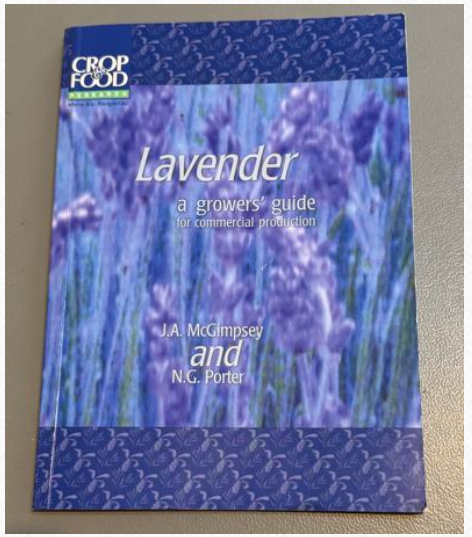
Producing a Quality Lavender Oil

What I'll cover today

- Key publications
- Lavender flower maturity
- Harvest timing: Quality vs Quantity
- Distillation timing: Quality vs Quantity

Reference materials

- ***Lavender a Grower's Guide***
  by Crop & Food Research



- Comprehensive guide for growers
- Covers cultivation, harvesting and oil production
- Everyone should have a copy
- nzlga-membership@lavender.org.nz

Reference materials

- ***Effects of Flower Maturity and Distillation Time on the Yield and Quality of Lavender and Lavandin Oils***
  by Dr Noel Porter, Crop & Food Research

- Scientific study on how timing affects oil yield and quality
- Valuable for refining harvesting and distillation practices
- Available from the Associations Library – Reference “RR05”
- NZLGA Copyright applies, so not to be distributed

It’s not just about timing

- Good soil health, ideal pH being one factor
- Healthy plants
- Plant maturity, effectively 3+ years
- Time to Pick
- Distillation duration
- Storage



Buds Flowers Withered

Crop & Food Book - Maturity Stages

1. Flower head with no open flowers – all still in bud.
2. First one or two flowers open.
3. Several flowers open but none withered. Still many buds.
4. Several flowers open, some beginning to wither.
5. Approximately equal quantities of withered flowers and buds; some open flowers.
6. Few buds left, some open flowers, but mostly withered flowers.
7. No buds remaining, few open flowers, most flowers withered.
8. All flowers withered.

8+. Capsules starting to open and shed seed.

Crop & Food Book – Maturity Scale

- Sample at least 50 flower stems, all collected randomly from the area to be harvested.
- Assess each flower stem and assign a score of 1 to 8+.
- Calculate the average score of the sample, which will indicate the average maturity of the crop.

- Score of 2 is optimum time for dried flowers.
- Score of 3 is acceptable for fresh flower market.
- Score between 4 and 6 is good for essential oil.
  - Optimum time for essential oil will vary depending on cultivar.
  - Keep a photographic record every year and detailed notes about weather conditions etc.
  - Records will enable comparisons between seasons and assist with making confident decisions.

RR05 - Maturity Stages

Stage 1 – 50% of flowers open, 50% still in bud, none withered, corresponding to maturity scale 3 in the Crop & Food book.

Stage 2 – 33% of flowers open, 33% still in bud, 33% withered, corresponding to maturity scale 4.5 in the Crop & Food book.

Stage 3 – 33% of flowers open, 67% withered, corresponding to maturity scale 6 in the Crop & Food book.

Stage 4 – all flowers withered but before shedding seeds, corresponding to maturity scale 8 in the Crop & Food book.

RR05 – When to harvest

- Plants in their 2nd and 3rd flowering season where obtained by C & F
- Oil samples were extracted for Pacific Blue, Avice Hill, Grosso and Super at the four stages.
- Oil yields were recorded for each of the stages.
- Samples of each stage were then analysed by GC and evaluated by nose.
- Note - the results refer to one growing site and one production year.

Timing of maximum yield

Pacific Blue
(RR05)

Timing of negative notes

Timing of aromatic quality

Table 2: Yields (ml/100 g fresh weight), oil composition (peak area percent) and main aromatic notes of Pacific Blue. The hedonistic response reflects like (0 to 5) or dislike (0 to –5).

