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Use of Simple Sequence Repeats (SSR) to Determine Incidence and Effectiveness of Self- and Cross-pollinated Avocado Fruit in Southern California

Continuing Project: Year 2 of 3

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Benefits to the Industry

SSR technology is a powerful tool to determine the pollen parents of avocado progeny of known maternal genetic background. The four SSR markers we have selected for use to determine pollen parents are powerfully informative for the range of cross pollinizing cultivars available in the selected orchards and, therefore, highly capable of discerning the specific pollen parent of each sampled fruit. The cultivars included in the study are Bacon, Ettinger, Fuerte, Harvest, Hass, Lamb Hass, Marvel, Nobel, SirPrize and Zutano. This, coupled with the opportunity to sample fruits in replicated experimental plots comparing cross- and self-pollinations in trees located various distances from pollinizing cultivars, and comparing retention of cross- vs. self-pollinated fruit over the development season makes this endeavor one of the most comprehensive ever preformed on avocado. As a result of this three-year suite of studies, avocado growers and advisors will, for the first time, unequivocally know the impact of interplanting complimentary cultivars, and how these ultimately influence the crop.

Objectives

The primary objective of this research is to determine the pollen parent of each fruit sampled early in fruit development and in those sampled late in fruit development at maturity. Secondarily with this knowledge applied to the population of fruits sampled from trees in experimental plots described below, the objectives include:

1. Estimate the proportions of successful self-pollinations with ‘Hass’ and cross-pollinations with specific cultivars that occurred in the individual rows of varying proximity to cross-pollinizing cultivars.
2. Determine if the proportion of outcrossed fruit increases during maturity due to preferential abscission of self-pollinated fruit as has been found for certain pollen parents of ‘Hass’.
3. Determine if there is preferential retention of cross-pollinated fruit pollinated by a specific cultivar during maturation.

Summary

In September of 2004, we had begun SSR analysis of the embryos in marble-sized 'Hass' fruits that were harvested at the Debusschere orchard located on the coastal plain near Camarillo in Ventura County on June 13, 2004. Approximately 25 marble-sized fruits were sampled evenly down six trees of interplanted rows and eight trees of 'Hass' rows consisting of ten trees in 48 rows across a block of trees interplanted every six rows with the cultivars listed above and nearby Lamb Hass (Fig. 1). The results of a portion of those samples in which analyses were completed were published in the *2004 California Avocado Research Symposium*. Details of the experimental and analytical protocols along with supporting literature were included therein. Collection of near-mature 'Hass' fruit was made on November 1, 2004. About 35 fruit were harvested per row. The early-season fruit samples represent the first of two samplings from the 2004 flowering season. SSR analysis of the approximately 1,000 embryos in these marble-sized, early-season fruit has now been completed, and we have proceeded on to analysis of these same 2004 fruit harvested near-maturity on November 1, 2004. Of the approximately 1,700 near-mature fruit sampled, we have analyzed more than 600.

Results and Discussion

Results of genetic analyses of the embryos from marble sized fruit sampled on June 13, 2004 from test plots B2 and A2 at Debusschere orchard are presented in Tables 1a (western half of orchard plot) and 1b (eastern half). The tables report the results of individual fruits sampled from eight trees down each solid 'Hass' row and six trees down each row interplanted with pollinizer trees. These rows consisted of ten trees in the north plot and ten trees in the south plot designated N and S in the row columns of Tables 1a and 1b.

Cross-pollination was greater than 50% only in "Hass' trees interplanted with 'Ettinger' and 'Fuerte' but substantially less than 50% cross pollination in trees interplanted with the other pollinizers. The extent of cross-pollination in adjacent rows was generally lower to non-existent compared to the pollinizer rows. On average, cross-pollination by any pollinizing cultivar was 6% or less. Over 70% of the fruit were self-pollinated. This is far greater than the proportion of self-pollination (about 30%) observed in near-mature fruit harvested in the previous year, 2003.

