SPRAY POLLINATION - METHOD, COSTS, AND BENEFITS

M.E. Hopping, J.A.K. Martyn

Ruakura Soil and Plant Research Station

Ministry of Agriculture and Fisheries

Hamilton

Introduction

Spray pollination can increase export yields by increasing fruit set and fruit size. We recommend that it be used initially as a supplement to normal bee pollination. With continuing development and operator confidence it has the potential to substitute for bee pollination altogether.

Bee pollination - the variable response

Bee pollination depends largely on the weather during flowering. We have run pollination trials for 7 years on a mature Te Puke orchard which is surrounded by similar orchards, all of which introduce bees. During this time we have recorded results from bee pollination and bee pollination plus hand pollination (optimum conditions). Fruit set from either bee or hand pollination was similar and generally exceeded 95% of potential flowers (Table 1). Thus some bees visited most flowers in all years. More variation was found in fruit weight with hand pollination always giving heavier fruit. Worst years were 1978, 1980, 1982 where the percentage reaching export weight averaged 31% less than hand pollination. In these years bees deposited sufficient pollen for fruit to set but not enough to produce the high seed numbers needed for export fruit.

Bee pollination is also influenced by orchard location. The MAF orchard at Rukuhia, Hamilton, is surrounded by pasture and isolated from other orchards. In 1985 competition from clover in the pasture coupled with wet weather reduced substantially bee activity in the orchard. Fruit set was reduced from 94% (hand pollination) to 75% (bees) and only 42% of bee pollinated fruit reached export weight.

At this orchard, one 0.6 ha block was bee and spray pollinated (spray pollination cost $324) and compared with an adjacent block of similar size which was bee pollinated alone. Export grade outs were more than doubled (Table 2) and the value of the additional 833 trays (net $4165) repaid the original investment in spray pollination many times over.

Spray pollination - the method

Pollen in male flowers that open before bees are introduced at 20-30% Hayward flowering is lost to the orchard environment and plays little to no part in pollination of the crop. The pollination package developed by MAF and licensed to Turners and Growers Ltd, Auckland, is designed to collect this wasted pollen resource and then to apply it back at a later date during Hayward flowering. There are three simple operations involved.

1. Flower collection, pollen extraction

Male flowers that are just opening are hand-harvested each day. Collected flowers are then passed through a mill which removes the pollen-laden anthers. The anthers are dried in a forced-draught drier overnight to release the pollen. Pollen is collected by simply vacuuming the dry anthers through a cyclone separator. At this stage the dry pollen should be stored in a deep freeze until the day of spraying.

2. Pollen-spray medium

Pollen must be suspended in a special medium, PollenAid, otherwise it will lose viability during spraying. PollenAid concentrate is diluted with deionised water in 200 litre lots prior to spraying.

3. Pollen spraying

Pre-weighed pollen from the deep freeze is mixed with PollenAid in a motorised mixing tank and then applied with small hand-held pressure sprayers to open Hayward flowers.

Important points

* collect male flower buds that are just about to open (maximum pollen)
* don't collect flowers in the rain
* ensure that anthers are dry before pollen extraction
* use deionised water for PollenAid
* count the number of flowers on some Hayward vines
* apply 4-5 g pollen/1200 flowers
* spray at 80-100 flowers/minute.

Spray pollination - benefits

There are four general areas where spray pollination can benefit orchard profitability:

* pollen deposition can be maximised and hence high seed numbers and large fruit can be obtained
* pollen sprays can be applied to wet flowers or during windy raining conditions
* pollen can be stored for up to 2 years and used as and when required
* spray pollination can substitute for bees (Hopping and Martyn 1986).

