP BacSp BacCa Anth EB LB LefMo SepLS StemLS	EB LB	No	No

Trade Name (OMRI in Green)	Source	Active ingredients	% Metallic Cu	REI hrs.[a]	Beans[b]	Crucifers[c]	Ca, Cel, Be[d]	Cucurbits[e]	Let, En, Es, Sp[f]	On, Gar, Le[g]	Tom, Egg, Pep[h]	Pototo[i]	GrHs On Label[j]	Miscl. Wa, Ch, Di, Pa[k]
Champ Formula 2F EPA 55146-64	Nufarm	**37.5% copper hydroxide**	24.4	48	Gr, Dr BrnSp ComBlt HaloBlt DM	Blkrot Alt LS DM	All 3 see label	AngLS Alt LS Anth DM PM GSB 2ee PhyBlt	Le,En,Es DM	O,G,L DM PurBlo BacBlt	TEP BacSe BacSp Anth EB LB GyLM SepLS	EB LB	Yes	All see label
Champ Dry Prill EPA 55146-57	Nufarm	**57.6% copper hydroxide**	37.5	24	Gr, Dr BrnSp ComBlt HaloBlt - - - -	Blkrot Alt LS DM	All 3 see label	AngLS Alt LS Anth DM PM GSB	L,En,Es DM;	O,G,L DM PurBlo BacBlt	TEP BacSe BacSp Anth EB LB GyLM SepLS	EB LB	Yes	All see label - - - - -
Champ WG EPA 55146-1	Nufarm	**77% copper hydroxide**	50	24	Gr, Dr BrnSp ComBlt HaloBlt	Blkrot Alt LS DM	All 3 see label	AngLS Alt LS Anth DM PM GSB	Sp Anth WhRst DM CerLS BlkLS	On,G DM PurBlo BacBlt	TEP BacSe BacSp Anth EB LB GyLM SepLS	EB LB	Yes	All see label
C-O-C-S WDG EPA 34704-326	Loveland	**73.5% copper oxychloride +13.4% basic copper sulfate**	51.3	48F; 24 GH	Gr, Dr BacBlt Anth CerLS DM	Blkrot DM	All 3 see label	Anth LefSp DM	L,Es,En DM Sp LefSp DM	On,G DM PurBlo	TEP BacSp EB LB SepLS	EB LB	Yes	No

Trade Name (OMRI in Green)	Source	Active ingredients	% Metallic Cu	REI hrs[a]	Beans[b]	Crucifers[c]	Ca, Cel, Be[d]	Cucurbits[e]	Let, En, Es, Sp[f]	On, Gar, Le[g]	Tom, Egg, Pep[h]	Potato[i]	GrHs On Label[j]	Miscl. Wa, Ch, Di, Pa[k]
Cueva Fungicide EPA 67702-2-70051	Certis	**10% copper octanoic acid**	1.8	4	Yes	BLS AltLS DM	All 3 see label	AngLS AltLS DM PM GSB Uloclad	L, En, Es BacSR DM PM LeaSp	O,G,L Etc. BotLB DM NeckR BacSR	TEP Anth BSpe BSpt EB, LB GyMld Septoria	EB LB	Yes	No
Cuprofix Ultra 40 Disperss EPA 70506-201	UPI	**71.1% basic copper sulfate**	40	48	Dr, Gr BrnSp ComBlt HaloBlt DM	Blkrot Alt LS DM	All 3 see label	AngLS Alt LS Anth DM PM GSB 2ee PhyBlt	Sp Anth DM CerLS WhRst	On, G BacBlt DM PurBlo	TEP BacSe BacSp Anth EB LB GyLM SepLS	EB LB	Yes	All see label
Kentan DF EPA 80289-2	Isagro	**61.3% copper hydroxide**	40	48	Dr, Gr BrnSp ComBlt HaloBlt Anth BacBlt CerLS	Blkrot Alt LS DM	All 3 see label	AngLS Alt LS Anth DM PM GSB	L,En,Es Sp Anth DM CerLS WhRst	On, G BacBlt DM PurBlo	TEP BacSe BacSp Anth EB LB GyLM BacCa	EB LB	Yes	All see label
Kocide 3000 EPA 352-662 **Also Registered** Kocide 101 (352-681) 77% Kocide 2000 (352-650) 53.8% Kocide 4.5LF (352-684) 37.5 Kocide DF (352-688) 61.4%	DuPont	**46.1 % copper hydroxide**	30	48	Dr, Gr BrnSp ComBlt HaloBlt	BlkRot Alt LS DM	All 3 see label	AngLS Alt LS Anth DM PM GSB 2ee PhyBlt	Sp Anth DM CerLS WhRst L,En,Es DM	On, G,L BacBlt DM PurBlo - - -	TEP BacSe BacSp Anth EB LB GyLM SepLS	EB LB	Yes	All see label - - - -

