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Yield, growth and fruit quality of the persimmon (Diospyros kaki L.) in south-east Queensland

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Summary

Six persimmon cultivars were tested in a coastal subtropical climate and evaluated during their first 3 years of production. Tanenashi, Tsuro magri and Hyakumo, which are dwarf and precocious, produced the highest yields ranging from 50 to 24 kg per tree in their fifth year after planting. Nightingale, which is semi-dwarf, did not bear well until the fifth year when it produced 26 kg. The vigorous Dai Dai Maru and Flat Seedless produced only 16 and 4 kg, respectively, in the fifth year. All the cultivars were of good appearance except for Hyakumo which had dark flesh caused by cross pollination-induced seed development. Hyakumo also had internal flecking due to tannin spots in the flesh. Only Hyakumo produced non-astringent fruit, which was also the most susceptible to fruit fly and bird damage. Only Nightingale and Flat Seedless had a distinctive flavour; the rest were sweet and bland. Nightingale is recommended for planting.

1. INTRODUCTION

The persimmon (*Diospyros kaki* L.) is a major horticultural crop in China and Japan. In these countries, the persimmon is used both as a fresh fruit and a processed product. On a much smaller scale, viable persimmon industries have been developed in California, Italy, Israel and Australia. In this country, no studies have been conducted to evaluate varietal or production problems. Our interest in evaluating this crop in subtropical regions of south-east Queensland is to make better use of frost prone, marginal horticultural land unsuited to most other crops. Based on current market prices of $12 per tray average (ex Brisbane), attractive gross returns per hectare could be realized. Current Australian markets appear to be undersupplied as indicated by the importation of fruit from the USA in the 1981 season. The possibilities of developing export markets of 'out of season fruit' to Japan and other Asian countries also appear good as the fruit is well liked in Asia.

In this paper we present data on growth, cropping, pest and disease problems and fruit quality characteristics of various persimmon varieties and make preliminary recommendations as a basis for establishing a viable industry. Included in the experiment were the main cultivars currently grown on a limited scale in southern temperate regions of Australia. This experiment is one of a series to evaluate the persimmon in this region. More cultivars are being introduced for testing.

The experiment was begun in September 1976 at the Maroochy Horticultural Research Station at Nambour, Queensland (26° 37′ S latitude and elevation 80 m).

2. MATERIALS AND METHODS

Site

The experiment was located on a yellow podzolic soil type, with a sandy loam surface layer overlying a sandy clay subsoil at a depth of 500 mm. Because of the shallow surface soil, rows were mounded to give a soil depth of 1000 mm along the rows to a width of 2 m.

Climatic data

The region has a mean annual temperature of 19.5°C. Mean monthly temperature during the fruit maturation period (February to April inclusive) is 22.1°C. Accumulated hours of sunshine from early fruit set (October) to fruit maturation (April) are 1460 h. Mean annual rainfall is 1797 mm with 60% of this falling in the summer (December to March) period.

Accumulated chilling hours, evaporation, rainfall and irrigation data recorded during the course of the experiment are presented in Table 1.

Table 1. Accumulated chilling hours, Class A pan evaporation, rainfall and irrigation applied during the course of the experiment

Year	Accumulated* chilling hours	Class A pan evaporation (mm)	Annual rainfall (mm)	Irrigation (mm)
September 1976–77	240.35	1558	1024	620†
1977–78	227.51	1581	1289	642
1978–79	207.55	1478	1261	363
1979–80	184.74	1646	1288	680
1980–May 81‡		1214	1111	534

*Accumulated chilling hours determined by the formula described by Munoz (1969).
†Irrigation commenced at planting in September 1976.
‡Completion of harvest.

Experimental design

The experiment was a randomized block design with six cultivars replicated four times with two-tree plots. The datum trees were guarded externally. The six cultivars tested were Tsuro magri, Tanenashi, Hyakumo, Dai Dai Maru, Nightingale and Flat Seedless. All cultivars were grafted on *Diospyros lotus* L. (date plum) rootstock.