Spray pollination - costs

The larger of the two pollination packages offered by Turners and Growers is designed for 10 canopy ha (Tomsett 1986). We have taken the costs of this package and imposed a flower picking rate of 1.5 kg/hr (our minimum rate), 350 Hayward vines/ha (male ratio 1:7) and have calculated what it would cost to spray pollinate a mature vine carrying 1200 flowers (Table 3). The cost for pergolas would be $7.34/vine and for T-bars $9.39/vine. The additional cost for T-bars is due to the extra time taken by people to spray the lower flowers at the end of canes. For the 1985/86 season it is reasonable to expect a $5.00 net/tray return for export fruit. Thus an additional 1.5 trays from pergola vines or 2.0 trays from T-bar vines would cover the costs associated with spray pollination.

Spray pollination - does it pay

MAF trials

Most orchards have one or more problem areas where poor pollination occurs regularly. These areas are often adjacent to shelter, in gullies, or in windy exposed areas. Spray pollination in these locations can markedly increase yields. In 2 trials at Te Puke in problem areas on mature pergola orchards spray pollination increased export yields at one site from 25.6 packed trays/vine to 33.8 trays/vine and at the other site from 0.19 to 0.39 bins/3 vines (Hopping and Jerram 1980).

It is, however, more pertinent to consider what would occur if spray pollination were to be done in a year when bee pollination was exceptional. Would a grower return an additional profit? In 1983/84 we spray pollinated mature pergola vines at Te Puke under conditions when bees set 90% of the flowers and only 6% of the fruit failed to reach export weight (Table 4). In this year, spray pollination set a further 6% of the flowers and all fruit reached export weight. As a consequence, overall yield was increased by 16%. Within this yield increase from spray pollination, 85% of all fruit reached 30-36 tray sizes compared with

57% from bee pollination. Clearly, spray pollination can return a profit even in a year of exceptional bee pollination.

Grower trials

Last year MAF assembled 6 pollination packages which were trialed by growers at Kerikeri, Waikato/Coromandel, Katikati, Opotiki, Gisborne, and Hawkes Bay. We provided instruction on spray pollination and monitored the results but took no actual part in pollen collection or pollen spraying. From this exercise, we and the growers discovered a number of problems which have been corrected in the subsequent commercial package sold by Turners and Growers. However, the results are of value to show what can be accomplished by growers on their own orchards.

Of the 19 growers involved 3 increased their yields by more than 30%, 3 by 20-30%, 3 by 10-20% and 10 either had no response or their response was less than 10% yield increase. For the present package costings, an 11% increase is the break-even point. Thus 9 growers received a profitable return and 10 did not. For one older pergola orchard in Hawkes Bay, yield was increased from 8.5 packed trays/vine (bees) to 19.5 trays/vine (bees + spray pollination) (Table 5). This increase was achieved through increased fruit set and increased fruit size.

The major problems experienced by growers in 1985 were:

* insufficient pollen applied. Of the 19 growers, 13 applied less than 2.5 g pollen/vine (compared with 4.2-5.4 g now recommended). Only one grower applied enough (6 g pollen/vine) and he obtained a yield increase of 31%. It is important that growers count flower numbers on at least 3 vines to know how much pollen to apply.

* variable pollen quality. In general, growers collected pollen from their own males. Some growers, however, used quality pollen from M series males and all of these growers increased their yields by more than 20%.

* excessive crop loads. Some growers carried more than 1800 fruit/vine, even after thinning. If crop loads are excessive no amount of spray pollination will correct the problem. Adjustment of high crop loads by thinning is spray pollination money wasted.

The average orchard

In the Bay of Plenty the 4 year average production from 14 monitored orchards was 6,500 trays/net canopy ha (400 vines). This represents 16.25 trays/vine. From our data and from the responses obtained by those who applied sufficient pollen in 1985 we suggest that spray pollination should increase export yields by at least 25%, or 4 trays/vine. For the costings given in Table 3 and at $5.00 net/tray, spray pollination should increase returns by at least $12 per vine for pergolas and $10 per vine for T-bars.