Trade Name (OMRI in Green)	Source	Active ingredients	% Metallic Cu	REI hrs[a]	Beans[b]	Crucifers[c]	Ca, Cel, Be[d]	Cucurbits[e]	Let, En, Es, Sp[f]	On, Gar, Le[g]	Tom, Egg, Pep[h]	Potato[i]	GrHs On Label[j]	Miscl. Wa, Ch, Di, Pa[k]
ManKocide EPA 352-690	DuPont	**46.1% copper hydroxide + 15% mancozeb**	30	48	No	No	No	ALL AngLS AltLS DM PM GSB **Scab** 2ee PhyBlt	No	On, Dry BacBlt BotLB DM PurBlo	T only BacSe BacSp Anth EB LB LefMo SepLS StemLS	EB LB	No	No
Nordox 75 WB EPA 48142-4	Nordox AS	**83.9% cuprous oxide**	75	12	Dr,Gr Anth HaloBlt CerLS DM	BlkLS BlkRot DM	All 3 see label for Dis.	AngLS AltLS Anth DM,PM GSB	Let DM Sp Anth DM,WhRu	On DM PurBlo	TEP EB, LB Speck Spot Canker GyLS LeaMld SepLS	EB LB	Yes	Yes see label
Nu Cop 50WP EPA 45002-7 **Also Registered** Nu Cop 3L (42750-75) Nu Cop HB (42750-132)	Albaugh	**77% copper hydroxide**	50	24	Bean BrnSp ComBlt HaloBlt	BlkRot AltLS DM	All 3 see label for Dis.	AngLS AltLS Anth DM Anth	Le,En,Es DM Sp DM Anth CerLS WhtRu	On DM PurBlo	TEP BacSe Anth EB	EB LB	Yes	All see label
Mastercop EPA 55272-18-66222	MANA	**21.46 % copper sulfate pentahydrate**	5.4	48	Dr, Gr BrnSp ComBlt HaloBlt	BlkLS BlkRot DM	All 3 see label for Dis.	AngLS AltLS Anth DM, PM GSB	Sp Anth DM CerLS WhtRu	On, Ga BacBlt DM PurBlt	TEP BacSpk BacSpt EB, LB LeaMld SepLS	EB LB	No	All see label

[a]**REI in hrs. =** Older, unrevised labels still have 24 hrs, while newer labels are 48hrs reentry time, but a few are 4 or 12 hrs.

[b]**Beans** = Green and Dry, if NS, then not specified on label, but assume can be used per all other copper labels; **Diseases: Brn Sp** = Bacterial brown spot (*Pseudomonas syringae* pv. *syringae*; **Com Blt** = Common bacterial blight (*Xanthomonas campestris* pv. *phaseoli*); **Halo Blt** = Halo blight (*Pseudomonas syringae* pv. *phaseolicola*); **Others Listed**: **Ang**ular **l**eaf **s**pot = *Phaeoisariopsis griseola* (tropical); **Anth**racnose = *Colletotrichum lindemuthianum*; **D**owny **m**ildew = *Phytophthora nicotianae* var. *parasitica* (tropical); **P**owdery **m**ildew = *Erysiphe polygoni* (tropical).

[c]**Crucifers** = applies for most but not for all crucifer crops, see label. Diseases: **Blk rot** = Black rot (*Xanthomonas campestris*); **Alt Blk LS** = Alternaria black leaf spot (*Alternaria* spp.); **DM** = Downy mildew (*Peronospora parasitica*).

[d]**Ca, Cel, Be** = Carrots, Celery and Beets; **Diseases** for **table beets** and **greens** includes **Cercospora Leaf Spot** (*Cercospora beticola*), **Downy mildew** (*Peronospora farinosa* f. sp. *spinaciae*), and **Phoma leaf spot** (*Phoma betae*); for **carrot** they include **Bacterial leaf blight** (*Xanthomonas campestris* pv. *carotae*), **Alternaria leaf blight** (*Alternaria dauci*), and **Cercospora leaf blight** (*Cercospora carotae*); and for **celery** and **celeriac**, **Bacterial leaf spot** (*Pseudomonas syringae* pv. *apii*), **Cercospora early blight** (*Cercospora apii*), and **Septoria late blight** (*S. apiicola*).