Crop establishment

Bare-rooted nursery trees of the six cultivars were graded and planted in September 1976. Sites were previously prepared by the addition of superphosphate at 0.45 kg m^{-2} and dolomite at 7.5 t ha^{-1}. Trees were spaced 4.6 m apart in the row with 5.5 m between rows, giving a density of 400 trees ha^{-1}.

Cultural practices

Irrigation

During the first 4 years of the experiment all trees were irrigated using a microtube irrigation system supplying 18 L h^{-1} to each tree from two outlets. In September 1980, this system was converted to an under-tree sprinkler irrigation system supplying 53 L h^{-1} from one sprinkler outlet per tree. Water was applied twice weekly with the quantity equal to 80% of evaporation from a class A pan over the foliage plan area of the canopy. Rainfall was taken into account but falls of 5 mm or less were ignored. The amount of water applied is shown in Table 1.

Nutrition

All trees received three applications of fertilizer per year until cropping began in 1979. A complete 11:5:14 NPK fertilizer was applied in September (bud break), with applications of nitrogen (ammonium nitrate 34% N) in October and November. Once trees began cropping in 1979 a further application of 11:5:14 was given in early January, 3 weeks before the start of harvesting. Rates of fertilizer applied increased with successive years. Total rates per tree of major elements applied each year were as follows:

1976–77 130 g N, 12 g P, 34 g K;
1977–78 160 g N, 24 g P, 68 g K;
1978–79 220 g N, 48 g P, 136 g K;
1979–80 240 g N, 60 g P, 170 g K;
1980–81 280 g N, 72 g P, 240 g K.

Pruning

All trees were trained to a modified central leader system. During the pre-cropping phase, all trees were pruned lightly twice yearly: in August, when dormant, and in mid November, during the growing period. Once trees began cropping (1979), summer pruning was discontinued.

Weed control

In September of each year, trees were mulched along the row with the sugar mill by-product 'bagasse' applied in a 1 m strip 80 mm deep. Weeds along the edge of the mulched strip were controlled with paraquat spot sprays and the inter-row area was mown six times per year.

Pest and disease control

a. Queensland fruit fly (*Dacus tryoni* (Froggatt))

1979 harvest period. Malathion/protein hydrolysate bait sprays were applied to the southern side of each tree trunk in early January 3 weeks before the start of harvesting. Two weeks before and every 21 days during the harvest period, dimethoate sprays were applied at 1 g L^{-1}.

1980 harvest period. Bait sprays were applied as in the 1979 harvest season and dimethoate sprays were applied at 14 day intervals.

1981 harvest period. During this season, no bait sprays were applied. Dimethoate was replaced by fenthion (1 mL L^{-1}) sprays applied at 14 day intervals.

b. Other insect pests

During the 1980 season, one methidathion spray at 0.5 mL L^{-1} was applied for the control of soft brown scale (*Coccus hesperidum*).

c. Birds (Australian crow (*Corvus orru*), Australian magpie (*Gymnorhina tibicen*))

1979 harvest period. Bird repellent sprays of anthraquinone at 7 g L^{-1} were applied at 14 day intervals from the first week in January to the end of the harvest period.

1980 and 1981 harvest periods. Anthraquinone was replaced by methiocarb sprays at 1 g L^{-1} applied at 14 day intervals.

d. Disease control

No disease problems were recorded.

Measurements and biometrical analyses

1. *Trunk girth measurements.* Measurements of trunk girth were made 30 cm above ground level on each datum tree at planting and each year during the period when trees were dormant.

2. *Relative increase in butt cross-sectional area (R).* This was calculated from $R = \ln A_2 - \ln A_1/(t_2 - t_1)$ for each growing season where A_2 and A_1 are butt cross-sectional areas recorded at times t_2 and t_1, respectively.

3. *Branch crotch angles.* The mean angle subtending all sub-leaders and the vertical central leader.

4. *Tree height.* Measured from the soil surface to the tip of the highest leader.

5. *Crown height (b).* Measured from point of first branching to the tip of the highest leader.

6. *East–west spread, north–south spread.* The spread of branch terminals at the widest point in the canopy.