	Stage 1	Stage 2	Stage 3	Stage 4
Yield	0.96	1.43	1.49	1.72
3-Octanone	1.54	1.87	1.87	2.33
Cineole	1.66	1.61	0.65	0.59
Limonene/phellandrene/*cis*-ocimene	0.86	0.82	0.42	0.32
trans-Ocimene	4.41	4.76	3.04	2.96
Linalool	32.97	34.80	36.47	37.91
Camphor	<0.1	<0.1	<0.1	<0.1
Borneol	0.49	0.43	0.36	0.33
Lavandulol	0.86	0.81	tr	tr
Terpinen-4-ol	6.68	6.73	11.17	13.60
α-Terpineol	0.48	0.41	0.30	0.32
Linalyl acetate	30.14	29.67	28.58	24.35
Lavandulyl acetate	4.29	4.00	3.56	3.00
β-Caryophyllene	1.90	1.64	1.57	1.48
Total high boiling point compounds	10.42	8.88	8.92	8.32
Dominant aromatic notes	Fresh light sweet	Rich sweet	Complex sweet, dry	Complex dry
Negative notes	-	-	Sour varnish appearing	Sour varnish evident
Impact	Soft	Good	Vigorous	Vigorous
Balance	Light, simple, lacks warmth	Good attractive	Dry	Dry
Hedonistic response (+5 to –5)	2	3	-1	-3

There is a very marked increase in yield and some changes in individual oil components that suggest harvest should be left as late as possible, but the aromatic characters change radically and become quite unpleasant by stage 4. Choice of harvest is therefore a compromise between yield and aromatic quality.

Timing of maximum yield

Avice Hill
(RR05)

Timing of negative notes

Timing of aromatic quality

Table 3: Yields (ml/100 g fresh weight), oil composition (peak area percent) and main aromatic notes of Avice Hill. The hedonistic response reflects like (0 to 5) or dislike (0 to –5).

	Stage 1	Stage 2	Stage 3	Stage 4
Yield	1.25	1.30	1.31	1.31
3-Octanone	1.55	2.27	2.62	2.48
Cineole	0.31	0.39	0.32	0.28
Limonene/phellandrene/*cis*-ocimene	<0.1	<0.1	<0.1	<0.1
trans-Ocimene	6.91	7.89	7.16	5.86
Linalool	9.95	8.73	8.32	10.37
Camphor	<0.1	<0.1	<0.1	0.16
Borneol	1.17	1.14	1.04	0.81
Lavandulol	tr	tr	tr	0.15
Terpinen-4-ol	2.73	3.68	4.87	6.55
α-Terpineol	0.57	0.48	0.50	0.37
Linalyl acetate	56.34	53.85	54.10	51.18
Lavandulyl acetate	2.88	2.87	2.77	2.83
β-Caryophyllene	4.45	4.51	4.44	4.55
Total high boiling point compounds	11.23	10.48	10.35	10.25
Dominant aromatic notes	Fresh,	Sweet,	Fresh, sweet	Sour varnish
	light sweet	sharp, fresh		
Negative notes	-	-	-	Strong sour
				varnish
Impact	Soft	Vigorous	Strong	Strong
Balance	Simple	Good	Good	Unacceptable
Hedonistic response (+5 to –5)	2	2	3	-4

Timing of maximum yield

Grosso
(RR05)

Timing of negative notes

Timing of aromatic quality

Table 4: Yields (ml/100 g fresh weight), oil composition (peak area percent) and main aromatic notes of Grosso. The hedonistic response reflects like (0 to 5) or dislike (0 to –5).

