Litchi Tomato: Trap Crop for *Globodera pallida* control

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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.

The presence of *G. pallida* in Idaho is viewed with alarm by other states and countries that import Idaho potatoes and other farm products. 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 US potatoes. Now import of all but Idaho potatoes has been restored in Japan. 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 by USDA-APHIS and ISDA. Potatoes cannot be grown in infested fields. With the potential loss of the fumigant methyl bromide in the near future, regulators and 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. *L*itchi tomato is preferred as a trap crop because it combines strong hatch stimulus with immunity to PCN and Ge. 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). In contrast, PCN decline in the absence of a host is typically low and under fallow conditions can take up to 30 years. Field experiments with litchi tomato in PCN infested fields in Idaho Falls are under way.

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

Idaho Falls Field trial 2013. Photo: Tina Gresham, USDA-APHIS

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.

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.

Litchi tomato can be slow to germinate, but, in Parma, plants emerged 12 to 14 days after seeding, with planting date having little impact. The optimum planting date to obtain maximum above ground growth in southern Idaho is mid to late May. The plants grow very slowly for the first 3 to 4 weeks, but growth is very rapid after the plants reach a height of 4 to 6 inches. LT starts to flower about 5 weeks after emergence, and then sets fruit about three weeks later. It is important to flail the crop before any of the fruit mature and turn red in order to prevent viable seed production and the possibility of volunteers. Therefore, we recommend flailing the crop

and incorporating all plant residues through tillage by 8 to 9 weeks after emergence. In Aberdeen, Litchi tomato emergence is 20 to 30 days after planting and biomass peaks mid-September.

Weed control. Weed control in LT is needed for several reasons: 1) to control its potential as a weed; 2) to control weeds 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 may be re-evaluated.

A two-pronged weed management plan developed at the University of Idaho to control weeds within the trap crop, and to prevent it from becoming a volunteer weed in years subsequent to planting has found that the herbicide pendimethalin, used in Europe for weed control in the trap crop partially controlled and stunted applied preemergence (PRE) but another herbicide used – rimsulfuron (Matrix), was safe to LT applied preemergence while causing only slight stunting postemergence (POST). Ethalfluralin (Sonalan) applied PRE also was safe to LT. Flumioxazin (Chateau) and metribuzin PRE controlled LT. Other PRE herbicides labeled for use in U.S. potatoes partially controlled LT and caused moderate- to severe-stunting. POST-applied small grain, corn and sugar beet herbicides such as bromoxynil (Buctril), fluroxypyr (Starane), and clopyralid (Curtail, Stinger) as well as glyphosate provided 80 to 98% control of the trap crop while it was partially tolerant of but had severe stunting caused by others such as carfentrazone (Aim), 2,4-D, and dicamba (Banvel). In the 2013 POST herbicide trial, all but Matrix knocked off the flowers. The results of these two 2013 herbicide screening 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 potentially many good herbicide choices in potatoes and other crops grown in rotation for controlling LT if it volunteers/becomes weedy.

2013 Aberdeen R&E Center Preemergence herbicide screening trial results

	control			
	1 inch	2-24 inch		
Herbicide	early	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	

2013 Aberdeen R&E Center Postemergence herbicide screening trial results

Herbicide	control/ burndown	stunt	
	---------- % ----------		
Buctril	98	-	controlled
Starane	93	-	
glyphosate	85	80	
Stinger	80	60	
metribuzin	40	50	partially controlled severe stunting
Raptor	50	55	
Harmony	30	60	
Aim	15	55	partially tolerant severe stunting
2,4-D Amine	13	45	
dicamba	15	45	
Matrix	5	25	tolerant some stunting
MCPA	9	30	

NOTE: all postemergence herbicide applications except Matrix “knocked” off most of the flowers.


Nontreated control


Chateau preemergence


Sonalan preemergence

bromoxynil postemergence

Starane postemergence

Matrix postemergence

<u>Rooting depth</u>. Soils in eastern ID can be gravelly and it's possible that PCN cysts may fall 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

<u>Flowering and fruit production</u>. 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.