



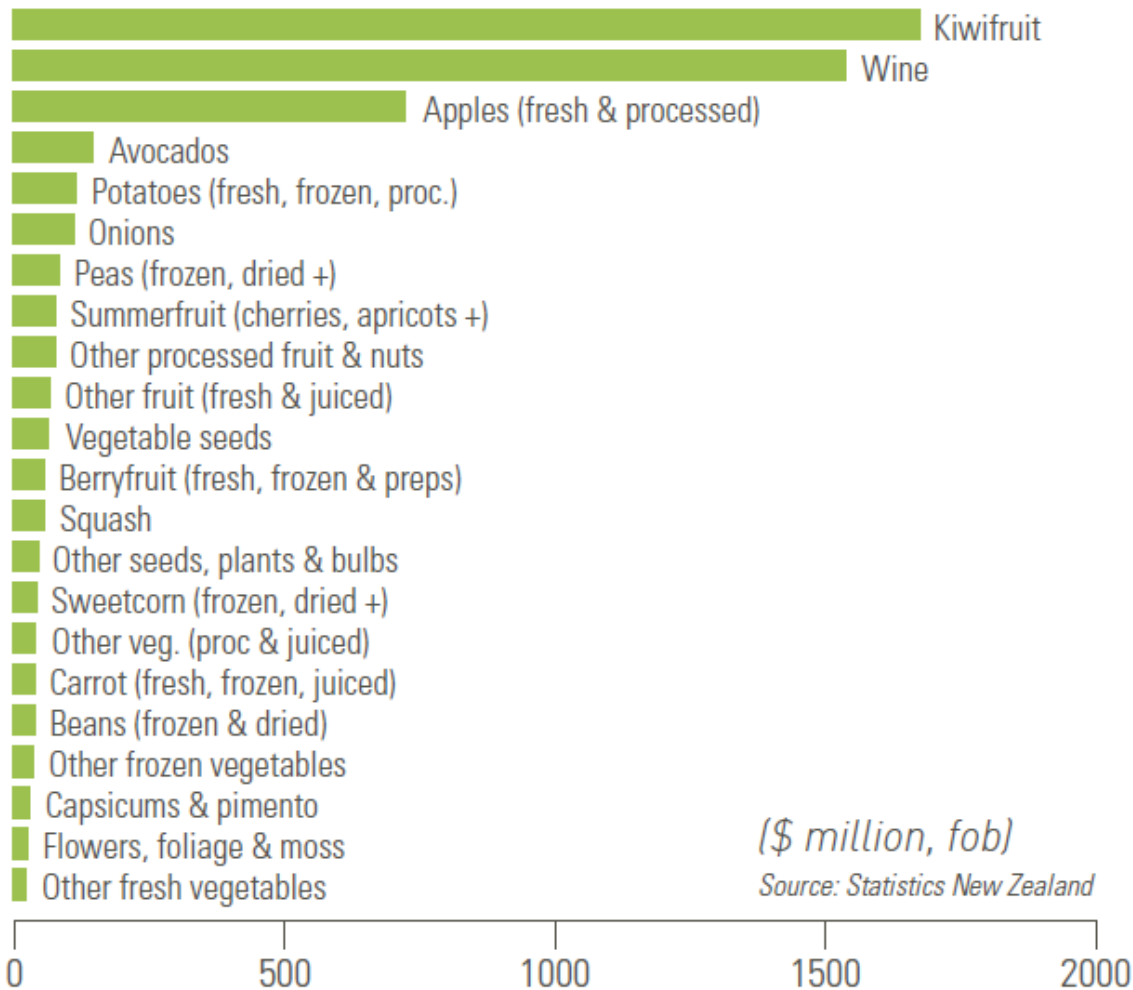
Can X-rays disinfect temperate pests in apples?