	Stage 1	Stage 2	Stage 3	Stage 4
Yield	2.5	3.0	2.6	2.7
3-Octanone	tr	0.25	0.37	0.43
Cineole	4.13	3.59	3.21	2.12
Limonene/phellandrene/*cis*-ocimene	0.79	0.75	0.69	0.58
trans-Ocimene	2.91	2.86	2.25	1.75
Linalool	25.27	26.52	29.83	35.42
Camphor	6.95	6.32	6.19	5.55
Borneol	3.04	3.22	3.71	4.68
Lavandulol	0.25	0.34	0.51	0.66
Terpinen-4-ol	1.32	1.84	2.59	3.80
α-Terpineol	0.46	0.47	0.33	0.42
Linalyl acetate	41.33	40.78	38.09	33.36
Lavandulyl acetate	2.13	2.09	2.11	1.79
β-Caryophyllene	1.40	1.34	1.24	1.02
Total high boiling point compounds	10.64	5.81	5.69	4.64
Dominant aromatic notes	Sharp, fresh, pungent	Sharp, fresh, sweet	Fresh, sweet, sharp	Dry, fresh
Negative notes	-	-	-	Slight old hay
Impact	Very strong	Strong	Vigorous	Medium
Balance	Too sharp	Very fresh	Good	Acceptable
Hedonistic response (+5 to –5)	1	2	3	2

The yield appears to peak, but the changes are not great. The aromatic characters do not decline much in later maturity. There is therefore a wider choice of harvest time without markedly affecting the oil yield or quality.

Timing of maximum yield

Super
(RR05)

Timing of negative notes

Timing of aromatic quality

Table 5: Yields (ml/100 g fresh weight), oil composition (peak area percent) and main aromatic notes of Super. The hedonistic response reflects like (0 to 5) or dislike (0 to –5).

	Stage 1	Stage 2	Stage 3	Stage 4
Yield	2.0	1.5*	1.8	1.7
3-Octanone	0.47	0.50	0.57	0.58
Cineole	8.15	7.93	7.99	6.86
Limonene/phellandrene/*cis*-ocimene	0.81	0.69	0.67	0.57
trans-Ocimene	5.95	4.04	4.64	3.41
Linalool	31.13	34.80	35.39	38.38
Camphor	9.43	10.86	9.41	8.81
Borneol	3.24	3.48	3.26	3.58
Lavandulol	0.16	0.22	0.21	0.23
Terpinen-4-ol	0.13	0.20	0.16	0.34
α-Terpineol	0.55	0.64	0.46	0.46
Linalyl acetate	28.15	25.53	25.84	25.09
Lavandulyl acetate	1.15	1.00	0.94	0.88
β-Caryophyllene	0.94	0.83	0.82	0.86
Total high boiling point compounds	4.51	4.34	4.18	4.17
Dominant aromatic notes	Fresh, sharp	Fresh, dry	Dry, sweet	Sweet, dry
			sharp	
Negative notes	-	-	Fecal,	Flat, some
			slightly burnt	old hay
Impact	Vigorous	Vigorous	Medium	Mild
Balance	Lacks	Fresh	Unacceptable	Acceptable
	sweetness			
Hedonistic response (+5 to –5)	0	2	-1	1

* - Flower heads dried on floor for two hours before distillation.

The changes with maturity in oil yield, composition and quality of all 4 cultivars are summarised in Table 6.

RR05 – Distillation Timing

- Plants in their 2nd and 3rd flowering season where obtained by C & F
- Oil samples were distilled for Pacific Blue, Avice Hill, Grosso and Super at the four stages.
- Distillation time was 60 minutes with samples taken every 5 minutes for analysis.
- Samples of each stage were then analysed by GC and evaluated by nose.
- The results refer to one growing site and one production year.

Table 7: Oil volumes (incremental, % of total volume and cumulative % of total volume), yields (ml/100 g fresh weight), oil composition (peak area percent) and main aromatic notes of oil fractions of Pacific Blue. The hedonistic response reflects like (0 to 5) or dislike (0 to –5).

