THE EFFECTS OF HYDROGEN CYANAMIDE AND MINERAL OIL ON KIWIFRUIT PERFORMANCE

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SUMMARY

Several rates of hydrogen cyanamide, with or without 1% mineral oil, were applied to dormant kiwifruit over three seasons and the effects on plant performance determined. Hydrogen cyanamide applications significantly increased budbreak and flower numbers on vines. While hydrogen cyanamide reduced seasonal variability, large differences in flower numbers were still evident and lateral flowers were not consistently removed. Damage to buds only markedly exceeded a tolerance level of 10% in one season, where twice the recommended rate was applied to vines. Despite large increases in crop load, mean fruit size was not reduced on treated vines. Applications of hydrogen cyanamide reduced the spread of the fruit weight distribution but did not affect reject rates. Oil applications had little effect on the development or productivity of kiwifruit vines.

Keywords: budbreak, flowering, hydrogen cyanamide, kiwifruit, mineral oil

INTRODUCTION

Seasonal variability in fruit production from kiwifruit vines in the Bay of Plenty, Auckland and Northland is partly due to insufficient winter chilling. Hydrogen cyanamide has been applied to dormant vines to counter this but there have been few detailed studies of its effects, particularly in warmer northern areas. The primary action of hydrogen cyanamide is on phenological development of vines in spring, particularly increased budbreak and flowering, and greater synchrony of these events (Henzell and Briscoe 1986). Kiwifruit often produce multiple flowers (a terminal flower with one or two lateral flowers on the same peduncle) and the lateral flowers generally produce small fruit. If hydrogen cyanamide is applied at the correct rate, it reduces the number of lateral flowers, and therefore small fruit produced by vines (Henzell and Allison 1993b). Phytotoxic effects of the chemical have been associated with excessive wetting of canes and poor drying conditions (Henzell and Allison 1993a). A secondary benefit of the chemical is its toxicity to lichen and scale on dormant vines (Blank *et al.* 1991).

Mineral oils can provide a useful alternative to organophosphates for control of both greedy scale (*Hemiberlesia rapax* (Comstock)) and latania scale (*H. latania* (Signoret)) on dormant kiwifruit (Blank *et al.* 1993). However there are reservations over the phytotoxic effects of mineral oil and its effects on subsequent vine performance. Recent studies have shown that oil applied to dormant vines often damages the terminal bud of canes (Blank *et al.* 1994) and thus reduces apical dominance in a similar manner to late tipping of canes (Manson *et al.* 1990).

The objective of this study was to quantify the phenological and yield effects of several rates of hydrogen cyanamide, applied alone or in combination with mineral oil, to dormant kiwifruit in Northland.

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METHODS

The experiment was carried out over three seasons on 6-year-old kiwifruit vines at Kerikeri Research Centre. Vines were trained on a T-Bar system and managed according to standard commercial practices. In addition, supplementary spray pollination was used but fruit were not thinned in order to maintain crop loading effects of treatments.

Five rates of hydrogen cyanamide (1.04, 2.08, 3.12, 4.16 and 6.24 kg/100 litres), applied as Hicane (520 g/litre), were combined with either 0.05% Agral LN or 1% mineral oil (Shell Sunspray). An untreated control and a mineral oil only treatment were used for comparison. This gave a total of 12 treatments which were replicated on the same three, 5 x 5 m plots (one bay) each season. Treatments were applied to dormant vines using a Cambrian 5 litre pressure sprayer to lightly wet canes (about 1 litre/plot). Applications were made on the optimum recommended date (7.8.89, 9.8.90, 13.8.91) each season during calm fine weather.

Budbreak was assessed three times per week on four, 1-year-old canes per plot. After budbreak was completed, shoot types and flower numbers were assessed on the same canes. Fruit were strip picked from plots and individually weighed using a McDonalds fruit grader linked to a computer for data capture.

RESULTS

There were no significant interactions between hydrogen cyanamide and mineral oil effects on kiwifruit performance and therefore these data have been combined and main effects are presented. Hydrogen cyanamide significantly ($P<0.001$) enhanced budbreak in each season with the number of buds which developed increasing with amount of chemical applied (Table 1). However, in the first season the benefits of high chemical rates were masked by phytotoxic effects. The duration of budbreak was reduced from an average of 41 days on untreated vines to 20 days on vines treated with 4 or 6 kg/100 litres (Fig. 1a). Although mineral oil applications did not have a significant effect on total budbreak, they influenced the rate of budbreak in 1990 and 1991 (Figure 1b). In 1990, a low chill season, oil applications increased the rate of budbreak while in the following cooler winter, oil had a negative effect.

