Reduced pesticide programme for peach based on tree phenology

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A variable reduced-rate pesticide programme was compared with a full-rate pesticide programme for the control of insects and diseases on peach during a 2-year study. Rates of insecticides and fungicides in the reduced programme were 25, 50 and 100% of full recommended rates on an a.i. ha^{-1} basis at 0–30, 31–90 and >90 days after full bloom, respectively. The reduced programme provided similar control of green peach aphid, oriental fruit moth, catfacing insects, peach scab and brown rot to that of the full-rate programme, with 51% less pesticide. The reduced programme is proposed as a means to make spray deposit on the target more uniform throughout the season, while maintaining effective insect and disease control with less pesticide.

Keywords: reduced pesticide; spray programme; peach insects; peach diseases

Much research has been conducted on the application rate of pesticides for insect and disease control to improve the efficiency of fruit production and reduce environmental contamination from pesticide residues. The introduction of low-volume concentrate spraying in the 1950s allowed pesticide rates to be lowered by reducing loss from runoff of high-volume sprays (Brann and Gunkel, 1951). Maber, Holland and Steven (1984) indicated that a reduction in pesticide rates of up to 50% may be possible by applying low-volume sprays with controlled droplet atomizers. Commercial control of mites and diseases has been obtained on apple and peach with 25% of recommended pesticide rates when applied in low-volume sprays (Whan, Smith and Morgan, 1983). Wicks and Nitschke (1986) reported that reduced pesticide rates effectively controlled apple scab when applied in low-volume sprays, but that higher volumes were needed as pesticide rates were lowered for powdery mildew and codling moth control.

A tree–row–volume spraying concept was developed to standardize chemical application rates on apple trees of various sizes and spacings (Byers, Hickey and Hill, 1971; Herrera-Aquirre and Unrath, 1980). This technique has been validated for reducing pesticide rates in high density plantings of dwarf trees (Byers *et al.*, 1989).

Changes in the canopy density of fruit trees over a 4- to 5-month spraying season can result in significant differences in foliar chemical deposition when a fixed application rate is used for the season. Sutton and Unrath (1988) found that deposits on apple at tight cluster were 1.2- to 2.0-fold greater than deposits at first or fifth cover. Hogmire *et al.* (1992) reported that a 50-fold increase in peach tree growth over a 98-day spraying season resulted in a 64 and 96% reduction in dye deposit in the periphery and centre of the tree, respectively. As pesticides are typically applied at the same rates throughout the season (Virginia and West Virginia Cooperative Extension Services, 1989), which usually results in acceptable insect and disease control, there would appear to be a potential to reduce rates early in the season when the tree canopy is less dense and drift between rows can contribute to spray deposit on the trees. A regression equation has been developed for calculating a variable reduced pesticide rate for peach based on days after full bloom (Hogmire *et al.*, 1992). This spray programme, which consisted of a gradually increasing rate of methyl parathion, used ~50% less insecticide to provide control of oriental fruit moth comparable to that with a full-rate season-long programme. This paper reports on a 2-year study to evaluate a simplified variable reduced-rate pesticide programme for insect and disease control on peach.

Materials and methods

This study was conducted during 1989 and 1990 in a 0.8 ha orchard of ‘Blake’ peach, *Prunus persica* (L.), planted on 6.1 × 6.1 m centres in 1978 at the West Virginia University Experiment Farm in Kearneysville, USA. The orchard was divided, in a randomized block design, into four replications of three row by six tree/row plots for each of two spray treatments and an unsprayed control. Identical treatments were assigned to plots in both years. A full- and reduced-rate pesticide programme consisted of seven and eight applications of fungicide and insecticide combinations in 1989 and 1990, respectively (*Tables 1* and *2*). All sprays were applied with a Swanson DA500 airblast

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Table 1. Full- and reduced-rate pesticide programmes on 'Blake' peach during 1989