Allan Woolf

Nangul A, Sanxter S, Sandra S, Postler M, Hall M, Redpath S, Wall M, Follett PA, **Waddell B***, Hunt M, Rowan D, Wohlers M, N Page-Weir, A Hawthorne, DHartnett and Jamieson L

Industry statistics – Apple third largest export

Horticultural exports 2017 (\$ million, fob)

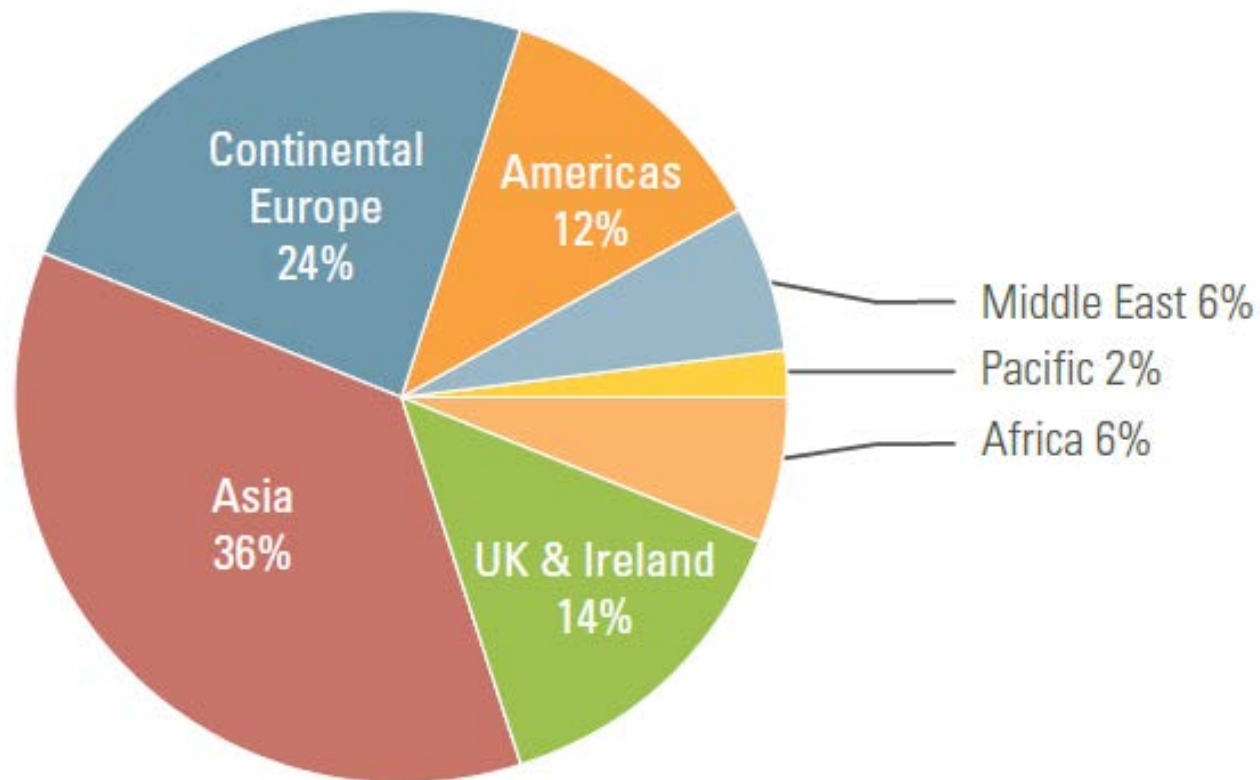


FreshFacts

(\$ million, fob)

Source: Statistics New Zealand

Apple export destinations by region (2017)



Introduction – Phytosanitary issues



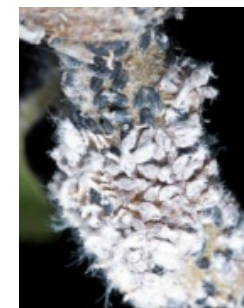
- Maintaining apple access to international markets is challenging (Taiwan, China, Japan)
- Accessing new ones - even more-so (e.g. Korea)
- 'Economic' access (e.g. Australia)



Dasineura mali (Kieffer)
(Diptera: Cecidomyiidae)
Apple leaf curling midge



Cydia pomonella (L.)
(Lepidoptera: Tortricidae)
Codling moth



Priority markets & SPS issues affecting NZ apple assess in 2016

Rank	Country	Technical SPS issues (insects)	Volume (MT)	Value (\$M FOB)
1	Australia	ALCM	241	0.7
2	China	CM, ALCM, WAA	17,491	51.3
3	Taiwan	CM, ALCM, WAA	32,333	78.7
4	India	CM, SJS	13,253	22.6
5	Japan	CM, ALCM	1,440	3.5
6	Indonesia	CM, SJS	8,496	18.9
7	Viet Nam	SJS	8,273	25.5
8	USA	LR, Passenger pests	48,624	112.3
9	Thailand	CM	24,231	49.5
10	Russia	OFM	5,695	8.4
11	Korea	No current access (ALCM, CM)	0	0