The proportions of self-pollinated fruit were greater in the near-mature fruit harvested on November 1, 2004 (Table 2a – western half and Table 2b – eastern half of orchard) than those sampled at the marble-sized stage of development. This result, however, must be viewed as preliminary until all of the near-mature fruit samples have been analyzed. These high levels of self pollination displayed throughout the orchard give us the greatest opportunity to test the hypothesis that cross-pollinated fruit are retained to maturity in preference to self-pollinated fruit. The results thus far obtained, however, do not support the hypothesis.

Proportions of fruit pollinated by each cultivar within each row at marble size were compared to the proportions of self- or cross-pollinations in fruit harvested from the same trees at near-maturity. The retention rate within each row observed in fruit pollinated by each cultivar was, thus, calculated between young fruit harvested at marble size (Y04) and near-mature fruit (M04) derived from flowers pollinated in spring of 2004 (Table 3). The formula to calculate the retention rate = % of M04 - % of Y04. A positive number indicates increased retention of fruit derived from a particular pollinizer, and a negative number indicates a decrease in retention of fruit pollinated by the indicated cultivar by the indicated amount. Zero indicates no change in fruit retention during development. Overall, we have observed about a 10% increase in proportion of self-pollinated fruit and a concomitant decrease in retained fruit derived from cross-pollination (Table 3). There was, thus, greater loss of fruit derived from pollination by each pollinizing cultivar than by those that were self-pollinated. Even those fruit pollinated by 'Ettinger' appeared to be less retentive than the selfed fruit and no better than the other cultivars that are involved in the study.

Conclusion

The proportion of self-pollination vs. cross-pollination is probably predominantly influenced by cool temperature conditions to which the trees are exposed from year to year. Self-pollination appears to be the dominant mode of pollination, and these preliminary results indicate that trees benefit from it, perhaps in preference over cross-pollination.

Acknowledgements

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Figure 1. Layout of Debusschere orchard plots B2 (north half) and A2 (south half). Orchard is bordered by tall windbreak rows of Poplar to the west and Eucalyptus to the east. 'Hass' (X) trees are interplanted with 'Ettinger' (ET), 'Nobel' (BL-567) (67), 'Fuerte' (F), and 'Zutano' (Z) in the indicated rows of the north half of the orchard. 'Hass' (X) trees are interplanted with 'Marvel' (BL-516) (16), 'Harvest' (HV), 'Bacon' (B), and 'SirPrize' (SP) in the indicated rows of the south half of the orchard. 'Lamb Hass' is interplanted with 'Hass' in rows 29, 35, 41, and 47 in the adjacent section immediately south of the displayed plotted section. 'Hass' fruit samples were collected evenly down rows among six trees in the interplanted rows and eight trees in 'Hass' rows.

												NORTH ROW													
26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	TREE
	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	1
W			ET						67						F						Z				
	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	2
I			ET						67						F						Z				
	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	xc	xc	x	x	x	x	x	x	3
N			ET						67						F						Z				
	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	xo	xo	x	x	x	x	x	x	4
D			ET						67						F						Z				
	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	5 B2
B			ET						67						F						Z				
	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	6
R			ET						67						F						Z				
	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	xc	xc	x	x	x	x	x	x	7
E			ET						67						F						Z				
	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	xo	xo	x	x	x	x	x	x	8
A			ET						67						F						Z				
	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	9
K			ET						67						F						Z				
	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	10
			ET						67						F						Z				TREE
	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	11
W			16						HV						B						SP				
	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	12
I			16						HV						B						SP				
	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	13
N			16						HV						B						SP				
	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	14
D			16						HV						B						SP				
	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	15 A2
B			16						HV						B						SP				
	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	16
R			16						HV						B						SP				
	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	17
E			16						HV						B						SP				
	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	18
A			16						HV						B						SP				
	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	19
K			16						HV						B						SP				
	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	20
			16						HV						B						SP				
26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	

Table 1a. Numbers and proportions of marble sized 'Hass' fruit harvested on June 13, 2004 that were pollinated by all potential pollen donors in the western half of the Debusschere orchard plot. Table representing the eastern half of the plot is shown in Table 1b.

