Wine Grape (var. Merlot) Response to Residual Imazethapyr (Pursuit®) in Soil

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Abstract

A dose-response trial was conducted to determine residual concentrations of imazethapyr (Pursuit®) herbicide in the soil that produce injury to newly planted Merlot grapes in two Walla Walla Valley soil types. Imazethapyr treatments were applied to individual pots in logarithmic dosage intervals (0.001, 0.004, 0.016, 0.064, 0.256, 1.024 ppm) plus an untreated control. The full label use rate for Pursuit in peas is 3 oz per acre of formulated product, which equates to 0.047 ppm active ingredient in a 3 inch soil depth. The full label use rate for Pursuit in alfalfa is 6 oz per acre or 0.0937 ppm in a 3 inch soil depth. Evaluations of grape plant injury were made at approximately 30, 60, and 100 days after treatment of soils (DAT). The experiment was terminated at 100 DAT. Injury observed included chlorosis, stunting, and downward leaf curling of transplanted grape cuttings. Significant differences in grape injury were evident between soil types when plants were evaluated at 60 and 100 DAT. Visible injury to grapes was less evident on soil with a higher percentage of organic matter. Results suggest that between 0.004 and 0.016 ppm may be a sufficient soil concentration of Pursuit to injure 'Merlot' grape. Because the half-life of imazethapyr can vary between 60 to 318 days depending on soil conditions it is possible that sufficient concentrations of imazethapyr at injurious levels could remain in soil from less than 1 year after application to more than 3 years after application, depending on specific soil and climatic conditions.

Key Words: wine grapes, imazethapyr, Pursuit, herbicide, carryover, crop injury.

Introduction

Many of the sloping fields of wind-deposited, loess soils in and around the Walla Walla Valley in northeastern Oregon and southeastern Washington have historically produced dryland cereal and pulse crops. In more recent years, a significant and important wine grape industry has developed with growers purchasing land and establishing vineyards in the Valley. Herbicide use and herbicide drift have become significant issues of concern for area wheat and grape growers. An advisory task force, with representatives from both producer groups, was formed in 1999 to share information about crops; to educate producers about precise timing of herbicide applications; to produce extension bulletins (Ball et al 2004) about herbicide injury on grapes; to produce a map of vineyard locations in the valley; and to enlist private and governmental agencies to raise awareness of herbicide use in the valley.

Members of the task force and area growers have suspected that injury to newly planted grapes may be attributable to residual imazethapyr (Pursuit®), a soil active herbicide used in lentils, peas, chickpeas and alfalfa. 'Merlot' grapes, which represent a substantial portion of the cultivars grown in the appellation, display distinguishable signs of injury. Pacific Northwest wine grape growers who establish vineyards on land formerly cropped to one of the above named crops may be at risk for injury to young grape plants if herbicide use history is not considered prior to vineyard establishment. Knowledge of the soil concentration of imazethapyr at which injury occurs would allow wine grape growers to assess the potential risk and to plan for appropriate use

of the land at the time of land purchase and plan appropriate crop rotations and/or remediation strategies to reduce imazethapyr concentrations prior to establishing a new vineyard.

Studies on imazethapyr persistence and degradation conducted in the 1990's focused on comparing biotic and abiotic degradation of imazethapyr (Cantwell et al. 1989); soil characteristics influencing degradation and persistence (Goetz et al. 1990); agricultural cropping practices that influence persistence (Curran et al. 1992); and spatial variability of soil sorption of imazethapyr across fields (Oliveira et al. 1999). Imazethapyr persistence increases with increased soil organic matter, increased clay content, pH below 6.5, and lower water content (Goetz et al. 1990). Imazethapyr remains in the top 30cm of soil and does not move appreciably with surface water. Imazethapyr persists by adsorption to soil particles that is reversible when conditions change, thus potentially causing crop injury (BASF Corporation 2002). Several studies on imazethapyr persistence in soil have been done with crops such as lentils and peas (Hanson and Thill 2001), corn (Loux et al 1989; Rabaey and Harvey 1997) and soybeans (Mills and Witt 1989). The problem with imazethapyr residue injury to new grape plantings has also been reported in several mid-west States where wine grapes are planted in fields formerly in soybean production. To date there have been no reported studies on the effects of soil residual imazethapyr on grapes.

The objective of this study was to determine residual concentrations of imazethapyr in the soil that produce injury to newly planted Merlot grapes in two Walla Walla Valley soil types. A dose-response trial was conducted using grape (*Vitis vinifera* var. Merlot) plants, two Walla Walla Valley silt loam soils, and six imazethapyr soil concentrations and an untreated check. If the concentration of imazethapyr that causes injury to Merlot grapes was known, a grower should be able to take a soil sample, have it analyzed for imazethapyr, and evaluate the risk.

Materials and Methods

Soil

Two soil types from previously untreated areas were used in the study. Soil properties are summarized in Table 1. One soil (Soil A) was collected from a vineyard soil in Walla Walla County, Washington on March 3, 2004. A second soil (Soil B) was collected from a vineyard soil in Walla Walla County, Washington on March 10, 2004. Soils were air dried, sifted, and dry stored until planting time. Analysis of soils before treatment detected no imazethapyr.

Table 1. Analysis of experimental soils.