Date	DAFB[a]	Pesticide	Rate (kg a.i. ha^{-1}) Full	Reduced
17 April	11	Benomyl 50 DF	0.56	0.14
		Sulfur 95 W	9.58	2.40
		Methyl parathion 2 FM	0.70	0.18
		Methomyl 1.8 L	0.63	0.16
3 May	27	Sulfur 95 W	15.97	3.99
		Methyl parathion 2 FM	0.70	0.18
17 May	41	Sulfur 95 W	15.97	7.99
		Methyl parathion 2 FM	0.70	0.35
31 May	55	Sulfur 95 W	15.97	7.99
		Methyl parathion 2 FM	0.70	0.35
14 June	69	Sulfur 95 W	15.97	7.99
		Methyl parathion 2 FM	0.70	0.35
7 July	91	Benomyl 50 DF	0.56	0.56
		Sulfur 95 W	9.58	9.58
		Methyl parathion 2 FM	0.70	0.70
26 July	110	Iprodione 4 F	1.12	1.12
		Methyl parathion 2 FM	0.70	0.70
		Total pesticide	90.81	44.73

[a]DAFB, days after full bloom

Table 2. Full- and reduced-rate pesticide programmes on 'Blake' peach during 1990

Date	DAFB[a]	Pesticide	Rate (kg a.i. ha^{-1}) Full	Reduced
9 April	11	Benomyl 50 DF	0.56	0.14
		Sulfur 95 W	9.58	2.40
		Methyl parathion 2 FM	0.70	0.18
		Methomyl 1.8 L	0.63	0.16
20 April	22	Sulfur 95 W	15.97	3.99
		Methyl parathion 2 FM	0.70	0.18
7 May	39	Sulfur 95 W	15.97	7.99
		Methyl parathion 2 FM	0.70	0.35
23 May	55	Sulfur 95 W	15.97	7.99
		Methyl parathion 2 FM	0.70	0.35
7 June	70	Sulfur 95 W	15.97	7.99
		Methyl parathion 2 FM	0.70	0.35
21 June	84	Sulfur 95 W	15.97	7.99
		Methyl parathion 2 FM	0.70	0.35
10 July	103	Benomyl 50 DF	0.56	0.56
		Sulfur 95 W	9.58	9.58
		Methyl parathion 2 FM	0.70	0.70
24 July	117	Iprodione 50 W	1.12	1.12
		Methyl parathion 2 FM	0.70	0.70
		Total pesticide	107.48	53.07

[a]As in *Table 1*

sprayer calibrated to deliver 935 l ha^{-1} while travelling at 3.9 km h^{-1}. Pesticide rates (kg a.i. ha^{-1}) (see *Tables 1* and *2*) for the full-rate programme were based on recommendations contained in the 1989–1990 Spray Bulletin for Commercial Tree Fruit Growers (Virginia and West Virginia Cooperative Extension Services, 1989). In the reduced-rate programme, the percentage of recommended pesticide rates applied at various days after full bloom (DAFB) were 25% for 0–30 DAFB (two sprays), 50% for 31–90 DAFB (three or four sprays), and 100% for >90 DAFB (two sprays).

Insect and disease control data were taken from the centre tree in the middle row of each three-row plot. The numbers of green peach aphid, *Myzus persicae* (Sulzer), colonies per tree and oriental fruit moth, *Grapholita molesta* (Busck), infested shoots per tree were determined in 1989 only on 15 May and 8 August, respectively. A 100-fruit sample was harvested from each tree on 14 August 1989 and 7 August 1990 and evaluated for damage by oriental fruit moth, catfacing insects [tarnished plant bug, *Lygus lineolaris* (Palisot de Beauvois); brown stink bug, *Euschistus servus* (Say); dusky stink bug, *Euschistus tristigmus* (Say); green stink bug, *Acrosternum hilare* (Say)], peach scab, *Cladosporium carpophilum* Thum and brown rot, *Monilinia fructicola* (Wint.) Honey. The incidence of brown rot was determined at harvest and after storage at room temperature for 4 days.

