

# Comprehensive List of Phosphorous Acid Compounds for Use on Vegetables by Given Disease

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Phosphorous acids (PA) ( $H_3PO_3$ ) (FRAC group 33, 0 DTH) have been on the market for more than a decade but their use in agriculture still raises many questions as to their effectiveness and proper use to maximize disease control. The accompanying table (Table 1) lists 9 different products registered for use in NY (underlined means registered). Most are not restricted by the DEC, but three are **\*restricted** (**\*Fosphite**, **\*Kphite**, and **\*Resist 57**), meaning that they can only be applied by registered commercial applicators. Most contain a percentage of mono- and di-potassium salts of phosphorous acid of specific a.i. per gallon, so the best means of comparison is to look at the equivalent lbs. of PA/gal shown in column 1 for aiding in their distinction. Nutrol (LidoChem, 100% K dihydrogen phosphate) has not been listed as it is primarily a plant nutrient and tank buffering agent providing some crop protection.

Perusal of the list of vegetables covered reveals that many major crops are included, ranging from Asparagus to Potatoes (many other minor vegetable (herbs and spices) are also included on the labels and should be checked individually). The particular diseases listed for control, for the most part, are limited to those known as oomycetes (a group of pathogens that include water molds, downy mildew and white rot), but the spectrum of activity on some labels has been expanded to include suppression of bacterial and other non-oomycete foliar pathogens. Also Silver Scurf of Potatoes as a Postharvest treatment appears on some labels. PA fungicides are especially effective against water molds since their systemic properties directly inhibit oxidative phosphorylation in these pathogens. The compound is translocated in the plant to the roots and therefore is effective against oomycetes that attack the root. It is also widely accepted that these acids can operate indirectly inside the plants by stimulate the plants natural defense response against pathogen attack, thus broadening the range of activity. Since the phosphorous acid labels are fairly generic in format, a listing of specific genera of oomycetes (actually on the label or implied) is shown in Table 2.

PA should not be viewed as a silver bullet, but can contribute in disease control in some specific situations. Some labels will specify that the product be tank-mixed (T-M) with protectants (mancozeb or chlorothalonil) to provide better disease control (ie. downy mildew). A wider array of disease control is available with <sup>M5 + 33</sup>Catamaran (phosphorous acid + chlorothalonil) which is labeled for some vegetables. Protection of potato in the field and in storage with PA has received considerable attention. In the case of in-furrow application for pink rot and leak control in potato, PA combined with mefenoxam is suggested on some labels. PA should not be used to cure late blight or pink rot infected tubers, but rather protecting health tubers with a postharvest application followed by good storage manage practices. It is critical to apply this treatment as soon as possible after harvest.

A common warning on most labels is not to apply the product in intervals of less than 3 days, and often recommend that it should be used at 1-4 week intervals, and not to exceed 4-6 applications/season. The acid is very stable in the plant, so other precautions include: not applying to a plant that is dormant or heat or moisture stressed (>4 hrs conditions favoring wet tissue), and to avoid copper phytotoxicity, not applying PA to plants treated with copper until a 3 week interval has passed.