Pollinizer					Ettinger												Nobel							
Row	27N		28N		29N		30N		31N		32N		33N		34N		35N		36N		37N		38N	
Fruits	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%
Total	23	100	21	100	23	100	16	100	21	100	23	100	21	100	24	100	24	100	23	100	25	100	23	100
Zutano	1	4.3	0	0	0	0	1	6.3	0	0.0	1	4.3	0	0.0	1	4.2	0	0.0	1	4.3	1	4.0	1	4.3
Hass	18	78.3	10	48	1	4	10	62.5	14	66.7	15	65.2	11	52.4	17	70.8	15	62.5	9	39.1	13	52.0	13	56.5
Fuerte	0	0.0	0	0	0	0	0	0.0	1	4.8	0	0.0	1	4.8	3	12.5	1	4.2	2	8.7	2	8.0	2	8.7
Ettinger	1	4.3	10	48	20	87	3	18.8	1	4.8	2	8.7	0	0.0	1	4.2	2	8.3	0	0.0	2	8.0	0	0.0
Bacon	1	4.3	0	0	0	0	0	0.0	1	4.8	0	0.0	2	9.5	1	4.2	0	0.0	0	0.0	0	0.0	0	0.0
SirPrize	0	0.0	0	0	0	0	1	6.3	0	0.0	1	4.3	0	0.0	1	4.2	2	8.3	2	8.7	2	8.0	3	13.0
Marvel	0	0.0	1	5	0	0	0	0.0	0	0.0	3	13.0	1	4.8	0	0.0	0	0.0	1	4.3	3	12.0	1	4.3
Harvest	0	0.0	0	0	1	4	0	0.0	4	19.0	1	4.3	2	9.5	0	0.0	1	4.2	0	0.0	2	8.0	1	4.3
Nobel	0	0.0	0	0	1	4	1	6.3	0	0.0	0	0.0	0	0.0	0	0.0	1	4.2	6	26.1	0	0.0	0	0.0
LambHass	2	8.7	0	0	0	0	0	0.0	0	0.0	0	0.0	4	19.0	0	0.0	2	8.3	2	8.7	0	0.0	2	8.7

Pollinizer					Marvel												Harvest							
Row	27S		28S		29S		30S		31S		32S		33S		34S		35S		36S		37S		38S	
Fruits	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%
Total	18	100	20	100	19	100	15	100	22	100	22	100	24	100	23	100	20	100	20	100	25	100	23	100
Zutano	0	0.0	0	0.0	0	0.0	4	26.7	1	4.5	1	4.5	1	4	1	4.3	0	0.0	3	15.0	0	0.0	0	0.0
Hass	9	39.1	11	50.0	8	36.4	8	53.3	19	86.4	20	90.9	20	83	17	73.9	13	65.0	15	75.0	25	100.0	23	100.0
Fuerte	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Ettinger	1	4.3	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	4	2	8.7	1	5.0	0	0.0	0	0.0	0	0.0
Bacon	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
SirPrize	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Marvel	6	26.1	5	22.7	7	31.8	0	0.0	0	0.0	1	4.5	0	0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Harvest	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0	0	0.0	5	25.0	2	10.0	0	0.0	0	0.0
Nobel	2	8.7	2	9.1	4	18.2	0	0.0	0	0.0	0	0.0	2	8	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
LambHass	0	0.0	2	9.1	0	0.0	3	20.0	2	9.1	0	0.0		0	3	13.0	1	5.0	0	0.0	0	0.0	0	0.0

Table 1b. Numbers and proportions of marble sized 'Hass' fruit harvested on June 13, 2004 that were pollinated by all potential pollen donors in the eastern half of the Debusschere orchard plot. Table representing the western half of the plot is shown in Table 1a.