	Soil A	Soil B
Type	silt loam	silt loam
pH	7.8	7.0
Organic matter (%)	2.4	3.6
CEC (meq)	20.6	19.8
Sand (%)	33.7	23.7
Silt(%)	57.3	64.3
Clay (%)	9.0	12.0
Pursuit® (ppm)	0	0

Plants

Certified 'Merlot' grape cuttings from plants with no previous exposure to imazethapyr were obtained from King Estate Vineyards, Eugene, Oregon on March 16, 2004. Cuttings were trimmed to the same number of buds where possible. Cuttings were soaked overnight in water before planting into commercial greenhouse soil in 2 L pots for rooting on April 1, 2004. Buds below the soil surface were trimmed off before planting. Cuttings were trimmed to allow approximately 3 buds above the soil. Pots were placed in the greenhouse at 78F and high humidity. Cuttings were placed on a heating pad at 80F on April 29, 2004 and removed once top growth was observed. Cuttings were fertilized weekly with Miracle Gro® at 1 Tbsp/gal after leaves emerged. Plants were hardened off outside for a week before being transplanted into treated soils.

Herbicide

Imazethapyr treatments were applied to individual pots in logarithmic dosage intervals (0.001, 0.004, 0.016, 0.064, 0.256, 1.024 ppm) plus an untreated control. The full label use rate for Pursuit in peas is 3 oz per acre of formulated product, which equates to 0.047 ppm active ingredient in a 3 inch soil depth. The full label use rate for Pursuit in alfalfa is 6 oz per acre or 0.0937 ppm in a 3 inch soil depth. Herbicide rates were chosen to represent a log-logistic range of concentrations. Herbicide concentrations were generated by serial dilution of a stock imazethapyr solution. Imazethapyr treatments were applied June 29, 2004, in 250 ml de-ionized water added to 2,200g dry soil, in a plastic bag, and mixed to distribute imazethapyr in the soil.

Bioassay

After transplanting rooted grape cuttings into treated soil, pots were held outside in a shaded area to acclimate before being moved to the vineyard. Treated pots were buried in rows in a randomized pattern July 9, 2004 and trellised as needed. Black plastic mulch loosely covered the row under the trellis to control weeds. Plants are watered daily for 5 minutes with a drip irrigation system that delivered 0.5 gal water/hr to each pot. Percent visible injury ratings were made at 30 day intervals for 3 months after transplanting. Digital photographs were taken on a regular basis as a record of visual injury symptoms.

Results

Evaluation of crop injury and growth were made at approximately 30, 60, and 100 days after treatment of soils (DAT). The experiment was terminated at 100 DAT. Injury observed included chlorosis, stunting, and downward leaf curling of transplanted grape cuttings (Figure 1). Visible injury to grapes increased as the soil concentration of imazethapyr increased in both soil types and at all dates of injury evaluation (Table 2). There were no interactions between soil type and imazethapyr concentration, although injury to grapes was generally greater in Soil A than in Soil B (Table 3). No significant differences in grape injury were evident between soil types when plants were evaluated 30 DAT. However, when evaluated at 60 and 100 DAT, visible injury to grapes was less evident on Soil B. This soil had a considerably higher percentage of organic matter (OM) than Soil A (Table 1). It is possible that more imazethapyr was adsorbed by the OM in Soil B (2.4% OM vs. 3.6%). Greater adsorption of imazethapyr by soil OM would lead to less imazethapyr being available in soil solution, therefore less herbicide would be available for uptake by grape roots resulting in less crop injury. However, it is expected that increased binding of

imazethapyr to soil OM will also translate into a longer overall soil persistence and may result in a longer potential carryover as noted by Goetz et al. (1990).

These results suggest that between 0.004 and 0.016 ppm may be a sufficient soil concentration of Pursuit® to injure Merlot grape. The labeled rate for Pursuit in peas is 0.047 ppm, so 0.016 ppm equates to about a third of a typical field use rate, and 0.004 ppm equates to less than one tenth of a field use rate. Because the half-life of imazethapyr can vary between 60 to 318 days depending on soil conditions (Loux et al. 1989, Goetz et al. 1990) it is possible that sufficient, residual amounts of imazethapyr could exist in soil and cause injury to new grape plantings. Concentrations of imazethapyr at injurious levels could remain in soil from less than 1 year after application to more than 3 years after application, depending on specific soil and climatic conditions.

Table 2. Wine grape visible injury at 30, 60, and 90 days after transplanting (DAT) into Pursuit® treated field soils.

	Soil A			Soil B		
Treatment	30 DAT	60 DAT	100 DAT	30 DAT	60 DAT	100 DAT
--ppm--	---------- % visible injury[1] ----------					
Untreated	0 a	0 a	2 a	2 a	0 a	7 a
0.001	2 a	12 ab	28 ab	2 a	0 a	13 ab
0.004	12 ab	20 abc	37 ab	3 a	2 ab	2 a
0.016	20 b	30 bc	55 bc	12 ab	15 bc	42 bc
0.064	25 b	38 cd	48 bc	18 b	17 c	48 c
0.256	22 b	30 bc	63 bc	23 bc	32 d	62 cd
1.024	45 c	58 d	83 c	33 c	43 d	85 d
LSD (0.05)	16	21	45	13	15	34

[1] Visible injury data within individual columns followed by the same letter are not different at a 5% level of significance using Fisher's protected LSD.

Table 3. Influence of soil type on wine grape visible injury after transplanting into Pursuit treated field soils. Values averaged over all herbicide treatment rates.

Days after transplanting	Soil A	Soil B	LSD (0.05)
	---------- % visible injury----------		
30	18	13	NS
60	30	15	7
90	45	37	14

Soil A – 2.4% organic matter (OM); Soil B – 3.6% OM. NS – not different at a 5% level of significance using Fisher's protected LSD.

Figure 1. Imazethapyr injury on newly transplanted 'Merlot' grape. Note chlorosis, leaf curling, and red areas on leaf margins.

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