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Effects of Different Levels of Chemical Input on Michigan Peach Orchard Soils

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Abstract

Three different levels of chemical input and integrated pest management strategies were employed in peach orchards to determine 1) the effects on fruit production and quality, 2) pesticide residues in the fruit, and 3) soil quality and soil water quality. Soil samples were analyzed for simazine residues and soil water samples were analyzed for nitrate. Fruit quality was assessed and pesticide residues of fruit determined. There were no differences in simazine residues and the levels of nitrate in the soil water were similar for all treatments. All fruit residue levels detected were well below the U.S. Environmental Protection Agency tolerance levels for peach fruit with no treatment differences. Fruit yield was highest in the conventional orchards and similar among the moderate and low chemical input treatments. The percentage of fruit free from insect and disease damage was highest in the conventional orchards and lowest in the low chemical input.

Introduction

Synthetic chemical inputs for peach production in the North Central region of the U. S. have risen steadily since the turn of the century. It has been increasingly difficult for peach producers to control certain insects and diseases and consumers are demanding fresh fruit produced with a minimum of chemical input to the fruit and the orchard environment. With the advent of integrated pest management strategies (IPM) and new biological controls, there exist the possibility of producing fruit with reduced use of synthetic chemicals. However, these techniques require greater skill in orchard management and the production results of using these strategies exclusively even on a moderate scale in unknown. This study was initiated to compare three levels of chemical input and integrated pest management strategies for each ones ability to produce a high volume of fruit and high quality of fruit, determine if reducing synthetic chemical input into the orchards reduces the detectable pesticide residues in the fruit, and determine how the different management strategies affect soil and soil water

Experimental

Six orchards were established of 0.41 ha and the center 0.3 ha of each orchard planted with *Prunus persica* 'Newhaven' peaches in 1990. The plots were located a minimum of 200 m apart and the treatment for each plot randomly selected. Treatments applied were conventional chemical input, moderate level of chemical input and low level of chemical input. The conventional treatment consisted of production practices typical of those used by peach producers in southwest Michigan. Specifically, that treatment had preplant fumigation, clean cultivation of the soil, broadcast application of fertilizer, scheduled insecticide sprays and herbicide sprays of paraquat and simazine, and dormant pruning. Pesticide sprays were utilized according to the spray guidelines issued by Michigan State University Cooperative Extension Service (Table 1). The moderate level of chemical input included a fescue ground cover, fertilizer application through drip irrigation lines, insect scouting for spray scheduling (Table 1), application of sulphur in place of synthetic fungicide sprays, conventional herbicide sprays of simazine and paraquat ,and dormant pruning. Scouting included monitoring the presence of Oriental fruit moth, tarnished plant bug, and peach tree borers with sticky boards and traps. Once treatment thresholds were exceeded a spray was made to control populations. The low level of chemical input included an endophytic rye ground cover for tarnished plant bug control, utilization of unconventional insect controls, insect scouting for spray scheduling (Table 1), *Pseudomonas* control of nematodes, nitrogen fertilizer applied in the form of horse manure, application of sulphur in place of synthetic fungicide sprays, biological control of nematodes, straw mulch in tree rows for weed control, no synthetic fertilizer application, and summer pruning. Insect controls included pheromone disruption for control of Oriental fruit moth by placing pheromone ties in the trees and effectively saturating the orchard environment and preventing adults from finding each other and mating. The amount of horse manure applied gave the equivalent amount of nitrogen per ha as the other fertilization methods.

Table 1. Summary of pesticide applications in 1992.

	Herbicides	Insecticides	Fungicides	Sulphur
Conventional	1	7	7	0
Moderate Input	1	5	2	6
Low Input	0	1	0	2

Samples were collected each year of the soil horizons and prepared for analysis of simazine residues. Soil collected in 1991 and 1992 from the A horizon was analyzed by enzyme–linked immunoabsorbant assay (ELISA)for triazines. Additionally, soil water samples were collected from a depth of 2 m by means of suction extractors placed in each orchard. The extractors were placed in the tree row in order to sample the soil water immediately below the tree roots and the zone of nitrogen fertilizer application. These water samples were analyzed for levels of nitrate.

Pesticide residues in fruit were determined in 1992 by collecting fruit samples immediately after harvest and extracting the residues according to U.S. Environmental Protection Agency (EPA) guidelines and gas chromatography of each sample. The results include detection of any metabolites included in the EPA tolerance limits for each chemical.

Fruit yield and quality were also determined immediately after harvest. A representative sample of peaches from each orchard was examined for insect damage and the causal insect identified, and examined for the presence of specific diseases. Also, ground color of each fruit measured and size distribution determined. Cold hardiness of tissues from each orchard was also measured over the winter months.

