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Andrew Jensen, Editor. ajensen@potatoes.com; 509-760-4859

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Litchi Tomato: Trap Crop for *Globodera pallida* control

Louise-Marie Dandurand, Pamela J.S. Hutchinson, Mike Thornton, University of Idaho
Chuck Brown, USDA-ARS, Prosser, Washington

The pale cyst nematode (PCN), *Globodera pallida*, is an internationally recognized quarantine pest. Damage from PCN can be extensive; for every 20 eggs per gram of soil there can be a 1 ton per acre yield loss. Left uncontrolled this nematode can cause up to 80% loss in yield. Cyst nematodes survive away from the plant host as eggs inside of cysts. A cyst is actually the dead body of an adult female nematode, and each cyst can contain several hundred eggs.

The narrow host range of cyst nematodes suggests that crop rotation could be effective for their control. But because of their obligate nature, cyst nematodes, and particularly *G. pallida*, hatch only in the presence of a suitable host that produces an appropriate chemical hatching factor. When a host isn't present, cysts can persist in soil for years; this makes crop rotation ineffective for eradication of this pest.

At one point prior to implementation of the current regulatory measures, import of Idaho fresh potato products and nursery stock was banned in Canada and Mexico, and Japan cut off importation of all U.S. potatoes. Now trade markets for Idaho potatoes in Canada and Mexico have also been restored with the exception of potatoes from Bingham and Bonneville Counties. Eradication of PCN is a top priority for the Idaho potato industry. Although in Europe PCN is managed through a combination of a seven-year rotation, partial resistance, and use of nematicides, these measures are not feasible for Idaho growers because there is no resistance in Idaho's signature russet varieties, a seven year crop rotation is impractical, and because of trade considerations. Consequently, PCN-infested and surrounding fields are regulated and potatoes cannot be grown in infested fields. With restrictions on the use of the fumigant methyl bromide growers need other effective strategies.

Use of litchi tomato as a trap crop for PCN

Non-host trap crops which stimulate egg hatching but do not support nematode reproduction can provide a strategy to eradicate PCN, since hatched juveniles have limited food reserves and die if they do not successfully parasitize plant roots. We are investigating a trap crop species which is closely related to potato, *Solanum sisymbriifolium* commonly known as litchi tomato (LT), which stimulates suicide hatch and is a non-host to PCN.

Litchi tomato is an annual herb native to South America that can reach up to 3 feet in height. The stems and branches are armed with spines that can be up to ½ inch in length. The flowers are white to pale blue. Litchi tomato is preferred as a trap crop because it combines strong hatch stimulus with immunity to PCN. One advantage of a trap crop such as litchi tomato is that roots can access greater depths of the soil than fumigants without the environmental consequences.

Efficacy of litchi tomato against PCN

Litchi tomato effectively decreases populations of PCN. Under greenhouse conditions litchi tomato almost entirely eliminated reproduction of PCN on a succeeding potato crop compared to fallow or a potato crop (Table 1). Experiments with litchi tomato in PCN infested fields in Idaho Falls indicated that when potato was planted after litchi tomato, reproduction of PCN on potato was nearly 90% less than on potato grown after a fallow rotation. In contrast, PCN decline in the absence of a host is typically low and under fallow conditions can take up to 30 years.

Table 1. Effect of litchi tomato on PCN reproduction in a subsequent potato crop

Treatment	*PCN cysts**
Potato after litchi tomato	1
Potato after fallow	271
Potato after potato	1021

*Average of six replicates

Selection of LT for desirable characteristics

Selections of LT for desirable characteristics such as reduced prickles, rapid germination, reduced flowering and berry set, greater root mass and higher production of hatching factor will enhance its value as a trap crop. These selections are ongoing. The short growing season in the Northwest results in reduced flowering and seed set. Phenotypes with large fruitful plants have dominated breeding efforts.

Agronomic performance and herbicide management of litchi tomato in Idaho

Field studies conducted in southern Idaho have shown that litchi tomato grows quite well in Idaho. LT has a very small seed (similar to tomato) and it is critical to plant shallow (~ ½ inch) in order to get good emergence. Any equipment capable of planting a small seed should work with LT, as long as seeding depth can be controlled. Devitalized mustard seed or other materials can be used as a filler (1 unit of seed per 3 units of filler) to help uniformly distribute the seed at planting. The optimum seeding rate was found to be around 100 seeds per square meter, which equates to 2.8 lbs of LT seed per acre. An application of an 80N-100P-60K fertilizer prior to planting was sufficient for growth of litchi tomato. Sprinkler irrigation should be used to maintain available soil moisture in the root zone above 65% until 1 week prior to flailing.

