

AMBIENT LOADING



of citrus at production source

Citrus has an edge on other fruit when it comes to ambient loading, due to its hardness and adaptability to conditions. By Mitchell Brooke



Studies have been conducted and scientific articles drafted by Drs Paul Cronjé and Tarl Berry, CRI (et al.) that outline the conditions of ambient loading. This reassuring research underscores the need for more studies, to further improve application. It presents a pathway for all citrus types to potentially be loaded ambient to non-cold protocol markets, under strictly controlled and guided measures.

An overview of the research and parameters

A 2021 research article, "Cooling of ambient-loaded citrus in refrigerated containers" published by Drs T Berry, P Cronjé, et al. outlines an ambient loading research trial that was carried out. The article clearly draws on the conclusion that ambient loading of citrus into refrigerated containers is effective. This research has essentially paved the way for a greater volume of citrus that has, in more recent years, been successfully loaded from ambient conditions into refrigerated containers.

The Perishable Products Export Control Board (PPECB) outlines the parameters and guidelines for ambient loading of citrus (refer to **sections 4 – 5** of said article).

There remains a need in the industry for trials that prove the feasibility of packing all citrus types from ambient temperature into reefer containers. This will be especially relevant to late mandarins, which are in a rapid growth phase and will need an alternative logistics and cold-chain solution to prevent foreseeable bottlenecks.

Ambient loading is an approach whereby fruit is loaded directly into the reefer container (having skipped the precooling facility), where the cooling commences. This method fundamentally addresses the impediments currently confronting the citrus industry: increased export volumes and associated logistical complications; increasing energy costs and associated increases in logistics, shipping and cold chain costs; and consumer buying behaviour, and the related demand for sustainable foods.

Ambient loading was amongst related topics featured in recent editions of the *SA Fruit Journal* with a call to fast-track innovation across the citrus export supply chain. Notably, innovation will be a fundamental driving force behind longer-term sustainability in the citrus industry. So, is ambient loading a noteworthy conduit for innovation in the citrus supply chain?