7. *Crown radius (a).* The mean of radial measurements taken in east–west, north–south directions.

8. *Tree canopy volume and surface area.* These were calculated from the formulae:

$$\text{Canopy volume} = \pi r^3 \, (2/3 - X + X^3/3)$$

$$\text{Canopy surface area} = 2\pi r^2 \, (1 - X)$$

In these formulae, $r = (a^2 + b^2)/2b$ and $X = (a^2 - b^2)/(a^2 + b^2)$, where a is crown radius and b is the crown height. In calculating these parameters, the longitudinal section of the tree was considered as half an ellipse rather than a semicircle. The formulae used are described by Shikhamany, Iyer, Ramachonder and Srinivasan (1978) for use with guavas, and are appropriate to use with persimmon, which has a similar canopy shape.

9. *Yields.* Trees were harvested twice weekly, with most cultivars requiring up to a maximum of 10 picks. Fruit were judged as unmarketable on the following criteria:

if fruit weighed <125 g;
were sunburnt, fruit fly stung or bird damaged in any way;
were overripe and soft;
if fruit surface area exhibited $>5\%$ superficial skin damage;
if fruit exhibited calyx end growth cracks.

The total number of unmarketable fruit was recorded for each cropping season. In addition, during 1979 and 1980, the number of fruit specifically damaged by fruit fly, birds or sunburn was also recorded.

Mean marketable fruit weights and mean harvest times were determined for the three cropping seasons. Other derived data included yield per cross-sectional area of butt and percentage marketable fruit.

10. *Fruit quality assessments.* During the 1981 harvest season, 20 fruit from each cultivar were randomly sampled at harvest for fruit quality assessments. Astringency ratings were made using the technique of Gazit and Levy (1963). The cut surface of the fruit was placed onto a dry filter paper previously impregnated with a 5% $FeCl_3$ solution. Based on the colour intensity developed, fruit astringency levels were rated from 1 to 5. The ratings were as follows: 1, non-astringent; 2, slightly astringent; 3, moderately astringent; 4, strongly astringent; 5, very strongly astringent. Astringency ratings were made when the fruit were both half and fully

coloured and while still firm. On complete softening, the fruit loses all traces of astringency. Internal flecking caused through the development of insoluble tannin spots was assessed visually on a percentage area basis. Brix readings were made on expressed juice using a Galileo refractometer.

11. *Biometrical methods.* All data were subject to analyses of variance and tested for cultivar × year interaction. Correlations between tree morphological and growth parameters and yield over the three cropping years were also determined.

3. RESULTS

Yield performance

Yield performance of the six cultivars tested is presented in Table 2. Significant interactions were recorded between cultivars and cropping years with respect to total fruit number per tree and total fruit weight per tree. Most of this interaction resulted from a reduction in yield of the Hyakumo cultivar between the 1980 and 1981 cropping years. The yield differences ($P < 0.01$) between the more precocious and less precocious cultivars were accentuated when evaluated on a butt cross-sectional area basis, with yields per cross-sectional area of butt recorded in the 1981 harvest season (in kilograms per square centimetre) as follows: Tanenashi 1.00, Tsuro magri 0.86, Nightingale 0.58, Hyakumo 0.45, Dai Dai Maru, 0.19 and Flat Seedless 0.06 kg cm^{-2}. As expected, significant differences in accumulated yields for each cultivar were also recorded (Table 2).

Table 2. Fruit yield per tree over three cropping years

Cultivar	Total fruit number per tree				Total fruit weight per tree (kg)			
	1979	1980	1981	Accumulated	1979	1980	1981	Accumulated
Tanenashi	85.4	102.0	285.9	473.3*a*	20.4	23.3	50.4	94.1*a*
Tsuro magri	125.8	86.0	256.9	468.7*a*	16.9	11.8	29.7	58.3*b*
Hyakumo	90.1	191.4	185.3	466.8*a*	15.2	25.1	24.0	64.3*b*
Nightingale	16.3	46.9	134.6	197.8*b*	3.1	7.5	26.1	36.7*c*
Dai Dai Maru	24.0	68.1	109.5	201.6*b*	4.2	12.2	15.9	32.3*c*
Flat Seedless	2.0	2.9	18.8	23.6*c*	0.5	0.5	4.4	5.4*d*
	Cultivars × years			Cultivars	Cultivars × years			Cultivars
l.s.d. (P = 0.05)	45.4			79.2	10.3			11.3
(P = 0.01)	60.5			109.5	13.9			15.6

*Figures in columns followed by different letters are significantly different at $P < 0.01$.