	Distillation fractions (minutes)									
	0-5	5-10	10-15	15-20	20-25	25-30	30-40	40-50	50-60	Total
Yield (increment volume, ml)	8.8	20.0	10.1	6.9	4.0	2.6	2.2	1.0	0.7	56.3
Yield (% of total volume)	15.6	35.5	17.9	12.3	7.1	4.6	3.9	1.8	1.2	
Cumulative yield (%total)	15.6	51.1	69.0	81.3	88.4	93.0	96.9	98.7	100.0	
Yield (ml/100 g fresh weight)	0.25	0.57	0.29	0.20	0.11	0.07	0.06	0.03	0.02	1.60
3-Octanone	4.09	3.16	1.59	0.86	0.52	0.37	0.27	<0.1	<0.1	
Cineole	2.77	2.12	0.99	0.71	0.67	0.71	0.86	1.03	1.18	
Limonene/phellandrene/*cis*-ocimene	1.47	1.14	0.56	0.44	0.44	0.49	0.63	0.81	1.01	
trans-Ocimene	7.96	5.93	2.48	1.65	1.51	1.56	1.86	2.29	2.76	
Linalool	36.15	36.83	38.24	36.97	34.46	32.06	28.41	23.62	17.75	
Camphor	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	
Borneol	0.28	0.37	0.46	0.52	0.59	0.66	0.74	0.75	0.62	
Lavandulol	0.60	0.77	0.96	1.10	1.25	1.34	1.39	1.25	0.90	
Terpinen-4-ol	6.88	8.01	9.40	10.21	10.66	10.87	10.25	8.68	0.57	
α-Terpineol	0.19	0.30	0.54	0.82	1.18	1.60	2.16	2.68	2.59	
Linalyl acetate	22.78	24.86	27.46	27.57	26.65	24.99	23.03	20.83	19.06	
Lavandulyl acetate	2.34	2.85	3.53	4.08	4.55	4.96	5.43	6.08	6.66	
β-Caryophyllene	1.06	1.37	1.74	1.99	2.25	2.45	2.69	3.11	3.81	
Total high boiling point compounds	4.72	6.56	8.97	10.73	12.77	14.67	17.47	21.72	29.71	
Dominant aromatic notes	Sweet,rich, fresh	Sweet,rich, fresh	Dry herbal, slight fruit	Strong herbal	Strong herbal	Herbal,hay cooked	Cooked herbal, hay	Acrid, hay	Acrid, hay	
Negative notes	-	-	-	-	Slightly cooked	Cooked	Cooked	Acrid, hay	Acrid, hay	
Impact	Gentle	Mild	Mild	Vigorous	Vigorous	Strong	Vigorous	Strong	Strong	
Balance	Sweet	Sweet	Dry	Herbal	Herbal	Cooked	Cooked	Acrid	Acrid	
Hedonistic response (+5 to –5)	+4	+4	+2	0	0	-2	-2	-3	-3	

Table 8: Oil volumes (incremental, % of total volume and cumulative % of total volume), yields (ml/100 g fresh weight), oil composition (peak area percent) and main aromatic notes of oil fractions of Avice Hill.

	Distillation fractions (minutes)									
	0-5	5-10	10-15	15-20	20-25	25-30	30-40	40-50	50-60	Total
Yield (increment volume, ml)	15.6	13.3	7.2	4.3	2.6	1.5	1.2	0.8	0.5	47
Yield (% of total volume)	33.2	28.3	15.3	9.2	5.5	3.2	2.6	1.7	1.1	
Cumulative yield (%total)	33.2	61.5	76.8	86.0	91.5	94.7	97.2	98.9	100.0	
Yield (ml/100 g fresh weight)	0.42	0.36	0.19	0.12	0.07	0.04	0.03	0.02	0.01	1.27
3-Octanone	5.75	1.97	0.88	0.55	0.37	<0.1	<0.1	<0.1	<0.1	
Cineole	0.91	0.39	<0.1	<0.1	<0.1	<0.1	tr	tr	tr	
Limonene/phellandrene/ *cis*-ocimene	0.34	0.21	<0.1	0.21	0.24	0.33	0.38	0.38	0.40	
trans-Ocimene	14.12	6.01	3.96	3.63	3.71	3.94	4.63	5.14	5.16	
Linalool	10.02	11.53	11.85	12.05	12.17	12.09	11.86	11.20	9.95	
Camphor	0.15	0.16	0.14	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	
Borneol	0.79	1.33	1.69	1.89	1.95	1.88	1.68	1.29	0.73	
Lavandulol	tr	tr	tr	tr	tr	tr	tr	tr	tr	
Terpinen-4-ol	3.66	4.93	5.34	5.26	4.78	4.38	3.54	2.22	1.39	
α-Terpineol	0.37	0.81	1.51	2.33	3.13	3.76	4.17	4.20	3.54	
Linalyl acetate	42.32	52.39	51.48	48.30	44.92	41.79	38.05	31.42	26.44	
Lavandulyl acetate	1.78	2.66	3.10	3.30	3.40	3.44	3.52	3.65	3.74	
β-Caryophyllene	2.32	4.34	5.53	5.96	6.07	6.14	6.50	7.68	9.30	
Total high boiling point compounds	4.40	8.85	12.52	14.82	16.74	18.66	21.23	27.97	36.12	
Dominant aromatic notes	Rich,sweet creamy	Rich,sweet dry	Sweet,fresh complex	Fruit,floral fresh	Floral, geranium	Green herb geranium	Green herb	Cooked herb acrid	Cooked herb acrid	
Negative notes	-	-	-		Solvent	Pungent	Cooked	Cooked acrid	Cooked acrid	
Impact	Strong	Strong	Strong	Vigorous	Vigorous	Vigorous	Medium	Medium	Medium	
Balance	Rich sweet	Rich	Good sweet and fresh	Fresh, floral	Floral	Green herb	Green herb	Cooked herb	Cooked herb	
Hedonistic response (+5 to –5)	+5	+5	+4	+2	0	-1	-2	-3	-3	