Figure 1: a. The effect of hydrogen cyanamide rates on the budbreak of kiwifruit vines in the 1990/91 season, trends in the other two seasons were similar. b. Mineral oil effects on the budbreak of kiwifruit vines over three seasons.

Phytotoxic effects of hydrogen cyanamide applications to vines were highly seasonal. In the first year large numbers of buds, and in some instances whole canes, died when high rates (4 or 6 kg/100 litres) were applied to vines (Table 1). In subsequent seasons, although hydrogen cyanamide did cause some bud death, this was compensated for by increases in budbreak and flower numbers on treated vines. Mineral oil applications to vines did not cause any phytotoxic effects.

TABLE 1: The effect of hydrogen cyanamide and oil on the development of kiwifruit buds.

Treatment	Budbreak (%)			Dead buds (% of total buds)		
Hydrogen cyanamide (kg ai/ 100 litres)	89/90	90/91	91/92	89/90	90/91	91/92
0	33	29	42	0.7	0.6	1.8
1.04	34	31	49	1.7	1.5	3.6
2.08	43	37	54	5.8	6.0	8.4
3.12	47	41	54	7.7	6.0	5.5
4.16	46	51	64	13.3	11.0	10.7
6.24	45	57	68	29.2	11.0	10.7
SED	2	5	3	4.4	1.3	2.1
Oil (%)						
0	41	39	56	12.2	5.6	5.1
1	41	43	54	7.2	5.9	6.8
SED	3	3	2	2.5	2.2	1.2

All rates of hydrogen cyanamide significantly increased the number of flowers produced on 1-year-old canes in 1990 and 1991, while in the first season only the 2 and 3 kg/100 litres rates gave a significant increase (Table 2). Increased flower numbers were due to the combined effects of higher budbreak, a greater proportion of flowering shoots and an increase in the number of flowers produced on each shoot. Hydrogen cyanamide applications also reduced the normally protracted flowering period of Northland vines from approximately 28 days to less than 10 days. In this study vines often produced significant numbers of lateral flowers (Table 2). In the first two seasons significantly more lateral flowers were thinned off vines to which 4 or 6 kg/100 litres of hydrogen cyanamide had been applied than untreated vines or those treated with lower rates. However in the final season, cyanamide applications did not reduce the excessive number of lateral flowers produced by vines. Mineral oil applications had no significant effect on the number of lateral flowers produced by vines.

TABLE 2: The effect of hydrogen cyanamide and oil on the flowering of kiwifruit vines.

Treatment	Flowers/winterbud			Lateral flowers (% of total flowers)		
Hydrogen cyanamide (kg ai/100 litres)	89/90	90/91	91/92	89/90	90/91	91/92
0	1.2	0.4	3.1	15	29	51
1.04	1.0	1.0	5.4	19	35	56
2.08	1.9	1.2	5.6	17	11	53
3.12	1.9	1.3	5.8	13	11	58
4.16	1.5	1.5	5.8	3	1	55
6.24	1.1	1.4	6.4	3	2	56
SED	0.4	0.2	0.8	2	3	2
Oil (%)						
0	1.4	1.0	5.5	9	14	54
1	1.5	1.3	5.2	15	16	56
SED	0.2	0.3	0.4	4	5	3

In the first two seasons, fruit numbers and yield increased with rate on vines treated with up to 4 kg/100 litres of hydrogen cyanamide (Table 3). A decrease in production on vines treated with the highest rate is not fully explained by phytotoxicity to buds and lateral flowers. In the final season, fruit numbers and yield, declined at the two highest rates of hydrogen cyanamide despite high flower numbers. This may be a reflection of both excessive budbreak and flower numbers produced that season and the effect of previous crop loads on these vines. Although hydrogen cyanamide had large effects on fruit numbers carried by vines, the mean fruit weight was equivalent to that on untreated vines. The spread of the fruit weight distribution (standard deviation) about the mean weight was also significantly reduced on vines to which 2 kg/100 litres or higher rates of hydrogen cyanamide were applied. This means that at any given mean fruit weight more fruit will fall in the export range on these vines. However hydrogen cyanamide applications had no effect on reject rates from vines. Mineral oil applications did not affect fruit production.

TABLE 3: The effect of hydrogen cyanamide and oil on kiwifruit production.