Spray pollination - future

We are actively seeking new spraying techniques which will improve pollen deposition. We have been involved with the development of hand-held air shear nozzles (ex USA) which substantially reduce the amount of pollen needed to obtain a full crop. In trials comparing Cambrian pressure sprayers with air shear sprayers, the air shear sprayer has given equivalent results in fruit set, fruit weight and export weight fruit but at less than half the pollen rate (table 6). Continued work in this area will further improve the economics of spray pollination through reducing the amount of pollen needed.

Summary

* Spray pollination can increase export yields through increased fruit set and heavier fruit at harvest.

* At least 4.2 g pollen must be applied per 1200 flowers to deposit enough pollen on the flower.

* Costs of spray pollination can be recouped by an additional 1.5 trays (pergola) or 2.0 trays (T-bar).

* In most years spray pollination should increase yields by at least 4 trays/vine.

References

Hopping, M.E.; Jerram, E.M. 1980. Supplementary pollination of tree fruits. II. Field trials on kiwifruit and Japanese plums. NZ Journal of Agricultural Research 23: 517-521.

Hopping, M.E.; Martyn, J.A.K. 1986. Spray pollination of kiwifruit, in NZKA National Research Conference Proceedings, Rotorua, July 8 1986 pp.6-8.

Tomsett, M. 1986. Model shows spray pollination profitable. NZ Kiwifruit, August: 22.

Table 1. Fruit set and percentage of fruit that exceeded 72 g from trial sites in a mature orchard at Te Puke over the years 1978-1984. Bee hives, 6-8/ha.

	Fruit set (%)		Export weight fruit	
	Average	**Range**	**Average**	**Range**
Bees	95	85-100	74	57-96
Bees + hand pollination	96	92-100	92	82-100

Table 2. Grade out of export and reject fruit from 2 adjacent blocks of 3 year old kiwifruit following bee pollination (5 hives/ha) or bees plus spray pollination.

Yield	Bees	Bees + spray pollination
Export (trays)	376	1209
Process, smalls (kg)	3081 *	1776
Export grade out (%)	30	71

* Estimated further 300 kg not picked.

Table 3. Cost of spray pollinating mature pergola or T-bar vines with the package of equipment offered by Turners and Growers Ltd, Auckland, and designed for 10 canopy ha.

	Annual cost ($)	
	Pergola	**T-bar**
Pollen ($1.17/g)	4.91	6.31
PollenAid, pollen spraying	2.43	3.08
TOTAL	7.34	9.39

Conditions: flower harvest, 1.5 kg/hr; labour, $6.00/hr; interest on working capital, 25%; 1200 flowers per Hayward vine; 2 sprays/yr; costs as per Tomsett (1986).

Table 4. Fruit set, reject fruit and export weight fruit following pollination by bees or with bees plus hand or spray pollination (4.75 g pollen/vine).

Mature orchard - Te Puke

1983/84 Season	Fruit set (%)	Reject fruit by weight (%)	Export weight fruit (Trays/1000 fruit)
Bees	90	6	27.4
Bees + hand pollination	96	3	28.7
Bees + spray pollination	96	0	30.2
% Gain (spray pollination)	6		10

Table 5. Fruit number, reject fruit and export trays/vine from a mature orchard in Hawkes Bay following bee pollination or bees + spray pollination (1985).

	Total fruit/ vine	Undersize fruit/vine	Trays/ vine
Bees	1066	501	8.5
Bees + spray pollination	1329	326	19.5

Table 6. Fruit set, average fruit weight, and percentage fruit that exceeded 70- g in weight following bee pollination or spray pollination with Cambrian pressure sprayers or air-shear sprayers*.

	Pollen/ 1000 flower(g)	Fruit set(%)	Fruit weight(g)	Export weight fruit(%)
Bees	-	75	67	42
Bees + Cambrian	4.4	95	109	98
Bees + air shear	1.7	97	108	98

* ex Shepperton Consolidated, Taupo.