Table 9: Oil volumes (incremental, % of total volume and cumulative % of total volume), yields (ml/100 g fresh weight), oil composition (peak area percent) and main aromatic notes of oil fractions of Grosso.

	Distillation fractions (minutes)									
	0-5	5-10	10-15	15-20	20-25	25-30	30-40	40-50	50-60	Total
Yield (increment volume, ml)	23.0	24.8	16.0	9.2	5.5	3.2	2.6	1.2	0.6	86.1
Yield (% of total volume)	26.7	28.8	18.6	10.7	6.4	3.7	3.0	1.4	0.7	
Cumulative yield (%total)	26.7	55.5	74.1	84.8	91.2	94.9	97.9	99.3	100.0	
Yield (ml/100 g fresh weight)	0.73	0.79	0.51	0.29	0.17	0.10	0.08	0.04	0.02	2.45
3-Octanone	0.64	0.38	0.22	<0.1	<0.1	<0.1	tr	nd	nd	
Cineole	7.64	3.37	1.61	1.02	0.77	0.48	0.52	0.34	0.28	
Limonene/phellandrene/*cis*-ocimene	1.59	0.64	0.36	0.3	0.31	0.24	0.48	0.58	0.62	
trans-Ocimene	5.07	2	1.06	0.83	0.81	0.65	1.12	1.3	1.42	
Linalool	33.71	34.6	31.87	29.48	27.76	25.78	23.5	19.32	15.86	
Camphor	6.86	7.19	6.73	6.08	5.42	4.53	3.67	2.43	1.59	
Borneol	2.22	3.19	4.19	5.15	5.65	5.68	5.29	4.41	3.43	
Lavandulol	0.34	0.49	0.62	0.71	0.73	0.72	0.65	0.52	0.39	
Terpinen-4-ol	1.92	2.48	2.86	3.05	3.01	2.85	2.51	1.91	1.31	
α-Terpineol	0.17	0.40	0.79	1.32	1.86	2.36	2.77	3.00	2.86	
Linalyl acetate	29.23	36.73	38.37	37.66	36.38	36.37	34.14	31.65	27.76	
Lavandulyl acetate	1.31	1.97	2.47	2.81	2.96	3.21	3.38	3.76	3.95	
β-Caryophyllene	0.61	0.9	1.16	1.34	1.4	1.52	1.64	1.94	2.36	
Total high boiling point compounds	1.57	2.98	5.2	7.09	8.63	10.41	13.07	18.37	26.23	
Dominant aromatic notes	Sweet	Sharp	Sharp	Herbal	Herbal	Dry	Burnt	Burnt	Dry	
	fresh	fresh	herbal	sharp		old flower	acrid	acrid	old hay	
Negative notes	-	-	-	-	Slightly	Slightly	Burnt	Burnt	Old hay	
					cooked	cooked	acrid	acrid		
Impact	Mild	Strong	Medium	Medium	Medium	Medium	Strong	Strong	Medium	
Balance	Fresh	Sharp	Sharp	Herbal	Herbal	Dry	Acrid	Burnt	Old hay	
Hedonistic response (+5 to –5)	+2	+1	+1	+1	0	0	-3	-3	-2	

Table 10: Oil volumes (incremental, % of total volume and cumulative % of total volume), yields (ml/100 g fresh weight), oil composition (peak area percent) and main aromatic notes of oil fractions of Super.