Treatment	Fruit number/plot			Mean fruit weight (g)			Fruit distribution standard deviation (g)		
Hydrogen cyanamide (kg ai/ 100 litres)	89/90	90/91	91/92	89/90	90/91	91/92	89/90	90/91	91/92
0	259	324	1121	123	99	80	26	31	32
1.04	293	460	1993	122	95	79	25	30	31
2.08	598	691	1832	113	94	78	21	28	28
3.12	556	865	1802	120	95	81	22	29	29
4.16	644	877	1699	118	95	81	21	28	27
6.24	294	637	1416	129	99	84	22	29	28
SED	90	97	158	3	3	2	1	2	1
Oil (%)									
0	423	652	1600	123	98	82	23	30	29
1	458	633	1561	118	95	79	22	29	29
SED	52	55	90	2	3	2	1	1	1

DISCUSSION

Application of hydrogen cyanamide to vines increased budburst and flowering of vines in each season and reduced the duration of these events. The effects of rates up to the commercial recommendation of 3 kg/100 litres were of the same magnitude as those reported by Henzell and Briscoe (1986). However, our study has shown that higher rates continued to improve budbreak and in some cases flower numbers. The thinning of lateral flowers is a reported benefit of 3 kg/100 litres applications while lower rates cyanamide to consistently remove unwanted lateral flowers and must also employ other thinning techniques. of this study the higher rates (4 and 6 kg/100 litres) removed lateral flowers more efficiently than either 2 or 3 kg/100 litres of hydrogen cyanamide. However there was no effect in the final season when vines produced excessive numbers of lateral flowers. This suggests that growers can not rely on hydrogen cyanamide to consistently remove unwanted lateral flowers and must also employ other thinning techniques. Despite large increases in fruit numbers on treated vines the mean weight of fruit was similar to that of untreated vines. This is the antithesis of crop loading models for fruit crops including kiwifruit (Richardson and McAneney 1990). Similar results with hydrogen cyanamide have been attributed to better canopy development and flower quality by Henzell *et al.* (1991). Fruit produced from inferior lateral flowers is generally small and has little commercial value.

However, in the final year of our study, consistent mean fruit weight across crop loads could not be attributed to the removal of lateral flowers and must have been due to increased photosynthetic and partitioning efficiencies. The reduced spread of the fruit size distribution, however, may be attributed to improved flower quality and synchrony of flowering.

Although applications of hydrogen cyanamide had a moderating effect, relatively modest temperature differences between seasons caused substantial variation in kiwifruit development. In the comparatively cool final year of the study the increase in flower numbers on untreated vines was twice that achieved with hydrogen cyanamide in any season. The number of lateral flowers produced on untreated vines varied between 15 and 51% over three seasons. In the Hawkes Bay vines consistently produced 25-28% of lateral flowers over three years (Cooper and Marshall 1990) while vines bore 8-24% over several seasons in the Bay of Plenty (Henzell and Allison 1993b). Such large variations in Northland may be related to excessive vigour of vines. While hydrogen cyanamide provides growers with a useful manipulative tool, a range of techniques are needed to counter such large swings in vine performance between seasons.

Phytotoxic effects of hydrogen cyanamide on kiwifruit, particularly on weak growth, have been associated with high water rates and poor drying conditions (Henzell and Briscoe 1988). In the current study the death of buds, and in some cases whole canes, occurred at high chemical rates. Particularly high losses at the 6 kg/100 litres rate in the first season may have been due to very cool temperatures following application. However, this was the only occasion when bud death markedly exceeded the acceptable level of 10% suggested by Henzell and Allison (1993a), despite the application of up to twice the commercially recommended rates of hydrogen cyanamide. The effects of dormant season applications of mineral oils on kiwifruit production is unclear. Some studies suggest no effects whilst others an increase of 10% in yield (Steven unpublished) or a decrease of 13-17% (Blank *et al.* 1994). The recommended rate of 1% used in this study had no major effect on flower or fruit production. However the small increase in flowers/winterbud and lateral fruit production due to oil application may explain how vines showing oil toxicity symptoms may show an increase in yield. Further work is required to determine if the addition of mineral oil to hydrogen cyanamide will give enhanced control of armoured scale. Mineral oil may serve as a wetting agent and enhance the spread of hydrogen cyanamide application. There may be considerable benefits in combining both operations in one application during August.

These findings suggest that in northern kiwifruit growing regions hydrogen cyanamide applications significantly improve vine performance but can not be relied upon to remove inferior lateral flowers from vines. A 1% mineral oil spray may be included with hydrogen cyanamide for scale control. A detailed cost-benefit analysis of this strategy needs to be carried out annually on each orchard, incorporating labour and chemical costs, and fruit returns.

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