**Table 1. Listing of phosphorous acid fungicides currently registered in New York.**

	Source	Active ingredients	Equivalent lbs Phosphorous Acid/gal	Asparagus	Beans, Peas (Legumes)	Crucifers (Brassica)	Beet, Carrot, Celery	Cucurbits	Lettuce, En, Es, Spin	Onion, Garlic, Leek, Sh	Tomato, Egg, Pepper	Potato	Potato Postharvest per Ton
<b>1) Agri-Fos</b> DEC Label Jan 8, 2010 EPA 71962-1	<b>Liquid Fert.</b> Specific label, species specified	45.8% Mono- & di-potassium salts Phosphorous acid 5.17 lb ai/gallon; REI 4 hrs; 0 DTH.	3.35	CrwRot, Spear slime	All Phyto, Pyth	All DM	Car Phyto, Pyth	All DM T-M with MZ	All DM	All DM T-M with MZ	Tom LB, Phyto Root Rot Egg, Pep Phyto Root rot	In-Fur PRot, Leak Foliar LB, PRot, Leak	Intended - Russet potatoes processing LB, PRot, 16.5 fl oz/0.5 gal water
<b>2) *Fosphite</b> DEC Label 9-14-2010 EPA 68573-2	<b>J. H. Biotech</b> Specific label, but only spp. specific for potato	53% Mono- & di-potassium salts Phosphorous acid 6.22 lb ai/gallon; REI 4 hrs; 0 DTH.	3.90	Phytop	All DM, Phyto	All DM, Phyto	All DM, Phyto	All DM, Phyto	All DM	On & Ga DM	Tom Phyto, Pyth Egg, Pep Phyto, Pyth	Foliar LB, PRot	LB, PRot 6.4-12.8 fl oz/0.5 gal/ton
<b>3) Fungi-Phite DF in lbs; Fungi-Phite in qts.</b> DEC Label 11-14-2011; or 6-16-2011 EPA 83472-3; or 83472-1	<b>Plant Protect.</b> Specific labels for both; species given for potato	99% Mono- & di-potassium salts Phosphorous acid; equivalent to 0.68 lb PA/pound; or 45.5% of phosphorous acid containing 5.41 lb/gal; REI 4 hrs; 0 DTH	? <b>3.38</b>	Phytop	All DM, Phyto, Pyth, Suppr Bac. & Lf. Dis.	All DM, Suppr. Bac. & Lf. Dis.	All DM	All SM, Phyto, Pyth, Suppr. Lf. Dis.	All DM, Phyto, Pyth, Suppr. Bac. & Lf. Dis.	All DM, Suppr. Bac. Dis.	All Phyto, Pyth, Suppr. Bac. Dis. & Lf. Dis.	Foliar PRot, Leak, Suppr. LB w protectant	Suppr. PRot, LB 0.65-1lb/0.5-1 gal water 1-1.5 pts/0.5-1 gal. water
<b>4) Helena ProPhyt</b>	<b>Luxembourg</b> Specific label, some species specified	54.5% Mono- & di-potassium salts Phosphorous acid (34.3%) lb ai/gallon; REI 4 hrs; 0 DTH.	<b>4.2</b>	no	All DM, Pyth Cottony leak SpBea n Pyth & Rhiz DO	All DM	no	All DM, Phytop. capsici	All DM	All DM PurBlich	Tom LB best T-M with or chlorot halonil	In-Fur w mefenoxam, PRot, LBtuR Phyt leak Foliar LB w protectant	13 fl oz/0.5gal water/ton; Suppr. of LB tuber rot, PRot, Pyth leak, & Silver Scurf

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<b>5) *Kphite 7LP</b> DEC Label 2-12-2010 EPA 73806-1	<b>Plant Food Systems</b> Generic Label; species specific only for potato	56% Mono- & di-potassium salts Phosphorous acid 7.03 lb ai/gallon; REI 4 hrs; 0 DTH.	4.41	Phyto	All DM, Phyto, Pyth, Bac. & Fungi	All DM, Phyto, Pyth.	All DM, Phyto, Pyth.	All DM, Phyto, Pyth.	All DM	On & Ga DM	All Phyto, Pyth	Foliar LB, PRot	No
<b>6) Phostrol</b> DEC Label 7/16/2012 EPA 55146-83	<b>Nufarm</b> Specific label; species specific	53.6% Mono- & dibasic Na,, K and NH3 phosphites; Phosphorous acid 6.69 lb ai/gallon; REI 4 hrs; 0 DTH	4.32 (35.6%)	Spearslime, Crw Rot	All	All DM	Cel	All DM Phyt capsici	All DM	All DM PurBlc h	Tom Phy root rot	In-Fur w mefenoxam, Foliar LB w protect.	LBTuRt PRot Leak SS 13 fl oz/0.5gal/ton
<b>7) Rampart</b> DEC Label 3-17-2010 EPA 34704-924	<b>Loveland</b> Very Generic; Species only for potato post-harvest use	53% Mono- & di-potassium salts Phosphorous acid 6.22 lb ai/gallon; REI 4 hrs; 0 DTH.	3.90	Phyto	All DM, Phyto Pyth	All DM, Phyto Pyth	All DM, Phyto Pyth	All DM, Phyto Pyth	All DM, Phyto Pyth	On & Ga DM	All Phyto Pyth	Foliar Phyt Pyth	LB & PRot 6.4-12.8 fl oz/0.5 gal water
<b>8) *Resist 57</b> DEC Label 1-11-2010 EPA 82940-1	<b>Actagro LLC</b> Very Generic label; species for potato	57% Mono- & di-potassium salts; Phosphorous acid 6.78 lb ai/gallon; REI 4 hrs; 0 DTH.	4.16	Phyto	All DM, Phyto Pyth Fus Rhiz	All DM, Phyto Pyth Fus Rhiz	All DM, Phyto Pyth Fus Rhiz	All DM, Phyto Pyth Fus Rhiz	All DM, Phyto Pyth Fus Rhiz	All DM, Phyto Pyth Fus Rhiz	All DM, Phyto Pyth Fus Rhiz	Foliar LB, PRot	LB, PRot, Silver Scurf; 0.1 gal/0.5 gal water/ton
<b>9) Reveille</b> DEC Label May 11, 2012 EPA 42519-22-5905	<b>Helena</b> Species specific	54.5% potassium phosphite; Phosphorous acid equivalent: 34.30%; REI 4 hrs; 0 DTH	4.2	no	All DM	All DM	no	All DM, Phyt capsici	All DM	All DM PurBlc h	All LB w protectant	Foliar LB w mzin-Fur PRot, LB tub rot, Pyth leak w mefanoxam	13 fl oz in 0.5 gal water/tonS uppr. LB tub rot, Prot