	0-5	5-10	10-15	15-20	20-30	30-40	40-60	Total
Yield (increment volume, ml)	20.0	9.0	3.6	2.0	1.4	0.6	0.2	36.8
Yield (% of total volume)	54.35	24.46	9.78	5.43	3.80	1.63	0.54	
Cumulative yield (%total)	54.4	78.8	88.6	94.0	97.8	99.5	100.0	
Yield (ml/100 g fresh weight)	0.92	0.41	0.17	0.09	0.06	0.03	0.01	1.69
3-Octanone	0.74	0.56	0.45	0.32	<0.1	tr	tr	
Cineole	11.83	7.72	5.23	2.83	1.28	0.59	0.30	
Limonene/phellandrene/ *cis*-ocimene	0.96	0.66	0.47	0.35	0.37	0.54	0.49	
trans-Ocimene	5.97	3.93	2.54	1.77	1.64	2.16	2.08	
Linalool	33.70	34.73	35.32	34.85	31.21	20.48	6.21	
Camphor	10.08	10.79	11.10	10.88	9.55	5.09	0.82	
Borneol	2.44	3.47	4.35	5.10	6.17	6.46	2.08	
Lavandulol	0.15	0.21	0.25	0.27	0.29	0.27	tr	
Terpinen-4-ol	0.15	0.21	0.26	0.30	0.34	0.31	tr	
α-Terpineol	0.37	0.65	1.02	1.42	2.02	2.49	0.80	
Linalyl acetate	22.92	26.24	26.74	27.18	27.31	25.22	18.83	
Lavandulyl acetate	0.80	1.01	1.13	1.27	1.54	2.04	2.06	
β-Caryophyllene	0.62	0.85	1.00	1.16	1.46	2.32	3.63	
Total high boiling point compounds	2.78	3.88	5.59	7.24	10.87	21.98	50.99	
Dominant aromatic notes	Sweet fresh	Sharp	Fresh	Herbal	Cooked	Old hay	Cooked	
	ester	fresh	earthy	slightly cooked	Herbal	cooked	acrid	
Negative notes	-	-	-	Cooked	Cooked	Old hay	Coooooked	
						cooked	Acrid	
Impact	Vigorous	Very strong	Vigorous	Medium	Medium	Medium	Vigorous	
Balance	Fresh	Sharp	Earthy	Herbal	Cooked	Cooked	Acrid	
Hedonistic response (+5 to –5)	+2	-1	+1	0	-2	-2	-3	

Notes For Small Batch Distillers

- Not all Growers are able to distil their entire crop at once due to their still capacity. They might span their harvest over several days, or possibly even weeks.
- Monitoring and documenting the maturity changes during the harvest and distilling period is very important.
- Don't mix all the oils from each day, keep them separate with good records as this will be beneficial in your learnings.
- If you are distilling yourself, experiment with the timings and the aromatic outcomes, keep good records and label everything, there could be a Gold in there that you'll want to replicate the timings next season!

Summary

- The Crop & Food research shows that there is an optimal maturity stage for each variety when it comes to yield and aromatic outcomes.
- There is no strict rule on when to pick as each grower's yield and quality will have variations based on their own site and climate, but these stages will assist in your learnings and ultimately your oil consistency.
- The same research shows that extended distillation time has a negative result on aromatic outcomes. If you are using a contracted distiller, have a discussion about this and perhaps experiment with the timings.
- If you are distilling yourself, absolutely experiment with the timings and monitor the aromatic outcomes, keep good records though and label everything, there could be gold in there!


SUPREME OIL AWARDS
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