

Selectivity of Organic Herbicides in Broccoli and Onions

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INTRODUCTION

Weed control in organic production is generally a two pronged approach that includes long term strategies such as managing the impacts of crop rotations and reducing weed seed deposits to the seedbank. In addition it encompasses short-term strategies to help the grower deal with weed issues that affect the profitability and productivity of the immediate crop. Examples of short-term weed control strategies include pregermination and cultivation, as well as other techniques such as use of mulches, flaming and solarization. Organic herbicides have not been utilized during the cropping cycle to a large degree. One exception is that they can be used as a post plant preemergence burn down of weeds prior to crop emergence. Current organic herbicides contain clove oil (eugenol), organic acids (citric and/or acetic) as well as other oils and acids either alone or in various combinations. These materials are contact herbicides that disrupt plant cell membranes and cause leakage of cellular fluids (Tworkoski 2002).

These materials are primarily effective on broadleaf weeds, and their effectiveness depends on plant size, spray volume and concentration of the material (Ferguson 2004). Percent control of organic herbicides declines precipitously as weeds grow beyond the two true leaf stage (Smith 2004). Broadcast applications of rates of organic herbicide high enough to achieve excellent weed control can be cost prohibitive (Boyd and Brennan 2006). However, weeding costs in organic vegetable production can be a significant part of the production budget (Tourte et al. 2004). Given limitations of organic herbicides and their cost, it is important that the materials be used in situations where they save organic growers time and money. The most cost effective use of these materials would be if they were able to kill weeds selectively in a crop. We initiated studies on onions and broccoli because these crops are routinely treated with weed control materials (i.e. contact herbicides or fertilizers) in conventional production at the two true leaf stage. They are able to withstand these chemicals due to the waxy cuticle on their leaves that sheds the spray. In this article we will report on studies conducted on their safety and weed control efficacy.

METHODS

Broccoli Trials: Trial results shown in Table 1 were conducted in 2004 and 2006 on commercial broccoli fields in Monterey and Santa Cruz Counties. Trial results in Table 2 were conducted on two organic farms in 2006 in Santa Cruz County. 2004 trials were conducted as part of larger weed trials in conventional fields and 2006 broccoli trial no. 1 was conducted on an organic farm and broccoli trial no. 2 was conducted as part of a larger weed trial. In the 2004 trials Xpress Organic (clove oil) was used and in 2006 Matran EC (clove oil) and Scythe (pelargonic acid) were used. Scythe is currently not an allowed organic herbicide but it is

scheduled to be reviewed by the National Organic Program in April 2007. Materials were applied at 30 to 35 days after seeding or transplanting (except for 2006 broccoli trial no. 2 which was applied at 45 days after seeding), and were applied over the top of the broccoli in 2004 and as a directed spray to the base of the plant in 2006. Weed evaluations were not available in 2004 trial no. 2 because the site was over sprayed with AN 20, but yield evaluations were conducted. Weed evaluations in 2006 trial no. 2 were not conducted because the materials were applied too late and the weeds were not susceptible to any of the materials that were sprayed. Table 2 shows the results of 2006 trials 3 and 4 which were conducted on an organic farm. The broccoli was transplanted and the plants had 4-5 true leaves at the time of spraying. In both trials conditions were good as weeds were small and the beds were smooth (no clods to block spray from contacting weeds). Matran EC was used in these trials at either one or two passes per seedline of an 8004 TeeJet nozzle directed to the base of the plant. All materials were applied with Humasol as a surfactant (@ 0.25%) with a one nozzle wand with an 8004 nozzle pressurized with a CO₂ backpack sprayer at 30 psi. Weed counts were made 14 days after treatment and weeding evaluations were made 20 days after treatment.

Onion Trials: Trial results shown in Table 3 were from trials conducted on commercial farms in Monterey County and were part of larger weed control evaluations (except green onion trial no. 2 which was conducted at the Hartnell East Campus research facility in Salinas). Unless otherwise noted applications were made at the 2nd true leaf stage which is typically 35 days after planting.