Data were subjected to analysis of variance appropriate for a randomized block design and Duncan's multiple range test was used to determine differences between treatment means using PROC GLM (SAS Institute Inc., 1985).

Results and discussion

The variable reduced-rate and full-rate pesticide programmes resulted in comparable control of all insects and diseases in both 1989 and 1990 (*Table 3*) with about 51% less pesticide (*Tables 1* and *2*). Both programmes resulted in a significantly lower level of insect and disease damage than occurred in the unsprayed plots.

The incidence of green peach aphid did not differ

Table 3. Insect and disease control on 'Blake' peach with full and reduced rates of pesticides in 1989 and 1990

				Percentage fruit damage by:				
							Brown rot	
Year	Treatment	Green peach aphid (colonies per tree)	Oriental fruit moth (infested shoots per tree)	Oriental fruit moth	Catfacing insects	Peach scab	Harvest	4 days postharvest
1989	Full rate	3.3 b	1.5 b	0 b	14.8 b	0.8 b	3.2 a	6.3 b
	Reduced rate	8.5 ab	1.8 b	0.5 b	17.5 b	1.0 b	3.5 a	5.5 b
	Unsprayed	18.3 a	6.5 a	5.2 a	41.0 a	7.0 a	7.8 a	21.3 a
1990	Full rate	—	—	0 b	6.5 b	0.5 b	2.3 b	17.0 b
	Reduced rate	—	—	0.5 b	8.5 b	1.8 b	7.0 b	20.3 b
	Unsprayed	—	—	10.3 a	28.0 a	62.3 a	16.3 a	86.8 a

Means in a given column and year followed by the same letter do not differ significantly (p = 0.05; Duncan's multiple range test) significantly between the two pesticide programmes, or between the reduced-rate programme and the unsprayed treatment. Green peach aphid is typically controlled with a single pesticide application at petal fall (Virginia and West Virginia Cooperative Extension Services, 1989). In this study, green peach aphid data reflect the efficacy of the petal fall (11 DAFB) application of methomyl, as methyl parathion is not effective against this pest. The reduced-rate application of methomyl at only 25% of the full-rate programme appears to be only marginally sufficient for the control of green peach aphid. At this early stage in the season, drift from spraying the outside rows of each three-row plot would significantly increase the total pesticide deposit on the centre row (Hogmire *et al.*, 1992), from which data were taken. Without this contribution in pesticide deposit from spray drift, it is unlikely that consistent control of green peach aphid could be achieved with 25% of the recommended pesticide rate.

Oriental fruit moth data reflect the efficacy of the pesticide programmes from shuck split or shuck fall (22 or 27 DAFB) until the end of the season, as there are four generations per year in West Virginia (Virginia and West Virginia Cooperative Extension Services, 1989). The reduced-rate programme provided effective control of this insect as measured by the number of infested shoots per tree and the percentage of fruit injury. Shoot injury is caused by the first and most of the second generation, and was therefore a reflection of adequate control with 25 and 50% of the recommended rate of methyl parathion in the reduced-rate programme in 1989. Fruit injury, which is caused primarily by the third and fourth generations, was kept to a very low level in both years in a reduced-rate programme of methyl parathion at 50%, followed by 100%, of the recommended rate.

Most of the fruit injury from catfacing insects occurs during a period of 4–6 weeks beginning at shuck split (Custer, 1981), which reflects control achieved with 25 and 50% of the recommended rate of methyl parathion in the reduced-rate programme. Although there was no significant difference between full- and reduced-rate pesticide programmes in the control of catfacing insects, the percentage of fruit injury was moderate to high in both treatments. There are three explanations for this occurrence: (1) data probably included some frost damage to fruit, which could not be distinguished from catfacing insect injury (Bobb, 1973); (2) the effectiveness rating of methyl parathion against catfacing insects is only good, instead of excellent (Virginia and West Virginia Cooperative Extension Services, 1989); (3) untreated controls maintained a high population of insects, which could continuously move into sprayed plots. Frost damage is believed to be responsible for the higher percentage of fruit injury in 1989, compared with 1990, because spring temperatures were colder and resulted in reduced yields (Hogmire *et al.*, 1992).