Apple Leaf Curling Midge (ALCM); Codling Moth (CM); Woolly Apple Aphid (WAA); San Jose Scale (SJS); Leafrollers (LR); Oriental Fruit Moth (PFM)

Introduction – Current systems



- Rely on comprehensive pre-and postharvest measures
- Effective against most pests
- However, if changes in acceptability of current control systems or pest profile, new incursions (fruit fly) alternatives options may be needed



Introduction – Dose for insect control



Prospective Comprehensive Generic Radiation Treatments for Quarantine Pests (Barkai-Golan & Follett – 2017)

Generic Dose (Gy)	Taxonomic Group
400	Insecta (all insects) Acari (all mites)
250	Lepidoptera (moths) (eggs and larvae only) Diptera (all flies) Hemiptera (all true bugs) Thysanoptera (all thrips) Collembola (all collembolans) Araneae (all spiders) Gastropoda (all snails and slugs)
150	Coleoptera (family Curculionidae only) Diptera (family Tephritidae only) Hymenoptera (family Formicidae only)
200	Codling moth (IPPC (2009b) ISPM No. 28 PT6)



Project Aims



1. Evaluate tolerance of apple cultivars grown commercially in NZ to a range of x-ray doses. (USDA collaboration). 2016-2018
2. Preliminary trials to determine tolerance of key pests to ionizing radiation (NZ-based treatment). 2018.

Year 1: Trial design



- 4 cultivars: ‘Fuji’, ‘Scifresh’*, ‘Scired’, ‘Royal Gala’*
(* = 1-MCP/SmartfreshSM – Standard industry treatments)
- All cultivars treated at one time (thus 8-11 weeks storage after harvest)
- 0, 150, 300, 600, 900, 1200, and 1300 Gy
- 5 replicate treatments – 1 tray (\approx 25 fruit)
- Dosimeters included
- Stored 0.5C for 8 weeks after treatment
- Assess: Fruit firmness, SSC, acidity, ethylene, internal and external disorders