The percentage marketable fruit yields are presented in Table 3. The significant interaction recorded in percentage marketable fruit yields between cultivars and years was mainly due to the reduction in percentage marketable yield for the Flat Seedless cultivar between the 1980 and 1981 cropping years. Most other cultivars showed significant improvements in percentage marketable yields over the three cropping seasons. Bird, fruit fly and, to a lesser extent, sunburn damage were the major causes of unmarketable fruit. The percentage unmarketable fruit yields attributable to these three causes, recorded in the 1979 and 1980 cropping years, is also presented in Table 3. Significant interaction occurred between cultivars and cropping years with all three attributes. Interaction in percentage bird damaged fruit between cultivars and years resulted from the huge reduction in bird damage recorded in the Hyakumo cultivar between the 1979 and 1980 cropping seasons. Interaction in percentage fruit fly damage between cultivars and years was due mainly to the slight reduction in percentage fruit fly damage recorded in the Nightingale cultivar between the 1979 and 1980 cropping seasons, compared to the marked increase recorded with other cultivars in the same period. Interaction in percentage sunburnt fruit between cultivars and years resulted from two causes: the marked increase in percentage sunburnt fruit of the Tanenashi and Tsuro magri cultivars between the 1979 and 1980 cropping seasons and the reduction in percentage sunburnt fruit in the Dai Dai Maru cultivar in the same period.

Table 3. Percentage marketable fruit and percentage unmarketable fruit attributable to bird, fruit fly and sunburn damage recorded over three and two cropping seasons, respectively

Cultivar	Percentage marketable			Percentage bird damage		Percentage fruit fly damage		Percentage sunburn damage	
	1979	1980	1981	1979	1980	1979	1980	1979	1980
Tanenashi	75.1*	80.0*	91.2*	18.4*	5.1*	3.8*	10.7*	0.9†	4.0†
	(60.1)	(63.5)	(75.7)	(25.4)	(13.1)	(11.3)	(19.1)	(1.2)	(2.1)
Tsuro magri	71.0	77.6	86.7	28.2	12.3	0.1	2.5	0.7	7.2
	(57.4)	(61.8)	(68.6)	(32.1)	(20.5)	(1.4)	(9.0)	(1.1)	(2.8)
Hyakumo	26.1	28.3	74.6	54.1	5.0	13.1	27.3	3.3	3.1
	(30.7)	(32.1)	(59.7)	(47.3)	(13.0)	(21.3)	(31.5)	(2.0)	(1.9)
Nightingale	46.7	73.0	95.6	36.0	7.3	3.9	2.3	3.5	4.7
	(43.1)	(58.7)	(77.9)	(36.9)	(15.6)	(11.5)	(8.7)	(2.0)	(2.3)
Dai Dai Maru	68.3	79.3	77.2	21.9	9.5	0.2	1.0	1.2	0.3
	(55.8)	(63.0)	(61.5)	(27.9)	(17.9)	(2.8)	(5.7)	(1.3)	(0.9)
Flat Seedless	83.5	93.7	73.3	16.6	5.0	0.4	1.0	0.1	0.1
	(66.1)	(75.5)	(58.9)	(24.0)	(12.9)	(3.4)	(5.7)	(0.8)	(0.8)
	Cultivars × years			Cultivars × years		Cultivars × years		Cultivars × years	
l.s.d. (P = 0.05)	9.9			4.8		6.0		0.9	
(P = 0.01)	13.3			6.5					

*Arcsine transformation. Transformed means in parentheses.
†$\sqrt{x + 0.5}$ transformation. Transformed means in parentheses.

