RESISTANCE OF BOTRYTIS TO FUNGICIDES IN HAWKES BAY VINEYARDS

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ABSTRACT

Isolates of *Botrytis cinerea* were collected from 14 Hawkes Bay vineyards which had been previously surveyed for fungicide resistance in 1985 to determine the current effectiveness of the dicarboximide resistance management strategy recommended by the New Zealand Committee on Pesticide Resistance. In most respects the botrytis populations still responded to dicarboximide applications as previously. The major difference was that resistance levels had increased although fewer dicarboximide sprays were applied. This could be attributed, in part, a change to late season application, and, in part, to the historical use of fungicides in these vineyards.

Keywords: fungicide resistance, grapes, *Botrytis cinerea*, dicarboximides

INTRODUCTION

A large scale survey of fungicide resistance in *Botrytis cinerea* in New Zealand vineyards was conducted in 1985 (Beever *et al.* 1989). Detailed trial work from 1985-1987 in co-operation with several agrochemical companies to determine the best strategy for handling the problem of fungicide resistance in vineyards resulted in a recommendation to reduce the maximum number of dicarboximide applications from four to three per season. This was achieved by replacing an application of dicarboximide at pre-bunch closure with an application of dichlofluanid. Subsequent research indicated that where the same selection pressure was applied from year to year, on average three dicarboximide applications per season would result in a dicarboximide resistance frequency of 64%, while two applications would result in a frequency of 38% (Beever *et al.* 1991). The key to managing dicarboximide resistance within a vineyard was found to be the decline in resistance frequency at the start of the season (Pak *et al.* 1990).

In the 1994 season research determined whether the management strategies developed and implemented in 1986 were still effective and if the botrytis population within vineyards continued to respond to dicarboximide selection pressure as previously.

METHODS

Fourteen vineyards in the Hawkes Bay region were sampled early in the season (December 1993) and again at harvest (April, 1994). The vineyards were chosen because they had been included in the 1985 survey. The early season samples consisted of leaf petioles with botrytis sclerotia while the harvest samples consisted of botrytis-infected grapes. Thirty samples were collected from each property on each occasion and transferred to the laboratory for incubation and isolation of cultures. Isolates were tested for resistance to the dicarboximide fungicides vinclozolin (Ronilan) and iprodione (Rovral) and to the benzimidazole fungicide benomyl (Benlate) using the active derivative carbendazim by the methods of Beever *et al.* (1989). The sampling and testing procedures were the same as those used in the 1985 survey. Spray records for the previous 10 years were collected for each vineyard, where possible.

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RESULTS AND DISCUSSION

The proportion of botrytis isolates within the vineyards sampled which were resistant to the dicarboximide and benzimidazole fungicide groups in the early season and harvest samples of the 1994 survey were compared with the harvest sample of the 1985 survey of the same 14 vineyards (Table 1). Benzimidazole resistance had reduced only slightly between 1985 and 1994 despite these fungicides having only been used sporadically over this period. Dicarboximide resistance in the 1994 harvest samples had increased on average by 20% between 1985 and 1994, although fewer sprays had been applied. This level of resistance would have been expected from three dicarboximide applications per year (Beever *et al.* 1991). Thus, compared with 1985, fewer than three sprays had resulted in significantly higher ($P<0.025$) levels of dicarboximide resistance. In order to understand how this situation arose, the data have been examined in more detail. A scatterplot of the harvest resistance levels of 1985 and 1994 (Fig. 1) shows that the largest increases in resistance occurred in those vineyards which had relatively low resistance in 1985. In only one vineyard was there a substantial decrease in resistance over this period, and in this case no dicarboximide fungicides were applied in the 1994 season. Since dicarboximide fungicides had been used on this vineyard in the 1993 season, this indicates that resistance frequency falls substantially within a single season in the absence of selection pressure, as previously reported (Pak *et al.* 1990).

TABLE 1: Mean fungicide resistance frequencies of 14 Hawkes Bay vineyards sampled in 1985 and 1993-94. Numbers in brackets are standard errors.

Year	Early season sample		Harvest sample		Average
	Dr[1] (%)	Br[2] (%)	Dr (%)	Br (%)	usage[3]
1985	-	-	40.2 (8.2)	25.6 (3.7)	3-4[4]
1994	58.8 (5.7)	15.9 (1.9)	63.3 (5.2)	15.8 (2.3)	1.2 (0.3)

[1] frequency of dicarboximide resistant strains
[2] frequency of benzimidazole resistant strains
[3] number of dicarboximide applications per season
[4] estimated

The average dicarboximide resistance frequency in the 1994 petiole sample (59%) did not differ significantly from that in the grape sample (63%) (Table 1). This suggests that the 1993 harvest results must have been similar to the 1994 season since the 1994 petiole samples should reflect the 1993 harvest resistance frequency, as this is when the petiole infections became established (Pak *et al.* 1990). This finding is consistent with the similar level of dicarboximide usage on these properties for the last two seasons (an average of 1.6 applications in 1993 versus 1.2 applications in 1994).

The change in resistance frequency over the course of the season (ie. the difference between the early season and harvest samples) in relation to the number of dicarboximide fungicide applications in that vineyard is shown in Fig. 2. Previous studies (Pak *et al.* 1990; Beever *et al.* 1991), showed that the change in resistance frequency over a season is related to the number of dicarboximide fungicide applications. In these trials a decrease in resistance frequency of over 30% occurred in the vineyard where no dicarboximide fungicides had been used and an increase of 20-30% occurred in the four vineyards where two sprays were applied. Where only one spray had been applied a decrease of 5-30% occurred in five vineyards, but in the other four resistance increased by 10-40%. The large increase in resistance frequency in these vineyards which had received only one dicarboximide fungicide application was unexpected since previous studies showed that large increases occurred where more sprays had been applied than in the previous season (Beever *et al.* 1991).