				Fuerte												Zutano						North		
39N		40N		41N		42N		43N		44N		45N		46N		47N		48N		49N		50N		Total		
#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	Fruits
24	100	25	100	21	100	24	100	22	100	23	100	25	100	22	100	15	100	19	100	16	100	9	100	512	100	Total
2	8.3	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	4.0	4	18.2	5	33.3	2	10.5	0	0.0	0	0.0	22	5.6	Zutano
16	66.7	8	32.0	3	14.3	16	66.7	15	68.2	16	69.6	17	68.0	13	59.1	7	46.7	13	68.4	13	81.3	4	44.4	287	73.4	Hass
1	4.2	9	36.0	12	57.1	2	8.3	2	9.1	5	21.7	1	4.0	0	0.0	0	0.0	0	0.0	1	6.3	0	0.0	45	11.5	Fuerte
0	0.0	1	4.0	0	0.0	1	4.2	0	0.0	1	4.3	5	20.0	3	13.6	1	6.7	3	15.8	0	0.0	0	0.0	58	14.8	Ettinger
0	0.0	2	8.0	1	4.8	1	4.2	1	4.5	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	10	2.6	Bacon
1	4.2	0	0.0	0	0.0	0	0.0	2	9.1	0	0.0	0	0.0	1	4.5	0	0.0	0	0.0	0	0.0	0	0.0	16	4.1	SirPrize
0	0.0	0	0.0	0	0.0	1	4.2	0	0.0	1	4.3	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	11	2.8	Marvel
2	8.3	1	4.0	1	4.8	2	8.3	2	9.1	0	0.0	1	4.0	1	4.5	0	0.0	0	0.0	1	6.3	0	0.0	22	5.6	Harvest
0	0.0	0	0.0	1	4.8	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	9	2.3	Nobel
2	8.3	4	16.0	3	14.3	1	4.2	0	0.0	0	0.0	0	0.0	0	0.0	2	13.3	1	5.3	1	6.3	5	55.6	32	8.2	L.Hass

				Bacon												SirPrize						South		
39S		40S		41S		42S		43S		44S		45S		46S		47S		48S		49S		50S		Total		
#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	Fruits
23	100	22	100	23	100	23	100	23	100	18	100	25	100	21	100	18	100	23	100	20	100	23	100	489	100	Total
1	4.3	2	9.1	2	8.7	1	4.3	0	0.0	0	0.0	1	4.0	2	9.5	4	22.2	1	4.3	1	5.0	1	4.3	26	6.1	Zutano
15	65.2	17	77.3	15	65.2	13	56.5	17	73.9	16	88.9	7	28.0	3	14.3	4	22.2	10	43.5	11	55.0	19	82.6	315	74.3	Hass
0	0.0	0	0.0	0	0.0	0	0.0	1	4.4	0	0.0	0	0.0	6	28.6	0	0.0	5	21.7	1	5.0	0	0.0	13	3.1	Fuerte
0	0.0	0	0.0	0	0.0	2	8.7	3	13.0	1	5.6	2	8.0	1	4.8	2	11.1	0	0.0	2	10.0	1	4.3	18	4.2	Ettinger
1	4.3	0	0.0	3	13.0	0	0.0	0	0.0	0	0.0	7	28.0	0	0.0	2	11.1	2	8.7	0	0.0	2	8.7	17	4.0	Bacon
0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	6	24.0	6	28.6	6	33.3	5	21.7	3	15.0	0	0.0	26	6.1	SirPrize
0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	19	4.5	Marvel
1	4.3	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	4.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	9	2.1	Harvest
0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	8	1.9	Nobel
5	21.7	3	13.6	3	13.0	7	30.4	2	8.7	1	5.6	1	4.0	3	14.3	0	0.0	0	0.0	2	10.0	0	0.0	38	9.0	L.Hass

Table 2a. Numbers and proportions of near-mature 'Hass' fruit harvested on November 1, 2004 that were pollinated by all potential pollen donors in the western half of the Debusschere orchard plot. Table representing the eastern half of the plot is shown in Table 2b.