The optimum planting date to obtain maximum above-ground LT growth in southern Idaho is mid to late May. It can be slow to germinate, but in SW Idaho, plants emerged 12 to 14 days after seeding, with planting date having little impact on time of emergence. LT also has been grown in SE Idaho near and in the PCN regulated area. Emergence there in the relatively short growing season typically occurs 3 to 4 weeks after planting. Regardless of location in southern Idaho, the plants

grow very slowly for the first 3 to 4 weeks, but once plants reach a height of 4 to 6 inches, rate of growth increases. Biomass peaked mid-September after a late-May planting in a SE ID research trial. LT starts to flower approximately 5 weeks after emergence, and then sets fruit about three weeks later. It is important to kill the crop before any of the fruit mature and turn red in order to prevent viable seed production and the possibility of volunteers in subsequent years. Therefore, before berry maturity (approximately 9 weeks after emergence in SE ID), we recommend chemical desiccation/kill followed by flailing the crop once it is dead. Plant residues can then be incorporated through tillage.

Herbicide management in LT

Herbicide management in LT is needed for several reasons: 1) to control its potential to become weedy; 2) to control weeds growing in the trap crop that may affect its production; and 3) to control other solanaceous plants that may be hosts to PCN, e.g. hairy nightshade (*Solanum physalifolium*). An introduced plant such as LT has the potential for weediness in subsequent years. Litchi tomato was added to IDAPA 02.06.09 Invasive Species Lists in the category Invasive Plants – Trap Crops, and containment, monitoring, and research possession and permitting is currently required in order to regulate its use as a trap crop. Until further information is known about effective herbicides for use in LT, anyone planting LT is required to have a containment plan filed with the ISDA. Containment of LT currently requires appropriate monitoring and fencing. Researchers at the University of Idaho have ISDA-approved plans for LT field research trials. Once effective herbicides have been evaluated the requirements for containment will be re-evaluated.

The LT management plan developed at the University of Idaho through herbicide tolerance and control trials conducted beginning 2012 includes rimsulfuron (Matrix and others) applied preemergence (PRE) or postemergence (POST) for control of hairy nightshade and other weeds in the trap crop. This herbicide has been used successfully in LT grown in Europe, however, LT was stunted when pendimethalin (Prowl H2O and others), also used in Europe for weed control in the trap crop, was applied PRE in the ID trials. Other herbicides screened in ID which were shown to be somewhat safe to LT are ethalfluralin (Sonalan and others) or linuron (Linex, Lorox) applied PRE. LT can be well-controlled if it volunteers in potatoes with flumioxazin (Chateau) PRE, and metribuzin PRE or POST. Other PRE-applied herbicides labeled for use in U.S. potatoes, such as EPTC (Eptam), dimethenamid-p (Outlook), s-metolachlor (Dual Magnum and others), and fomesafen (Reflex) partially controlled LT causing moderate-to severe-stunting. POST-applied small grain, corn, and sugar beet herbicides such as bromoxynil (Buctril and others), fluroxypyr (Starane), and clopyralid (Curtail, Stinger) as well as glyphosate can provide up to 100% kill of the trap crop. While it was partially tolerant of but had severe stunting by others such as carfentrazone (Aim), 2,4-D, and dicamba (Banvel and others). Non-crop POST-applied herbicides, aminopyralid (Milestone) and imazapic (Plateau) also successfully kill LT. Further screening is being conducted by the University of Idaho and includes herbicides which could potentially cause flower drop/berry prevention which would allow the trap crop to be grown longer in the season. The results of these trials show that while LT is tolerant of a few herbicides tested which could be used for weed control in the trap crop, there are many better herbicide choices in potatoes and other crops grown in rotation for controlling LT if it volunteers/becomes weedy.

Litchi Tomato Herbicide Research Aberdeen R&E Center and Shelley, ID 2014 and 2015