Fruit Quality - Calavo – X-ray treatment



Year 1 Results



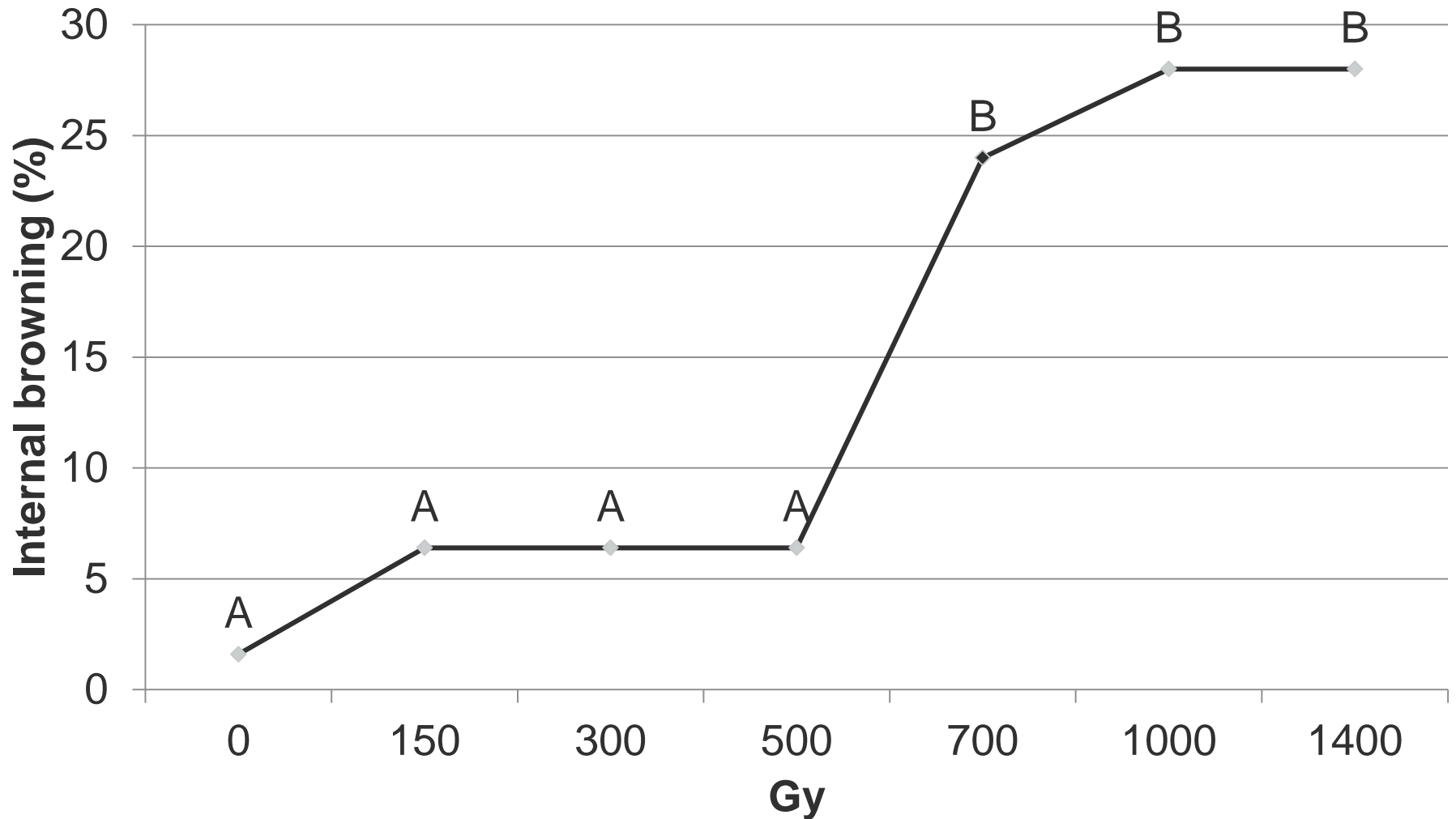
- No significant effects on SSC, skin colour (L, C)
- Significant effect on fruit firmness, acidity and skin colour (Hue angle)
- Internal browning at high doses for 'Royal Gala'
- Internal browning not observed in any other cultivars

Fruit firmness (Kgf)



Dose (Gy)	'Fuji'	'Scifresh'	'Scired'	'Royal Gala'
0	6.3	7.2	8.6	6.7
150	6.8	7.3	8.5	6.8
300	6.7	7.2	8.7	6.9
500	6.1	6.7	8.1	6.4
700	6.3	7.1	8.1	6.0
1000	6.1	6.8	7.9	5.4
1400	5.6	6.5	6.9	5.0

Internal browning – dose response – ‘Royal Gala’



Apple damage rating 'Royal Gala'



Slight
Acceptable

Moderate
Not acceptable

Severe
Not acceptable



Year 2: Trial design (Two parts)



A: Effect of treatment at one storage time

- 5 cultivars: ‘Fuji’, ‘Scifresh’*, ‘Scired’, ‘Scilate’ and ‘Royal Gala’* (* = 1-MCP/SmartfreshSM – Standard industry treatments)
- 4 weeks storage before treatment
- 0, 200, 400, 600 and 800 Gy
- 3 replicate treatments – 100 fruit/rep
- Dosimeters included
- Stored 0.5C for 10 wks after treatment
- Assess: Fruit firmness, SSC, acidity, ethylene, internal and external disorders