[e]**Cucurbits** = usually applies to all in plant group unless noted on label; **Diseases: AngLS =** Angular leaf spot (*Pseudomonas syringae* pv. *lachrymans*), **bacterial leaf spot** (*Xanthomonas campestris* pv. *cucurbitae*), **is not listed**; **Anth** = Anthracnose (*Colletotrichum orbiculare*), **AltLS** = Alternaria leaf spot (*Alternaria cucumerina*), **DM** = Downy mildew (*Pseudoperonospora cubensis*), **PM** = Powdery mildew (several species), **GSB** = Gummy Stem Blight (*Didymella bryoniae*, **sexual** and *Phoma cucurbitacearum*, **asexual**), **Scab** = (*Cladosporium cucumerinum*); **Uloclad** = (*Ulocladium cucurbitae*); **Phytophthora blight** = **PhyBlt** (*Phytophthora capsici*) **2ee label applies** for Champ 2F, Cuprofix Ultra 40Disperss, Kocide 2000, 3000, 4.5 LF and DF, and ManKocide DF.

[f]**Let, En, Es, Sp** = Lettuce, Endive, Escarole, and Spinach, and will vary by copper product; **Diseases of Lettuce**: **Anth** = Anthracnose (*Microdochium panattonianum*) also **Endive** and **Escarole**, **DM** = Downy mildew (*Bremia lactucae*), **Bacterial diseases not listed** = Bacterial leaf spot (*Xanthomonas campestris* pv. *vitians)* (seed source), Marginal leaf blight (*Pseudomonas marginalis* pv. *marginalis* (ubiquitous), Varnish spot (*Pseudomonas cichorii*) (seed); **also not listed**, Septoria leaf spot (*Septoria lactucae*) (seed source) ; **Diseases of Spinach**, **CerLS** = Cercospora leaf spot (*Cercospora beticola*), **DM** = (*Peronospora farinosa* f. sp. *spinaciae*), and **WhRst** = White rust (*Albugo occidentalis*).

[g]**On, Gar, Le** = Onion, Garlic, Leek; Most labels handle **Diseases of Onion and Garlic** and some include **Leek: BacBlt = not specified**, but bacteria could include Xanthomonas leaf blight (*Xanthomonas campestris*), Bacterial soft rot (*Erwinia carotovara* sub sp. *carotovora*), Slippery skin (*Pseudomonas gladioli* pv. *allicola*), and Bacterial canker and Sour skin (*Burkholderia cepacia*); **Diseases of Dry Bulb Onion** when using mancozeb + copper: **BacBlt** = Bacterial blight, **BotyLB** = Botrytis leaf blight (*Botrytis squamosa*), **DM** = Downy mildew (*Peronospora destructor*), and **PurBlo** = Purple blotch (*Alternaria porri*).

[h]**Tom, Egg, Pep** = Tomato, Eggplant, Pepper; **Tomato**: **BacSe** = Bacterial speck (*Pseudomonas syringae* pv. *tomato*), **BacSp** = Bacterial spot (*Xanthomonas campestris* pv. *vesicatoria*), and **BacCa** = Bacterial canker (*Clavibacter michiganensis* subsp. *michiganensis*), **Anth** = Anthracnose (*Colletotrichum coccodes*), **EB** = Early blight (*Alternaria tomatophila*), **LB** = Late blight (*Phytophthora infestans*), **LefMo** = Leaf mold or **GyLM** = Gray leaf mold (*Fulvia fulva*), **SepLS** = Septoria leaf spot (*Septoria lycopersici*), **StemLS** = Stemphylium leaf spot or Gray leaf spot (*Stemphylium solani*); **Eggplant**: includes at least **Alt Blt**, **Anth** and **Phomopsis**; **Peppers**: includes **BacSp** and others add **Anth** and **Cer LS**.

[i]**Pot** = Potato; **Diseases of Potato**: **EB** = Early blight (*Alternaria solani*), **LB** = Late blight (*Phytophthora infestans*).

[j]**GrHs** use is specifically mentioned on the label, (but according to EPA ruling, others may also be used unless specifically mentioned as prohibited)

[k]**Miscl.** = Watercress, Chives, Dill, and Parsley. **Diseases of Watercress**: Cercospora leaf spot (*Cercospora nasturtii*); **Diseases of Chives**: Downy mildew (*Peronospora destructor*); **Diseases of Dill**: Phoma leaf spot, Rhizoctonia foliage blight; **Diseases of Parsley**: Bacterial blight (*Pseudomonas* sp.).

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