Tolerance and control with potato herbicides

Aberdeen R&E Center

Chateau 1.5 oz/A applied preemergence

Aberdeen R&E Center

Metribuzin 75DF 2/3 lb/A preemergence

Aberdeen R&E Center

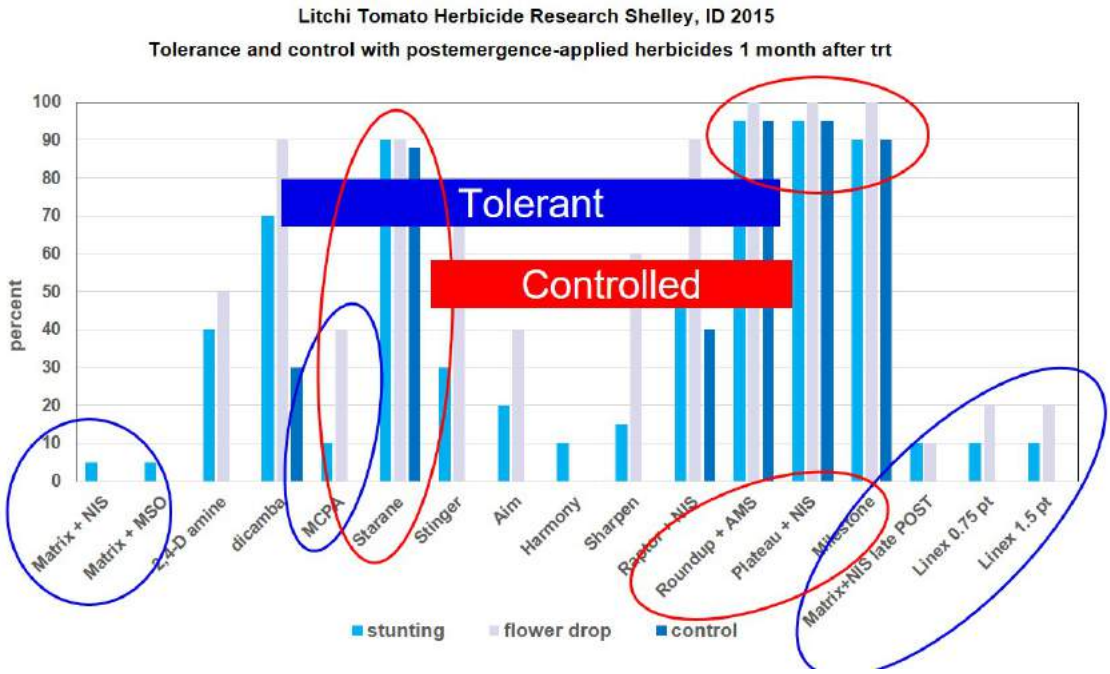
Metribuzin 75DF 2/3 lb/A applied postemergence

Shelley, ID 2015

Matrix 1.5 oz/A + NIS postemergence

Aberdeen R&E Center Preemergence herbicide screening trial results

	control			
Herbicide	1 inch early	2-24 inch late	stunt late	
	---------- % ----------			
Metribuzin	100	97	-	controlled
Chateau	99	100	-	
Eptam	83	68	50	partially controlled
Prowl H2O	65	75	88	severe-stunting
Dual Magnum	58	18	38	
Linex	45	55	25	partially controlled
Outlook	37	52	37	moderate stunting
Reflex	35	35	35	partially tolerant
Matrix	0	5	0	tolerant
Sonalan	0	0	10	



Litchi Tomato Herbicide Research Aberdeen R&E Center and Shelley

LT tolerance and control with small grain/corn and noncrop/rangeland herbicides

Roundup Power Max 22 fl oz/A + AMS POST

Plateau 12 fl oz/A + NIS POST

Buctril POST

Milestone 7 fl oz/A POST

Starane 0.5 pt/A POST

Rooting depth. Soils in eastern ID can be gravelly and it's possible that PCN cysts may occur deeper in that soil type than in others. In a gravel soil site trial conducted in 2013, LT roots grew to the gravel layer even when it was 5 ft below the soil surface.


Rooting depth trial trench


Top roots in first 1 ft


Roots down to gravel layer 5 ft depth

Flowering and fruit production. Besides the herbicides discussed above which stunt and prevent LT flowering, the plant growth regulator Ethephon was effective in reducing both flowering and fruit production in litchi tomato when sprayed three times over the summer at a rate of 16 oz/ac. The use of this growth regulator might help reduce the possibility of seed production and allow a slight delay in the date to mow down of the foliage. Use of those herbicides and/or this growth regulator would help reduce the possibility of seed production. Mowing down the foliage 8 to 9 weeks after emergence prior to seed set also would be an option.

New Website and Refurbished Research Library Database at www.nwpotatoresearch.com

Since 2012 the Washington, Idaho, and Oregon potato commissions have cooperated in research funding and management, and have called this cooperative venture the Northwest Potato Research Consortium. The Consortium has been represented on the Web by www.nwpotatoresearch.com, which included the 'research library' developed by the WSPC in the 2000s. Recently, a long-awaited redesign and reprogramming of the website was completed and is live online now. For those of you with research library passwords, your old login will work on the new site. For those without a login and password, there is a user-friendly means to request a password. As with all websites aiming to convey information both old and new, this site will be constantly changing and developing, presenting new information on the front end, and databasing more information and documents in the research library. I encourage everyone to have a look, and of course offer feedback anytime! – Andy Jensen, Consortium Manager