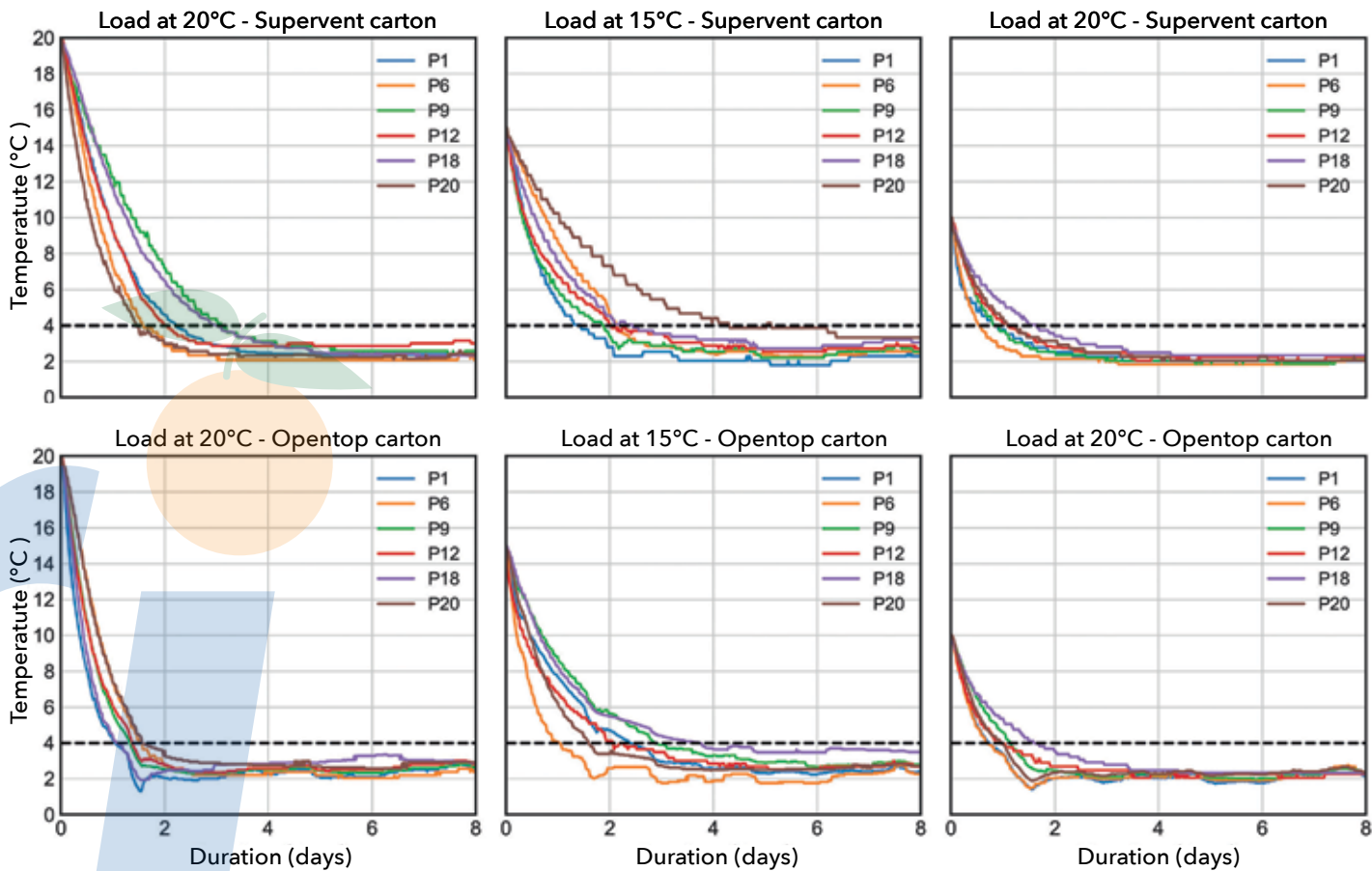


Illustration 1. Graphs indicating temperature profile loaded ambient to 4°C

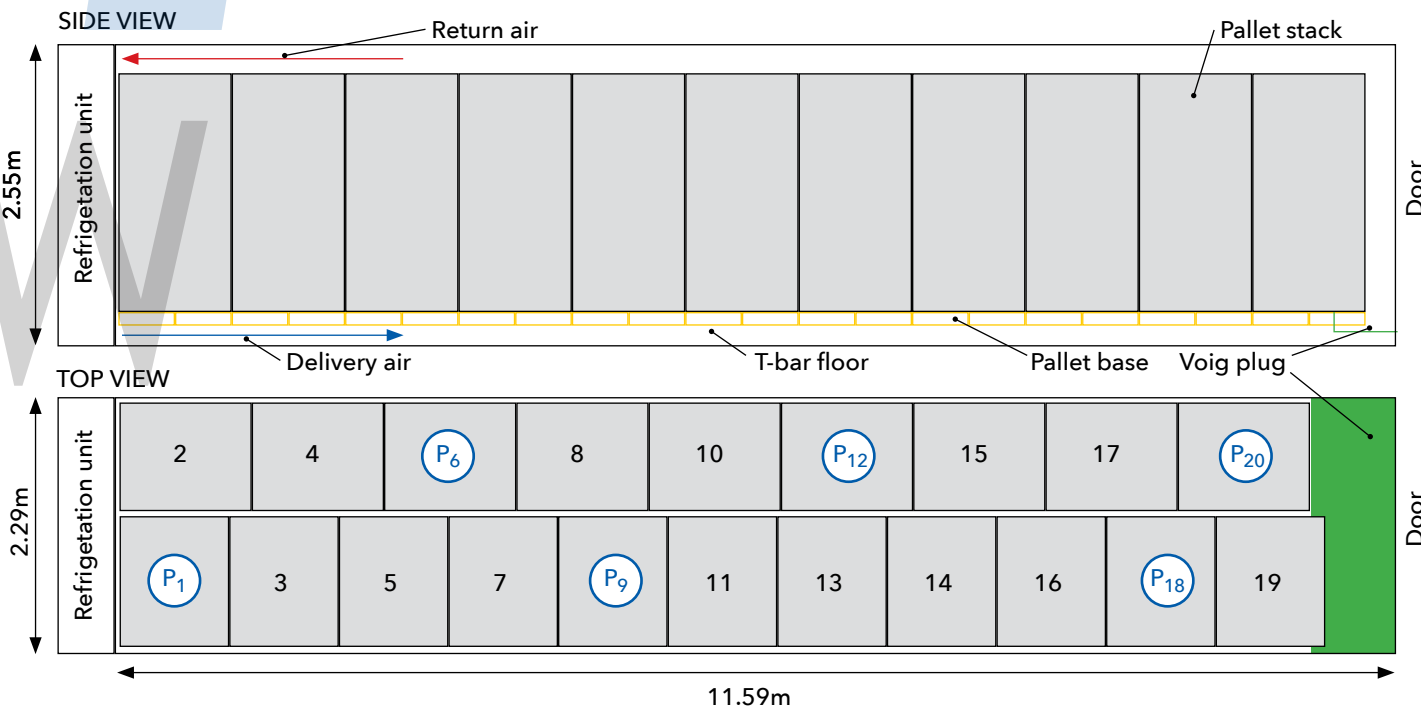


Figure 1. Top and side views showing the pallet layout inside a refrigerated container, as well as the placement of the void plug (green). White circles indicate which pallets were probed with loggers.

Ambient loading as an application

The application of ambient loading has gained momentum over the years. A variety of loading location options have been pursued, from loading reefer containers ambient at warehouses in port precincts to transporting containers by road that were loaded ambient at packhouses, and railing of reefer containers packed ambient at packhouses to port terminals for export. Perhaps by the increasing demands of cold treatment shipment applications, many have sought to send fruit to cold stores as a batch rather than to pursue loading ambient as a dedicated measure in the process. The most significant success in packing ambient citrus into refrigerated containers has been to dedicate the application to fixed programmes and markets that do not require precooling in the importing protocol.

In this way, container lots can be assembled and accumulated and containers packed as timeously as possible. The product packed should be loaded with cooling commencing promptly, thus limiting the product's potential risk exposure. The biggest mistake in ambient loading is accumulating fruit over a series of consignments with delays in container lot collections. This delays the packing of the containers and exposes the product to the risk of quality issues. The guiding principle

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should always be to accumulate a container lot at the packhouse in the shortest timeframe possible. Then, to send the fruit to be packed into a refrigerated container the moment it lands on the cross-docking facilities floor or at most, a day or two later.