Pollinizer					Ettinger												Nobel							
Row	27N		28N		29N		30N		31N		32N		33N		34N		35N		36N		37N		38N	
Fruits	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%
Total	0																							
Zutano	0																							
Hass	0																							
Fuerte	0																							
Ettinger	0																							
Bacon	0																							
SirPrize	0																							
Marvel	0																							
Harvest	0																							
Nobel	0																							
LambHass	0																							

Pollinizer					Marvel												Harvest							
Row	27S		28S		29S		30S		31S		32S		33S		34S		35S		36S		37S		38S	
Fruits	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%
Total	31	100	31	100	30	100	31	100	31	100	31	100	31	100	29	100	31	100	25	100	28	100	31	100
Zutano	2	6	0	0	0	0	0	0	0	0	1	3	1	3	1	3	0	0	0	0	1	4	0	0
Hass	21	68	15	48	16	53	23	74	30	97	27	87	26	84	25	86	19	61	24	96	25	89	28	90
Fuerte	0	0	2	6	0	0	0	0	1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ettinger	0	0	1	3	0	0	1	3	0	0	0	0	1	3	1	3	0	0	0	0	0	0	1	3
Bacon	0	0	0	0	0	0	2	6	0	0	1	3	0	0	0	0	0	0	0	0	1	4	0	0
SirPrize	0	0	2	6	0	0	1	3	0	0	1	3	1	3	0	0	1	3	1	4	1	4	2	6
Marvel	8	26	9	29	11	37	4	13	0	0	1	3	0	0	0	0	0	0	0	0	0	0	0	0
Harvest	0	0	0	0	1	3	0	0	0	0	0	0	0	0	1	3	10	32	0.0	0	0	0	0	0
Nobel	0	0	2	6	0	0	0	0	0	0	0	0	0	0	1	3	1	3	0	0	0	0	0	0
LambHass	0		0	0	2	7	0	0	0	0	0	0	2	6	0	0	0	0	0	0	0	0	0	0

Table 2b. Numbers and proportions of near-mature ‘Hass’ fruit harvested on November 1, 2004 that were pollinated by all potential pollen donors in the eastern half of the Debusschere orchard plot. Table representing the western half of the plot is shown in Table 2a.

				Fuerte										Zutano						North		
39N		40N		41N		42N		43N		44N		45N		46N		47N		48N		49N		50N		Total		
#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	Fruits
																										Total
																										Zutano
																										Hass
																										Fuerte
																										Ettinger
																										Bacon
																										SirPrize
																										Marvel
																										Harvest
																										Nobel
																										L.Hass

				Bacon										SirPrize						South		
39S		40S		41S		42S		43S		44S		45S		46S		47S		48S		49S		50S		Total		
#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	Fruits
30	100	29	100	30	100	30	100	30	100																	Total
1	3	2	7	0	0	0	0	3	10																	Zutano
23	77	20	69	18	60	27	90	27	90																	Hass
3	10	1	3	2	7	0	0	0	0																	Fuerte
0	0	0	0	0	0	2	7	0	0																	Ettinger
1	3	1	3	4	13	0	0	0	0																	Bacon
0	0	2	7	2	7	1	3	0	0																	SirPrize
0	0	0	0	0	0	0	0	0	0																	Marvel
2	7	0	0	0	0	0	0	0	0																	Harvest
0	0	2	7	0	0	0	0	0	0																	Nobel
0	0	1	3	4	13	0	0	0	0																	L.Hass

Table 3. Comparison of percentage pollination within each row by each cultivar between young fruit (Y04) harvested at marble size and near-mature fruit (M04) derived from flowers pollinated in spring of 2004. The formula to calculate the Retention rate = % of M04 - % of Y04. A positive number indicates increased retention, and a negative number indicates a decrease in retention of fruit pollinated by the indicated cultivar by the indicated amount. Zero indicates no change in fruit retention during development.