RESULTS AND DISCUSSION

Broccoli Trials: In the 2004 trials Xpress Organic was highly phytotoxic to broccoli in trial no. 1, but much less so in trial no. 2, as evidence by the yield evaluation (Table 1). In 2006 broccoli trial 1 the best weed control was obtained with two passes of a directed nozzle applying 3.5% of Matran EC. This treatment also had the lowest weeding time. In 2006 broccoli trial no. 2 all rates or application methods of Matran EC and Scythe yielded similarly and all yielded from 86 to 89% of the untreated control. Table 2 shows the results from trials 3 and 4 in which transplants were used and the Matran EC was effectively applied as a directed spray. For instance, two passes of an 8.1% solution reduced weeds by 99.5% and reduced weeding time from 34.9 hours per acre in the untreated check to 5.8 hours per acre; however, phytotoxicity ratings were unacceptably high in all herbicide treatments. In trial No. 4 the rate of Matran EC was reduced and phytotoxicity ratings were reduced to acceptable levels. Two passes of 3.5% of Matran EC provided 91.2% control of weeds, but given the high weed population it did not reduce weeding time as dramatically as was seen in trial no. 3.

Onion Trials: Onions cannot benefit from directed sprays as can be used in broccoli. All treatments are applied over-the-top of the crop and as a result greater selectivity is needed. In 2005 green onion trial no. 1 moderate weed control was achieved using a 10 to 20% solution of Matran EC. Both rates had modest phytotoxicity ratings and reduced time for weeding (Table 3). 2005 green onion trial no. 2 was located on a site with high weed pressure. Both Matran EC and

Scythe applied at the first true leaf stage had better weed control than second true leaf applications. Scythe had improved weed control over Matran EC. Both materials had moderate phytotoxicity ratings. All treatments improved the yield over the untreated control given significant stunting from severe weed competition. In the 2005 dry bulb onion trial Matran EC at 20% applied at the second true leaf provided low to moderate weed control and reduced hand weeding by 31% over the untreated control. It had low phytotoxicity ratings and yielded well. In the 2006 dry bulb onion trial we used Scythe at 3.0% at the second true leaf stage and saw no weed control and extremely high hand weeding time. This was due to the fact that, given the cool, wet weather in the spring of 2006, the onions grew slowly and the weeds much quicker than normal. As a result, even conventional herbicides had difficulties controlling weeds in 2006.

CONCLUSION

The organic herbicides examined in these studies are not safe for over-the-top use on broccoli. Low rates of these herbicides can be used on broccoli if they are applied as a directed spray to the base of the plant. If too much of the material gets up onto the foliage it can cause significant phytotoxicity. If however, the material is successfully applied acceptable yields can be achieved. Onions are different in that there is no way that the spray material can be directed to the base of the plants. As a result, there is greater need for selectivity for the onions and careful selection of appropriate rates. More effective weed control can be achieved if the organic herbicides can be applied at the first true leaf stage; however, we observed greater phytotoxicity on the crop when applied at this earlier growth stage. If applications go on too late and the weeds are too big, the low rates of organic herbicides that need to be applied in order to safeguard safety on the onions will not be adequate to effectively control weeds.

Clearly, there is more work that needs to be done to further evaluate the selective use of organic herbicides on broccoli and onions. If sprays can be effectively directed on broccoli, organic herbicides can be safely used on this crop. More work needs to be done on onions to further evaluate the rates of organic herbicides that can be used and the stage of growth that they can be safely applied.

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Table 3. Summary of weed control, phytotoxicity, weeding time and yield of four trials on green and dry bulb onions

Treatment	Rate	Weed Control % of untreated	Phyto ¹	Weed Time Hrs/A	Yield % of untreated
		2005 Green Onion Trial No. 1			
Untreated	-----	-----	0.0	10.6	-----
Matran EC	10% v/v	66.3	0.5	4.2	-----
Matran EC	20% v/v	32.7	0.0	7.0	-----
		2005 Green Onion Trial No. 2			
Untreated	-----	0.0 ²	0.0	-----	-----
Matran EC	20% v/v @ 1 st true leaf	5.7 ²	2.3	-----	244
Matran EC	20% v/v @ 2 nd true leaf	4.0 ²	3.3	-----	262
Scythe	5.0% v/v @ 1 st true leaf	8.3 ²	4.8	-----	188
Scythe	5.0% v/v @ 2 nd true leaf	7.0 ²	3.0	-----	270
		2005 Dry Bulb Onion Trial			
Untreated	-----	-----	0.0	20.7	----
Matran EC	20% v/v	38.8	0.5	14.3	96.2
		2006 Dry Bulb Onion Trial			
Untreated	-----	-----	0.0	97.3	----
Scythe	3.0% v/v	122.8	0.0	96.9	109.4

1 – Scale: 0 = no crop damage to 10 = crop dead; 2 – Scale: 0 = no weed control to 10 = complete weed control;