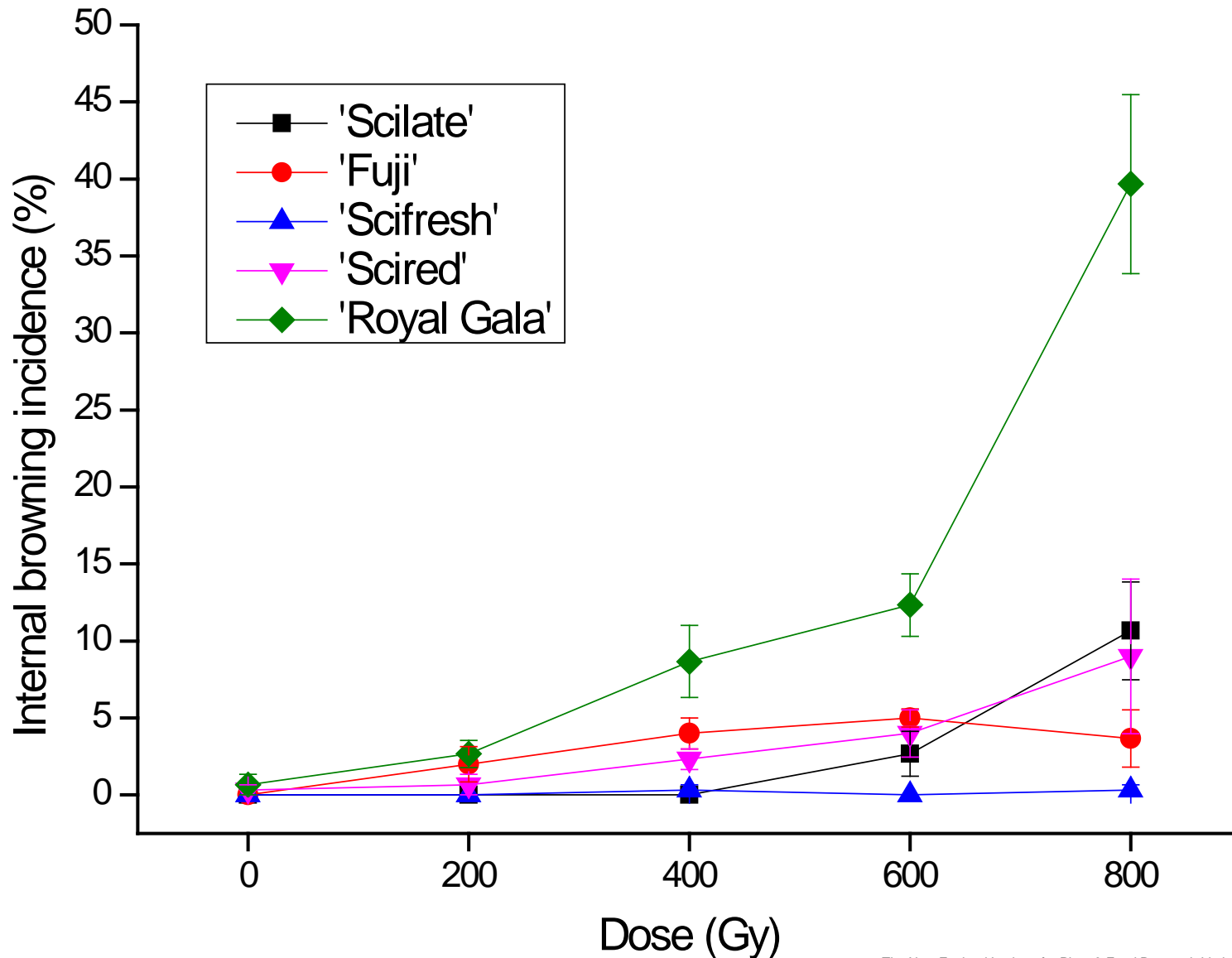
Year 2: Trial Design



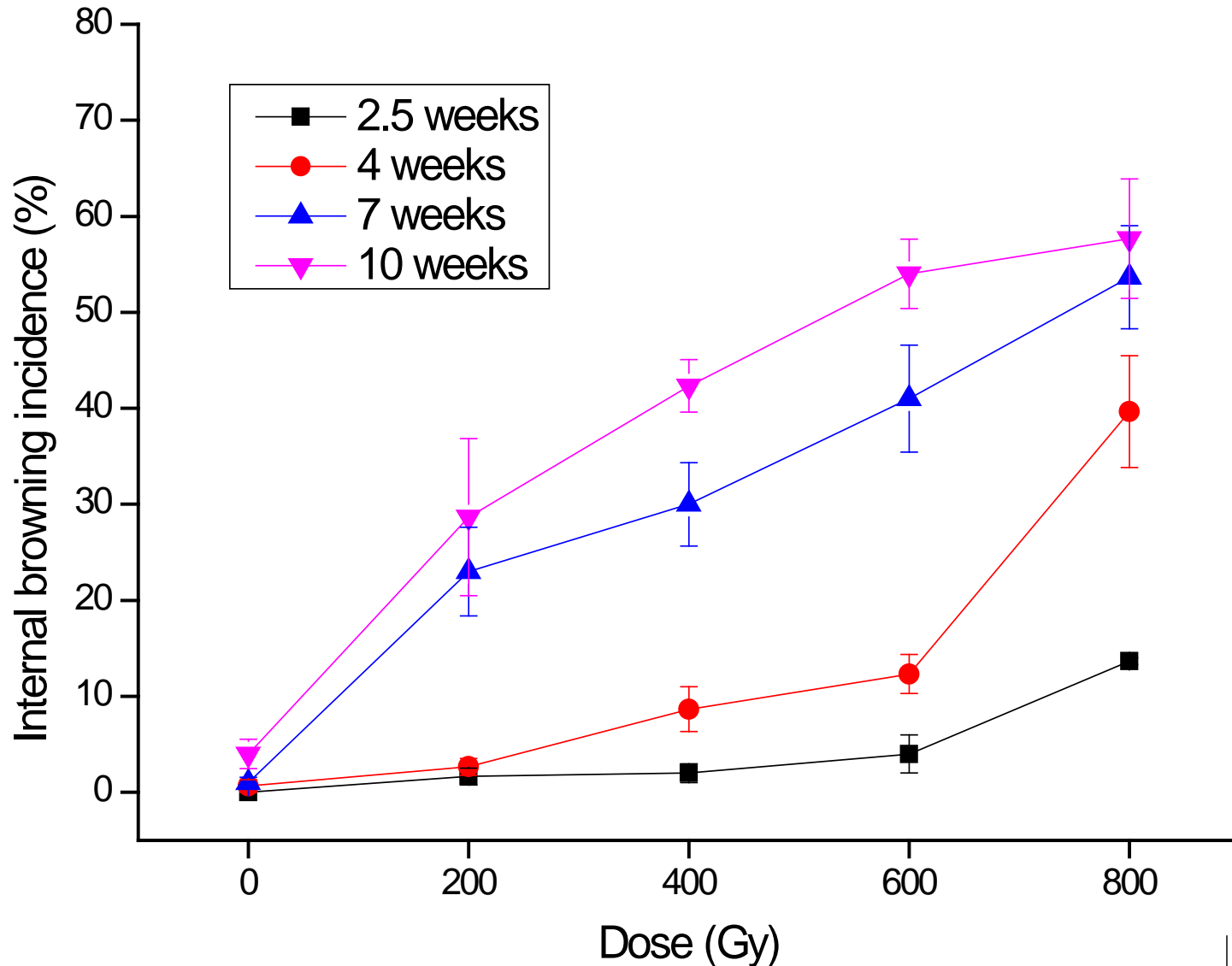
B) Effect of storage time before x-ray treatment for one cultivar ('Royal Gala')

- 'Royal Gala': Storage duration: 2.5, 4, 7 and 10 weeks before x-ray treatment
- (same treatments, storage and assessments as above)

Internal browning – 4 weeks storage



Storage duration before treatment - 'Royal Gala'



Fruit firmness (Kgf) – 4 weeks storage



Dose (Gy)	'Fuji'	'Scifresh'	'Scired'	'Scilate'	'Royal Gala'
0	7.2	7.5	8.2	8.5	6.9
200	7.2	7.4	7.8	8.0	7.2
400	7.0	7.8	7.8	8.0	6.6
600	6.9	7.6	7.4	7.8	5.8
800	6.8	7.3	7.1	7.5	6.7
LSD	0.66875				

Overall conclusions



- X-ray treatment looks likely to result in acceptable fruit quality (200-400 Gy) (generic codling moth dose)
- Some cultivars more sensitive than others
- Most cultivars will tolerate up to 400 Gy with < 4% internal damage
- But 'Royal Gala' very sensitive
- Damage might be further reduced if treated <2 weeks of storage (i.e. time after harvest).

Future plans



- Evaluate effect of storage duration on cultivars other than 'Royal Gala' (under way now - year 3, 2018)
- Evaluate short pre-treatment storage times (<2 weeks)
- Evaluate other cultivars
- Determine ALCM dose response

Hopefully... the not-to-distant future



- laboratory-based x-ray unit, a research facility for variety of users.
- CAPEX application



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RANGAHAU AHUMĀRA KAI



www.plantandfood.com

Barbara.Waddell@plantandfood.co.nz