Pollinizer							Marvel											
Row	27S			28S			29S			30S			31S			32S		
Stage*	M04	Y04	%-%	M04	Y04	%-%	M04	Y04	%-%	M04	Y04	%-%	M04	Y04	%-%	M04	Y04	%-%
Total	31	18	0.0	31	23	0.0	30	19	0.0	31	16	0.0	31	20	0.0	31	22	0.0
Zutano	2	0	6.5	0	0	0.0	0	0	0.0	0	5	-31.3	0	1	-5.0	1	1	-1.3
Hass	21	9	17.7	15	11	0.6	16	8	11.2	23	4	49.2	30	14	26.8	27	20	-3.8
Fuerte	0	0	0.0	2	0	6.5	0	0	0.0	0	0	0.0	1	0	3.2	0	0	0.0
Ettinger	0	1	-5.6	1	3	-9.8	0	0	0.0	1	0	3.2	0	0	0.0	0	0	0.0
Bacon	0	0	0.0	0	0	0.0	0	0	0.0	2	0	6.5	0	0	0.0	1	0	3.2
SirPrize	0	0	0.0	2	0	6.5	0	0	0.0	1	0	3.2	0	0	0.0	1	0	3.2
Marvel	8	6	-7.5	9	5	7.3	11	7	-0.2	4	4	-12.1	0	4	-20.0	1	1	-1.3
Harvest	0	0	0.0	0	0	0.0	1	0	3.3	0	0	0.0	0	0	0.0	0	0	0.0
Nobel	0	2	-11.1	2	2	-2.2	0	4	-21.1	0	0	0.0	0	1	-5.0	0	0	0.0
LambHass	0	0	0.0	0	2	-8.7	2	0	6.7	0	3	-18.8	0	0	0.0	0	0	0.0

Pollinizer							Harvest											
Row	33S			34S			35S			36S			37S			38S		
Stage*	M04	Y04	%-%	M04	Y04	%-%	M04	Y04	%-%	M04	Y04	%-%	M04	Y04	%-%	M04	Y04	%-%
Total	31	24	0.0	29	23	0.0	31	18	0.0	25	17	0.0	28	22	0.0	31	22	0.0
Zutano	1	1	-0.9	1	1	-0.9	0	0	0.0	0	3	-17.6	1	0	3.6	0	0	0.0
Hass	26	20	0.5	25	17	12.3	19	10	5.7	24	11	31.3	25	20	-1.6	28	22	-9.7
Fuerte	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Ettinger	1	1	-0.9	1	2	-5.2	0	0	0.0	0	0	0.0	0	0	0.0	1	0	3.2
Bacon	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	1	0	3.6	0	0	0.0
SirPrize	1	0	3.2	0	0	0.0	1	1	-2.3	1	0	4.0	1	0	3.6	2	0	6.5
Marvel	0	0	0.0	0	2	-8.7	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Harvest	0	0	0.0	1	0	3.4	10	6	-1.1	0.0	2	-11.8	0	0	0.0	0	0	0.0
Nobel	0	2	-8.3	1	1	-0.9	1	1	-2.3	0	1	-5.9	0	0	0.0	0	0	0.0
Lamb Hass	2	0	6.5	0	0	0.0	0	0	0.0	0	0	0.0	0	2	-9.1	0	0	0.0

Table 3 CONTINUED.

						Bacon												Pollinizer
39S			40S			41S			42S			43S			Total			Row
M04	Y04	%-%	M04	Y04	%-%	M04	Y04	%-%	M04	Y04	%-%	M04	Y04	%-%	M04	Y04	%-%	Stage*
30	24	0.0	29	22	0.0	30	22	0.0	30	22	0.0	30	23	0.0	509	357	0.0	Total
1	1	-0.8	2	2	-2.2	0	4	-18.2	0	1	-4.5	3	0	10.0	12	20	-3.2	Zutano
23	15	14.2	20	17	-8.3	18	13	0.9	27	13	30.9	27	17	16.1	394	241	9.9	Hass
3	0	10.0	1	0	3.4	2	1	2.1	0	2	-9.1	0	1	-4.3	9	4	0.6	Fuerte
0	0	0.0	0	0	0.0	0	0	0.0	2	2	-2.4	0	3	-13.0	7	12	-2.0	Ettinger
1	1	-0.8	1	0	3.4	4	1	8.8	0	0	0.0	0	0	0.0	10	2	1.4	Bacon
0	0	0.0	2	0	6.9	2	0	6.7	1	0	3.3	0	0	0.0	15	1	2.7	SirPrize
0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	33	29	-1.6	Marvel
2	1	2.5	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0	14	9	0.2	Harvest
0	1	-4.2	2	2	-2.2	0	0	0.0	0	0	0.0	0	0	0.0	6	17	-3.6	Nobel
0	5	-20.8	1	1	-1.1	4	3	-0.3	0	4	-18.2	0	2	-8.7	9	22	-4.4	L.Hass