Mean marketable fruit weights for most cultivars remained relatively constant over the three cropping seasons with significant differences ($P < 0.01$) recorded between varieties. Mean marketable fruit weights recorded in the 1981 harvest season in grams were as follows: Tanenashi 189, Tsuro magri 134, Hyakumo 219, Nightingale 206, Dai Dai Maru 163 and Flat Seedless 254 g.

Significant differences ($P < 0.01$) were also recorded between cultivars in mean harvest dates. Mean harvest dates recorded in the 1981 harvest season in days from 1 January were as follows: Hyakumo 56.6, Tanenashi 57.7, Nightingale 61.4, Tsuro magri 69.6, Dai Dai Maru 79.1 and Flat Seedless 80.3 days.

Tree growth and morphological characteristics

Significant interaction effects ($P < 0.01$) were present in trunk girth between cultivars and years, due to the differences in girth between cultivars at planting. Changes in R (relative increase in butt cross-sectional area) gave a better indication, however, of seasonal growth patterns (Table 4). As expected, R slowed as annual yield increased for each cultivar. Interaction effects present in R between cultivars and cropping years were due to an earlier fall in R of the more precocious bearing cultivars, Tanenashi, Tsuro magri and Hyakumo, with the start of cropping in the 1979 harvest season.

Tree morphological characteristics are presented in Table 5. Significant interactions between cultivars and cropping years for tree heights, canopy volumes and canopy surface areas were recorded. These interactions were due to a reduction in vegetative growth of the more

Table 4. Relative increase in butt cross-sectional area (*R*)

Variety	1976–77	1977–78	1978–79	1979–80	1980–81
Tanenashi	1.08	1.07	0.55	0.59	0.12
Tsuro magri	0.89	0.68	0.22	0.34	0.12
Hyakumo	1.33	0.95	0.34	0.39	0.12
Nightingale	1.03	0.89	0.53	0.23	0.13
Dai Dai Maru	0.88	0.85	0.63	0.17	0.13
Flat Seedless	1.34	0.87	0.68	0.25	0.16
	Cultivars × years				
l.s.d. (P = 0.05)	0.17				
(P = 0.01)	0.22				

precocious bearing cultivars Tanenashi, Tsuro magri and Hyakumo as a result of increasing cropping load.

The less precocious bearing cultivars Nightingale, Flat Seedless and Dai Dai Maru recorded greater growth particularly in the first two cropping seasons. Significant main effects of varieties and cropping years were also present in canopy radii and mean branch crotch angles (Table 5). The cultivar Flat Seedless exhibited a particularly upright growth habit. Correlations between tree morphological and growth characteristics and yield are presented in Table 6.

Table 5. Tree morphological characteristics recorded over three cropping seasons

Variety	Canopy radius (m) 1979	1980	1981	Crotch angles (deg.) 1979	1980	1981	Tree height (m) 1979	1980	1981	Canopy volume (m³) 1979	1980	1981	Canopy surface area (m²) 1979	1980	1981
Tanenashi	0.81	1.00	1.06	55.5	56.7	57.6	2.35	2.45	2.65	4.83	6.75	8.23	15.98	18.47	21.63
Tsuro magri	0.82	0.90	0.93	42.6	43.4	45.3	2.53	2.60	2.85	6.58	7.20	10.08	18.25	19.87	23.62
Hyakumo	1.05	1.22	1.26	41.4	48.5	57.6	2.83	2.85	2.95	10.23	12.45	12.50	24.95	26.61	27.40
Nightingale	0.79	0.97	1.10	33.6	34.7	35.6	2.90	3.35	3.75	10.60	14.00	21.35	23.46	32.16	40.88
Dai Dai Maru	1.04	1.28	1.40	31.7	37.5	41.2	3.92	3.98	4.25	25.10	29.38	41.23	44.12	44.67	53.96
Flat Seedless	0.82	0.90	0.94	24.0	26.2	27.5	3.45	4.05	4.33	16.48	27.35	32.95	32.23	44.98	51.90
	Cultivars		Years	Cultivars		Years	Cultivars × years			Cultivars × years			Cultivars × years		
l.s.d. (P = 0.05)	0.11		0.08	7.93		2.15	0.30			5.26			5.22		
(P = 0.01)	0.15		0.11	8.62		3.45	0.40			7.01			6.96		