Results

Table 2 shows the residues of triazines found in the soil A horizon and Figure 1 shows the nitrate levels at 2 m depth for each treatment. The pesticide residues in the fruit samples for 1992 are given in Table 3. Fruit yield and quality are given in Table 4.

Table 2. Triazine residues found in soil A horizon in 1992.

Treatment	ppb
Conventional	8.0
Moderate Input	22.3
Low Input	12.2

Figure 1. Nitrate levels of soil water collected from a depth of 2 m (ordinate: ppm; abscissa: months of 1991 and 1992).

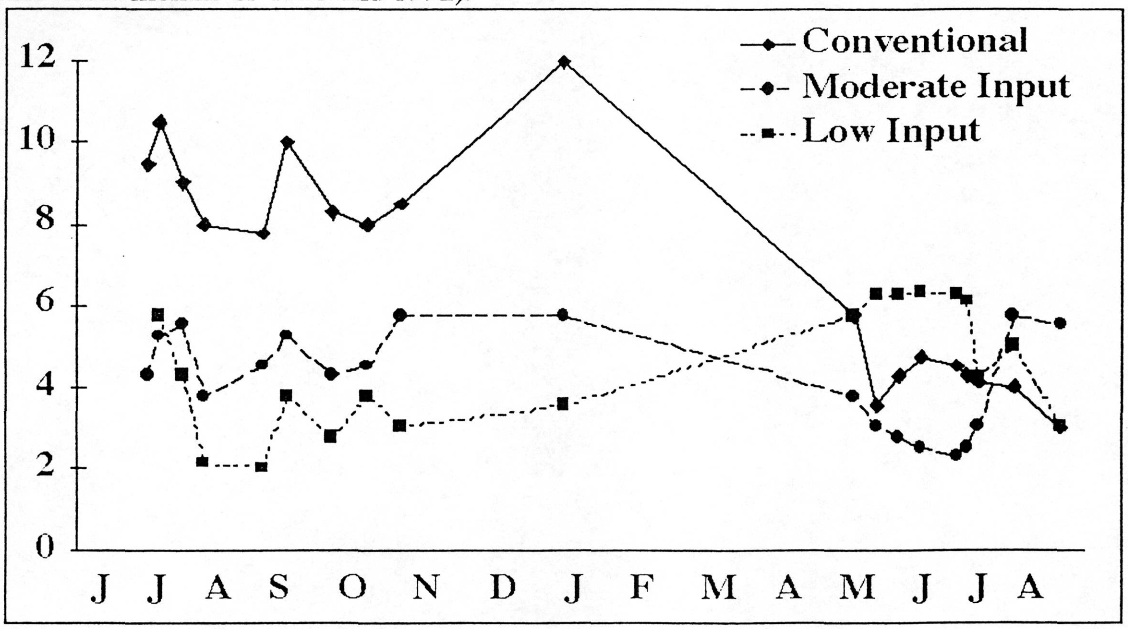

Table 3. Fruit pesticide residue levels in 1992 crop.

	Treatment Levels (ppm)		
Pesticide	Conventional	Moderate Input	Low Input
captan	<0.10	<0.10	<0.10
chlorothalonil	<0.50	<0.50	<0.50
iprodione	0.69	<0.0125	<0.0125
fenvalerate	1.160	1.086	0.995
chlorpyrifos	<0.010	<0.010	<0.010

Table 4. 1992 fruit yield and per cent of fruit free from insect and disease damage.

Treatment	Fruit Yield (kg/tree)	Per cent fruit free from insect and disease damage
Conventional	9.33	95.1
Moderate Input	5.78	87.1
Low Input	5.00	79.6

Discussion

The analysis of soil samples for the presence of triazines demonstrated that the orchards had very low levels of residual simazine and there was no statistical difference among the treatments. It is interesting to note that the low chemical input orchards exhibited some residual triazine according to the ELISA test even though no simazine was applied in to those orchards since their establishment. The 12.2 ppb may be the background level of triazine in the ELISA kit or possibly there could be residual triazines in the soil from applications made before 1989, at which time there are no records of land use. In any event, the triazine levels found were not statistically different from each other or from the blank control used in the ELISA test. Additional soil samples are being taken in 1993 and to be taken in 1994 to compare residual simazine among the treatments as well as at different soil depths.

The populations of nematodes in each of the orchards have not yet been studied but treatment comparisons should be made in the future.

Nitrate levels in soil water collected from 2 m deep in the soil were not statistically different for the treatments and were generally less than 10 ppm. The levels did not change significantly over the time period reported here and interestingly were not altered proximate to the time of nitrogen fertilization. It is apparent that none of the fertilization techniques used resulted in accumulation of excess nitrate at 2 m in 1991 and 1992. Soil water samples continue to be monitored for nitrate in 1993 and 1994.