**Table 1 Disclaimer: Please read the pesticide label prior to use. The information contained in the article is not a substitute for a pesticide label. Trade names used herein are for convenience only; no endorsement of products is intended, nor is criticism of unnamed products implied. Some of this information is historical in nature and may no longer be applicable.**

Table 2. Genera of oomycetes not generally identified on most current phosphorous acid fungicide labels.

Oomycetes genus	Disease and crop listed	Affected crop part(s)	Products labeled
<i>Albugo occidentalis</i>	White rust of <u>Spinach</u>	Blister-like pustules on underside of leaves	ProPhyt only
<i>Aphanomyces</i> <i>A. cochlioides</i>	Damping off and black root rot of <u>Bean</u>	Roots and lower stem	Not specified on any label
<i>A. euteiches</i>	Root rot of <u>Pea</u>		
<i>Bremia</i> <i>B. lactucae</i> , several pathotypes	Downy mildew of <u>all Lettuce</u> types	Chlorotic and angular on upper foliage; sporulation on underside	All labels, some specified
<i>Peronospora</i> <i>P. destructor</i>	Downy mildew of <u>Onion</u> (primary), also <u>Garlic</u> , <u>Leek</u> and <u>Shallot</u>	Bleaching of leaf tips, with irregular chlorotic blotches on leaves	All labels, some specified
<i>P. farinose</i> f. sp. <i>spinaciae</i>	Downy mildew of <u>Spinach</u>	Light green to dull yellowing on upper side; sporulation on underside	All labels, not specified
<i>P. farinose</i> f. sp. <i>betae</i>	Downy mildew of <u>Table Beet</u> and <u>Swiss Chard</u> (coastal regions of CA and OR)	Infects plants in all stages pathogen grows systemically with in young leaves to apical point	All, not specified
<i>P. jaapiana</i>	Downy mildew of <u>Rhubarb</u> (restricted occurrence)	Seedlings and any stage of growth.	All, not specified
<i>P. parasitica</i> , host specialization	Downy mildew of Brassica crops ( <u>Brussels sprout</u> , <u>Cabbage</u> , <u>Cauliflower</u> , <u>Radish</u> )	Seedling stage to maturity and into storage	All, some specified by species
<i>P. viciae</i> ; <i>P. viciae</i> f. sp. <i>pisi</i>	Downy mildew of <u>Pea</u> and <u>Broad bean</u>	Pathogen is seedborne and seeds fail to germinate. Seed growing areas. Blotches delineated by vein on upper surface. Gray to purplish underside of leaves from sporulation	All, not specified
<i>Plasmopara lactucae-radicis</i>	Downy mildew of <u>Lettuce</u> , second type	Restricted to roots; sporulation on root surface and oospores in the root cortex	All, not specified
<i>Pseudoperonospora cubensis</i>	Downy mildew of cucurbits (primarily <u>Cucumber</u> , <u>Summer Squash</u> , <u>Pumpkins</u> , <u>Muskmelon</u> , but also <u>Winter Squash</u> )	Pale green to greasy appearing, angular and rectangular spots delimited by leaf veins. As lesions age they turn brown and necrotic on upper leaf surface; sporulation occurs on the underside	All, some species specified on label
<i>Pythium</i> spp.	Damping off of <u>Bean</u> , <u>Pea</u> , <u>Crucifers</u> , <u>Beet</u> , <u>Carrot</u> , <u>Celery</u> , <u>Cucurbits</u> , <u>Tomato</u> , <u>Pepper</u> , <u>Potato</u>	Seeds and seedling stems	All, not specified by species
<i>Phytophthora capsici</i>	Damping off, root rot, crown canker, foliar blight, <u>Cucurbits</u> , <u>Eggplant</u> , <u>Pepper</u> , <u>Tomato</u>	Damping off, root rot, crown canker, foliar blight and fruit rot	All, some specified
<i>Phytophthora erythroseptica</i>	Pink rot of <u>Potatoes</u>	Stolons, roots, tubers	All, specified
<i>Phytophthora infestans</i>	Late blight of <u>Tomato</u> and <u>Potato</u>	Stems, foliage, fruit and tuber blight	All, specified
<i>Phytophthora megasperma</i>	Spear and crown rot of <u>Asparagus</u>	Brownish lesions on spears & crowns	All, not specified