Table 6. Correlation coefficient (*r*) values of tree morphological and growth parameters with yield over three cropping seasons

Tree morphological and growth parameters	1979	1980	1981
Tree height	−0.68**	−0.61**	−0.75**
Trunk girth	−0.03 n.s.	−0.03 n.s.	−0.40 n.s.
Relative increase in butt cross-sectional area (*R*)	−0.64**	0.48*	−0.57**
Crotch angles	0.83**	0.89**	0.85**
Crown radius	−0.06 n.s.	0.21 n.s.	−0.09 n.s.
Canopy volume	−0.64**	−0.46*	−0.66**
Canopy surface area	−0.73**	−0.56**	−0.62**

n.s. = $P > 0.05$
* = $P < 0.05$
** = $P < 0.01$

Fruit quality assessments

Fruit quality characteristics of the cultivars tested are presented in Table 7.

Table 7. Fruit quality characteristics recorded during the 1981 cropping season

Characteristic	Cultivar					
	Tanenashi	Tsuro magri	Hyakumo	Nightingale	Dai Dai Maru	Flat Seedless
Cultivar class*	PCA	PCA	PVN	PCA	PCA	PCA
Fruit shape	Conical	Conical	Round	Conical	Oval	Square
Skin colour	Yellow	Yellow	Yellow	Red	Orange	Orange
Internal colour	Orange	Orange	Brown	Red	Orange	Orange
Flavour	Bland	Bland	Bland	Distinctive	Bland	Distinctive
Fruit size (cm):						
Length	7.93	6.58	7.06	7.79	6.04	5.85
Breadth	7.43	5.40	7.48	7.35	7.13	8.97
Fruit weight (g)	185	115	145	199	170	234
Seed number per fruit	0.3	1.0	5.0	2.4	5.3	5.3
Seed weight per fruit (g)	0.3	1.0	5.9	1.5	4.1	4.7
Internal flecking (%)	nil	0.5	80	nil	nil	nil
Astringency rating:						
Half coloured	4.48	3.75	1.38	3.48	3.78	4.35
Full coloured	3.70	2.70	0.50	2.30	1.80	2.00
Brix (°): eating ripe	13.1	9.95	12.0	13.0	17.1	14.5

*PC = pollination constant
PV = pollination variant
A = astringent
N = non-astringent

4. DISCUSSION

The persimmon appears to be readily adaptable to the subtropical environment of south-east Queensland. Based on Japanese data (Kajiura 1980), the persimmon requires a long season to mature the crop to full ripeness, with up to 1400 h of sunshine and average temperatures in the fruit maturation period between 16° to 22°C. These conditions are well met in south-east Queensland. None of the cultivars tested suffered from delayed or sporadic budbreak problems associated with lack of insufficient winter chilling. Japanese researchers have also found that the persimmon has little or no chilling requirement to ensure uniform budbreak (Oppenheimer 1961).

Cultivars differed markedly in terms of precocity of bearing and growth performance. For example, total fruit yields recorded in the 1981 harvest season (in tonnes per hectare) were as follows: Tanenashi 20.17, Tsuro magri 11.86, Nightingale 10.45, Hyakumo 9.59, Dai Dai Maru 6.35 and Flat Seedless 1.77. When yields per butt cross-sectional area, a measure of yield efficiency or fruitfulness (Westwood and Roberts 1970), are compared, the differences between the more precocious and less precocious cultivars are accentuated. The most precocious cultivars were dwarf or semi-dwarf types (Table 5). The relationship between tree yield and tree morphological characteristics is shown by the significant negative correlations recorded between yield and tree heights, canopy volumes and canopy surface areas (Table 6). Based on tree heights and canopy volume (Table 5), cultivars could be classified into three main groups: dwarf and highly precocious (cultivars Tanenashi, Tsuro magri and Hyakumo); semi-dwarf and moderately precocious (cultivar Nightingale); and vigorous and non-precocious (cultivars Dai Dai Maru and Flat Seedless). Highest positive correlations were recorded between yield and mean branch crotch angles. Arching or maintaining shoots horizontally has long been shown to inhibit vegetative growth and to promote floral initiation (Champagnat 1954). All cultivars exhibited a natural tendency to increase branch crotch angles in successive cropping years. This occurred as a result of increasing crop load on new terminal growths. In less precocious cultivars, this process may be enhanced by the use of training or trellising systems and warrants further investigation. Application of 0.8% IAA in lanolin paste to narrow limb crotches was, however, not successful in widening crotch angles.