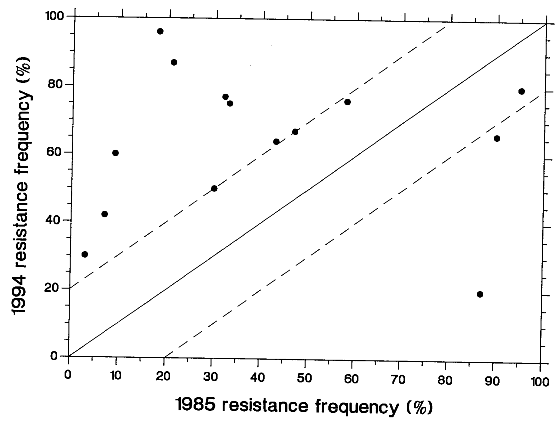

FIGURE 1: Frequency (%) of dicarboximide resistant strains in 14 vineyards sampled at harvest of 1985 and 1994. The broken lines indicate the bounds within which a point should lie if no significant change in resistance has occurred.

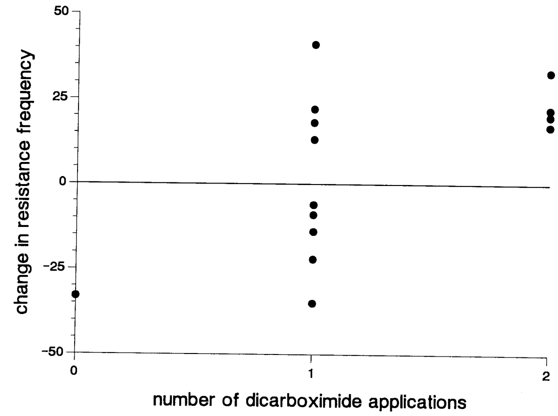

FIGURE 2: Change in frequency (%) of dicarboximide resistant strains over the 1994 season (difference between the petiole and harvest samples) in relation to the number of dicarboximide fungicide applications in the 1994 season.

This may be partially explained by the history of dicarboximide fungicide usage on these properties over the past 10 years. The relationship between the resistance frequency at the start of the 1994 season and the average dicarboximide fungicide usage over the past 10 years is shown in Fig. 3. Those vineyards which showed a large increase in resistance frequency with only one spray tended to be those with the highest historical usage of dicarboximide fungicides ($R^2 = 0.40$, $P<0.05$).

A further explanation of why fewer sprays have resulted in large increases in resistance frequency is the timing of the spray application in relation to disease progress during the season. The more rapid the rate of disease increase then the larger is the increase in fungicide resistance resulting from a given spray. Therefore, a spray

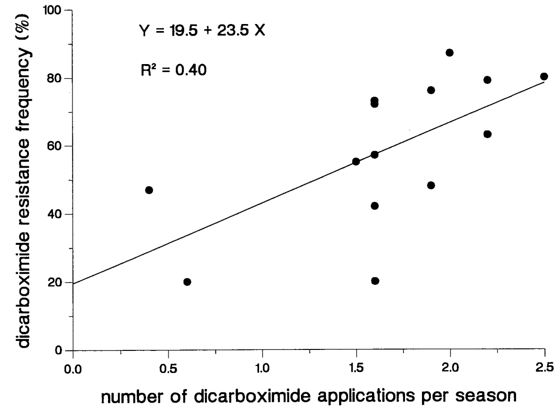

FIGURE 3: Frequency (%) of dicarboximide resistant strains on the petiole sample collected at the start of the 1994 season in relation to the long-term usage of dicarboximide fungicides over the past 10 years (average number of sprays per season).

applied early in the season, when disease increases relatively slowly, will have less of an impact on fungicide resistance levels than will a spray applied towards the end of the season when the disease is increasing more rapidly (Pak *et al.* 1990). As awareness of fungicide resistance has increased growers have tended to use fewer dicarboximide applications and reserved the use of a single dicarboximide application till late in the season. This has contributed to an increase in resistance frequency in spite of the reduced use of dicarboximide fungicides. The relative merits of early versus late fungicide applications for disease control are unclear.

In this survey there were no reports of a loss of disease control. A high fungicide resistance level at harvest does not necessarily result in a loss of disease control since the effectiveness of a single dicarboximide fungicide application is determined by the amount of resistance at the time the spray is applied and not that resulting from the spray itself. However, the results illustrate the potential for disease control problems if two or more dicarboximide fungicide applications are used late in the season in years where there is a high disease pressure.

In summary, the results indicate that, on average, fewer dicarboximide applications resulted in higher levels of dicarboximide resistance than found in previous studies. The increase in dicarboximide resistance frequency can be partially attributed to the long-term average number of dicarboximide applications per season and the change in usage pattern from mid-season to late-season applications. In most respects the dynamics of dicarboximide resistance in the botrytis population are similar to those reported in earlier studies. Most significantly, dicarboximide resistance frequency continues to decline rapidly within a single season where no dicarboximides have been applied.

REFERENCES

Beever, R.E., Laracy, E.P. and Pak, H.A., 1989. Strains of *Botrytis cinerea* resistant to dicarboximide and benzimidazole fungicides in New Zealand vineyards. *Plant Pathology 38*: 427-437

Beever, R.E., Pak, H.A. and Laracy, E.P., 1991. An hypothesis to account for the behaviour of dicarboximide-resistant strains of *Botrytis cinerea* in vineyards. *Plant Pathology 40*: 342-346

Pak, H.A., Beever, R.E. and Laracy, E.P., 1990. Population dynamics of dicarboximide resistant strains of *Botrytis cinerea* on grapevine in New Zealand. *Plant Pathology 39*: 301-309