MAJOR CAUSES OF IMPERFECTIONS IN THE BAY OF PLENTY KIWIFRUIT CROP

A.M. FERGUSON

Entomology Division, DSIR, Christchurch

Summary

The factors causing imperfections in kiwifruit (*Actinidia chinensis* var. *chinensis*) were determined and evaluated from four Bay of Plenty sites, and during four seasons. The levels of these factors varied widely from year to year, between sites and from vine to vine. Nevertheless, when insect control by spray treatments was practiced, 36% (range 14.2 to 84.1%) of fruit at harvest failed to reach a defined standard of export quality, with wind rub consistently being the major cause of imperfection. Where no insect control measures were undertaken 82% (range 65.0 to 92.7%) failed this standard. This reduction in quality was largely the result of both wind rub and insect presence and/or damage. The measures required to improve the level of perfection of harvested kiwifruit are outlined and discussed.

INTRODUCTION

Phytosanitary standards of quality for imported agricultural and horticultural produce have been promulgated by most countries. Thus exported produce must conform to these regulations and for a luxury item such as kiwifruit high standards of quality and perfection are required. A "perfect" export kiwifruit may be defined as one which is undamaged, of a standard shape and size weighing more than 60 g cv 'Hayward' or 35 g cvs 'Abbott' and 'Bruno', free of insects and fungi, and with an acceptable level of chemical residues. In some crops the proportion of imperfect fruit may be substantial, yet there are few figures published on the total amount and causes involved.

Fletcher (1974) suggested that possibly 25% of sprayed kiwifruit were non-exportable and Troy (1977) reported a 22.3% rejection rate in sprayed fruit submitted for pre-export inspection. From sprayed orchards using tee-bar training Owen (1979) suggested about 12% of fruit was of sub-export standard. However, all these figures were obtained from fruit submitted for export which had been pre-selected by the grower to exclude those with obvious imperfections.

The levels and major causes of imperfect kiwifruit at harvest, without any pre-selection, are reported in this paper.

METHOD

Four Bay of Plenty kiwifruit orchards, taken at random but excluding pergola-trained vines, were sampled during the seasons shown in Tables 1 and 2. Since previous evaluations and grower experience indicated a requirement for insecticidal applications unsprayed and sprayed vines were compared. The spray programme followed the then current MAF recommendations for insecticides (azinphos-methyl, phosmet, carbaryl) which were applied by either hand-lance, hydraulic boom, or air-blast sprayer.

Loss of, or damage to, 25 randomly taken terminal flowers and fruitlets was sampled once from each of two vines on two orchards in 1975 and 1976. At all four sites in 1976 and 1977, 50 randomly taken fruiting terminals were inspected in January and March for loss of fruit and wind and insect (lepidopterous and passion vine hopper (*Scolypopa australis*)) damage to fruit. At harvest, the entire crop was removed from two to thirty vines per site and more than 30% of the fruit examined microscopically.

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Insecticide residues were not considered in this survey but were analysed from three sites; otherwise the definition of perfection follows that outlined in the introduction. When an imperfect fruit was found the cause or causes were diagnosed and recorded.

RESULTS AND DISCUSSION

From 2 to 5% of terminal flower buds failed to open, decomposed (dry), and fell with the stalk attached. On female vines distant from males, or isolated vines, up to 10% of set flowers (fruitlets) per vine abscised at the calyx-stalk junction. This may have been due to inadequate fertilisation. J.M. Young (pers comm) investigated bacterial decay of flower buds and found infection levels of about 9% during 1979-80. Therefore, loss in fruiting potential over this period is generally unlikely to exceed 15%.

Over the growing season a few fruit occasionally disappeared from a vine, possibly due to opossums (*Trichosurus vulpecula*) and/or rats (*Rattus* sp.) as suggested by teeth patterns on fruit and observations of these animals on the vines. Although no serious loss of fruit was consistently observed, under exceptional circumstances examples of storm winds and drought showed that severe loss could occur.

The major causes, and their proportions, of imperfect fruit at harvest are shown in Tables 1 and 2. The results from four additional sites which were sampled, generally support the figures presented.

TABLE 1: Major causes of imperfection in kiwifruit (cv 'Abbott') at harvest, site 1, 1974-77, Bay of Plenty

Year	1974		1975		1976		1977	
Treatment	unsp.	spray	unsp.	spray	unsp.	spray	unsp.	spray
No. sprays	0	6	0	7	0	6	0	6
% imperfect fruit	65.0	21.6	88.3	8.4	92.7	38.3	77.6	19.3
Cause (%)*								
<i>Physical/physiological:</i>								
wind rub	**	**	**	**	21.6	15.1	14.4	14.8
dew drop	5.0	1.1	**	**	3.4	3.1	2.7	3.9
undersize	3.0	1.0	**	**	8.2	4.5	6.1	5.7
other damage	2.0	0	4.7	2.0	6.1	2.8	1.1	0.4
<i>Insects:</i>								
lepidoptera	28.0	3.9	44.5	0.3	36.9	2.9	31.6	3.3
greedy scale	46.0	2.9	77.3	1.0	68.1	1.0	56.6	3.8
mites	12.0	9.8	35.3	5.3	38.3	10.0	24.6	0.2
passion vine hopper	**	**	**	**	9.8	3.8	4.5	1.4
other insects	24.0	5.0	1.6	0.4	1.5	0.4	0.2	0

* % of total fruit. Cause columns do not sum to % imperfect fruit because of multiple injuries to individual fruit

** not assessed

The use of insecticides resulted in an almost fourfold, and significant (5% level), increase in the amount of perfect fruit averaging 19% (unsprayed) vs 78% (sprayed) (Table 1). However, the total level of imperfection varied annually in accordance with changing environmental conditions at any particular site, e.g. site 1 (Table 1) 1974 vs 1975, and 1976 vs 1977; site 2 (Table 2). Similarly, it was evident that variation between sites occurred in the same season (1975; 1976; Tables 1 and 2) due to site and probably cultivar. The application of insecticide(s) did not reduce variability and the 14 - 84% imperfection level in sprayed fruit was higher than that suggested by Fletcher (1974), Troy (1977) and Owen (1979). This was expected because in this survey the whole crop was harvested whereas the previous figures were based on selected harvesting by the grower.