The control of peach scab and brown rot in the reduced-rate fungicide programme did not differ significantly from the full-rate programme in either year, even though there was a ninefold and fourfold (postharvest) increase in fruit injury from these diseases, respectively, on unsprayed trees in 1990. Control of peach scab typically requires fungicide applications beginning at 10–12 days after shuck split and continuing until 40 days before harvest (Jones and Sutton, 1984). Sulfur provided excellent control of peach scab in this study, under both low and high disease pressure, at a reduced rate of 25%, followed by 50% (22–84 DAFB), of a full-rate programme. Fruit susceptibility to brown rot infection increases from 2–3 weeks before harvest through the postharvest period (Jones and Sutton, 1984). This is also the period of lowest pesticide deposit because of increased canopy density and the bending of branches from increased fruit weight, which inhibits spray penetration throughout the tree (Hogmire *et al.*, 1992). The reduced-rate programme, which maintained pesticide rates at 100% at >90 DAFB, was identical to the full-rate programme during the last two applications, resulting in no significant difference in brown rot control. Whereas the pesticide programmes maintained the incidence of peach scab at a similar level in both years, there was a three- to fourfold increase in the level of brown rot in the 1990 versus the 1989 postharvest evaluation. This is believed to be primarily the result of disease carryover from 1989 and more favourable weather conditions for infection in 1990. In 1990, 3 days of precipitation (total of 4.1 cm) at an average temperature of 21.5°C preceded fruit harvest on 7 August. By comparison, only 0.5 cm of rain at an average temperature of 17.3°C occurred during the week preceding harvest in 1989.

This study demonstrates that the total quantity of pesticide applied per season can be reduced significantly, without sacrificing insect and disease control, by basing pesticide rates on tree phenology. Our programme of gradually increasing rates from 25 to 100% of recommended, based on days after full bloom, is in contrast to most spray schedules, which recommend a given pesticide at the same rate throughout the season (e.g. Virginia and West Virginia Cooperative Extension Services, 1989). Recommended pesticide rates are typically based on evaluation of a rate series on replicated single-tree or single-row plots (Biddinger and Howitt, 1989). Hogmire *et al.* (1992) demonstrated that chemical deposit on peach trees can be significantly higher when sprays are applied to multiple rows, as practised by growers, compared with single-row research plots. This increased deposit results from spray drift, which was reported to represent as much as 39% of the total deposit from multiple-row spraying at the beginning of the season when tree growth is minimal. Because of the contribution of drift to total chemical deposit when spraying multiple rows, recommended application rates derived from single-row tests may be higher than necessary early in the season. Byers, Lyons and Donohue (1985) recommended that chemical rates for bloom thinning of peach, derived from single-row tests, be reduced by

30–40% for whole-block application in order to prevent overthinning from drift.

A variable reduced-rate pesticide programme based on tree phenology will be most effective and result in the greatest pesticide reduction for those insects and diseases, such as oriental fruit moth, catfacing insects and peach scab, where control begins early in the season and involves multiple applications as tree growth occurs. The reduced-rate programme utilizes the contribution of spray drift to produce a more uniform pesticide deposit as the tree grows, instead of excessive deposits early in the season that typify application of the same rate throughout the year (Hogmire *et al.*, 1992). This is not meant to ignore the possibility that a higher pesticide deposit, necessitating the use of a higher pesticide rate, may be required at certain times of the season in a given year under high pest pressure or environmental conditions that favour a disease epidemic. These conditions, as well as sprayer characteristics and tree parameters, are important factors that will influence the success of this variable reduced-rate pesticide programme.

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