Marked improvements in percentage marketable fruit yields were obtained in successive seasons due to improved pest control strategies (Table 3). Cultivars differed markedly in their susceptibility to fruit fly damage, with early maturing cultivars such as Tanenashi and Hyakumo being most susceptible. Observations by Murray (1976) in passionfruit indicated that fruit fly is most active during the months of September to April inclusive, with early summer rains increasing fly activity. The marked increase in fruit fly damage between the 1979 and 1980 seasons, even though spraying intensity increased, suggests that seasonal conditions have an important effect on regulating fruit fly populations. Thus selection of late maturing cultivars would be advantageous.

The much higher incidence of fruit fly stings and bird damage in the Hyakumo cultivar may also have been related to the much lower levels of astringency of this variety. The combination of malathion/protein hydrolysate bait sprays and cover spraying appeared to be the most effective means of reducing fruit fly damage. In the 1981 season, fenthion (1 g L^{-1}) replaced dimethoate (1 g L^{-1}) as the latter chemical contributed to superficial skin blemishing. Further improvements in fruit fly control may have been achieved by reducing the interval between spraying from 14 to 10 days and by growing only one cultivar, preferably a mid to late season variety in isolation.

Good bird control was achieved by applying bird repellent sprays during the harvest period. Methicarb (1 g L^{-1}) proved to be more effective in bird control than anthraquinone (7 g L^{-1}), as indicated by the marked reduction in percentage bird damaged fruit between the 1979 and 1980 harvest seasons (Table 3).

Besides bird, fruit fly and sunburn damage, superficial skin blemishing was observed in most cultivars. Similar damage has been observed in persimmons grown in northern New South Wales. This damage has been attributed to greenhouse thrips (*Heliothrips haemorrhoidalis*) (Loebel, personal communication).

Using the classification system developed by Hume (1914), all cultivars with the exception of Hyakumo were classified as astringent, pollination constant types. These cultivars do not undergo any change in flesh colour as a result of pollination. The cultivar Hyakumo was classified as a pollination variant type because darkening of the flesh results from pollination and seed development. In this experiment, all cultivars were cross-pollinated and produced seeded fruit (Table 7). Astringency levels at maturity varied markedly between cultivars (Table 7) and did not disappear completely until fruit became soft and ready for eating. All cultivars with the exception of Hyakumo would require treatment to remove astringency while maintaining fruit firmness. The most successful of these treatments is carbon dioxide gassing (Guelfat-reich, Benaire and Metal 1975).

With the exception of one cultivar, Hyakumo, all cultivars tested in this experiment were of excellent external and internal appearance. However, in terms of fruit flavour characteristics most cultivars were sweet and bland. Only two cultivars, Nightingale and Flat Seedless, could be considered to have distinctive flavour characteristics.

5. CONCLUSIONS

Provided pest problems can be overcome, the persimmon is readily adaptable to the subtropical environment of south-east Queensland. Based on fruit quality and yield potential in the first 5 years after planting, only one cultivar, Nightingale, can presently be recommended for planting. Further introductions of the best overseas cultivars are being made and it is anticipated that these will replace existing Australian cultivars. The future of the persimmon as a crop in Australia will depend on the selection of high quality, good flavoured cultivars and efficient marketing techniques to ensure that a firm, non-astringent fruit reaches the consumer.

6. ACKNOWLEDGEMENTS

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