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TABLE 2: Major causes of imperfection in kiwifruit at harvest from three sites, 1975-76, Bay of Plenty

Year	1975	1976		1976		1976	
Site No.	2†	2†		3††		4†	
Treatment	spray	unsp.	spray	unsp.	spray	spray	spray
No. sprays	2	0	4	0	5	8	10
% imperfect fruit	56.1	88.4	84.1	77.7	64.0	14.2	19.8
Cause (%)*							
<i>Physical/physiological:</i>							
wind rub	37.5	56.3	57.1	6.5	13.6	11.6	17.6
dew drop	2.1	25.9	25.1	2.8	3.0	1.6	0.7
undersize	5.2	12.7	9.8	+	+	+	+
other damage	6.4	10.3	13.9	25.1	28.4	1.0	2.6
<i>Insects:</i>							
lepidoptera	6.8	37.2	28.5	57.3	18.9	4.3	1.0
greedy scale	0	3.0	0	8.2	2.7	0.5	0.1
mites	0.1	10.5	1.9	17.2	1.9	2.2	0.8
passion vine hopper	+	3.8	1.0	8.9	5.6	7.0	8.4
other insects	2.4	0.2	0.2	0.4	1.5	1.2	0.7

† cv 'Hayward'

†† cv 'Bruno'

* % of total fruit. Cause columns do not sum to % imperfect fruit because of multiple injuries to individual fruit

+ not assessed

Insects and/or their damage were consistently the major component of imperfection in unsprayed fruit and, therefore, it was not surprising to find that the application of insecticide(s) reduced the level of imperfection. Hence a number of sprays, applied correctly (Bradley 1977; Barber 1979), are essential for fruit intended for export. However, on sprayed vines the total imperfection level could still be relatively great because of physical or physiological causes, such as wind rub or dew drop (Tables 1 and 2, 1976 sites 1 - 3). Physical damage did not directly increase insect damage to unsprayed fruit and fruit damaged by more than one cause was more common on unsprayed vines than sprayed vines (Tables 1 and 2).

Wind rub was the major cause of imperfection of sprayed fruit in all seasons at each orchard, except site 3, even in apparently well sheltered places. This reinforces the recommendation that kiwifruit vines must have adequate wind protection. Owen (1979) reported fewer fruit from pergola vines were rejected for export due to wind rub; thus, this training system, or an alternative such as a lowered tee bar, may be appropriate for windy areas. Damage caused by fruit contacting wire was due to, or increased by, wind and therefore the removal of redundant wires and/or selective pruning are advisable.

Dew drop, or streaking, a longitudinal scar about two-thirds the length of a fruit often terminating in a hook, is caused by a stamen becoming attached to the elongating ovary (Davison pers comm). This fault was consistently found (1 - 5%) although at site 2 the rate was 25% in 1976 possibly due to cultivar.

Undersize fruit occur when one, or a number, of factors such as temperature, light, cultivar, degree of fertilisation or plant shape are unsuitable for adequate growth. Small fruit were present at each site but varied greatly between vines (0 - 12%) possibly in response to their varying distances from a source of male pollen. On sprayed vines, small fruit were often the second-most common reason for imperfection after wind rub.

Causes responsible for a 5% or less imperfection level, or occurring infrequently, have been grouped in the Tables under the headings "other damage" (physical/physiological) and "other insects". The first category includes mechanical and bird damage, and fasciation; the second the presence of ca. 17 insect species. The

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high "other insect" figure at site 1, 1974 (Table 1), was due to an unsprayed vine with 44% of fruit infested by live and dead greenhouse thrips (*Heliothrips haemorrhoidalis*). This situation could be avoided during an export harvest by by-passing the vine and later picking the fruit for treatment by a post-harvest technique such as fumigation or dipping.

At site 3 (Table 2) the reason for the 25.1 and 28.4% "other damage" was fruit discolouration. The cause of this was unknown but may have been due to fruit exudates secreted from the skin-calyx junction.

Whether sprayed or not, fruit were damaged by lepidopteran larvae at each site in every season. Levels varied yearly (unsprayed, Table 1) and between sites (both Tables). On sprayed fruit the higher incidence in 1976 at sites 2 and 3, compared with the other sites, may indicate that the timing of applications is critical to minimise damage.

The major reasons why some kiwifruit fail to reach the defined standard of perfection have been diagnosed and assessed but the seasonal and site-specific nature of these factors indicate that other factors will be found, e.g., storage decay and over sized fruit.

CONCLUSION

It may be concluded from this survey that at least 20 - 30% of sprayed kiwifruit in the Bay of Plenty area would be rejected for export at harvest in most years. Vines sprayed with insecticide consistently provided a greater proportion of the high quality fruit required for export. A number of sprays, correctly timed and applied, are clearly essential, but management to reduce losses from wind rub and undersized fruit are also necessary.

Elimination of a 25% rejection of fruit would represent a \$10.6 million increase in overseas receipts from the current \$32 million exported yield.

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