In some cases, packhouses send five trucks of 24 pallets (totalling 120 pallets) to be packed into six containers as a lot, or send four trucks of 25 pallets (totalling 100 pallets) to pack into five containers as a lot. The featured trials conducted by Drs Cronjé and Berry suggest that citrus loaded ambient at 20°C into a refrigerated container can be cooled to 4°C within four days of powering the unit consistently after packing. Additionally, the research outputs suggest that a step-down protocol should be applied when loading injury-sensitive varieties.

Market volume for ambient loading

If one considers which countries citrus can be exported to by loading from ambient into refrigerated containers, at least a third of the volume exported from port regions in SA can be loaded as ambient. Therefore, there is considerable scope for additional volumes of citrus to be loaded this way. However, the data contained in **Table 1**. omits the soft citrus categories that are prohibited from loading ambient at this time. As outlined earlier, late mandarins are a fast-growing commodity. Hence, ambient loading of late mandarin categories (being hardier amongst mandarin categories) should be aggressively explored. Only countries that do not require precooling or cold treatment are permitted to load product from ambient temperatures.

Where is the big gain on ambient loading?

There's a historical trend to pack refrigerated containers at conventional sites where citrus is loaded from ambient, either at packhouses or port facilities. But the C. Steinweg Bridge facility in City

Deep, Johannesburg, may have cracked the code to the most effective method. At this site, citrus is routed from packhouses to the ambient warehouse in City Deep, where the product is accumulated and loaded onsite alongside the City Deep Rail Terminal operated by Transnet Freight Rail. The containers are collected from container depots within the precinct, packed at C. Steinweg Bridge and either plugged in onsite, or at the City Deep Terminal.

It takes only a few hours for the reefer containers to be packed and plugged into power, kickstarting the cold chain soon after loading the containers. A trainload of up to 48 reefer containers is then loaded onto the purpose-built reefer train sets (equipped with diesel generators). Thus, providing power to the containers whilst being transported to port for export. A typical rail transit time from City Deep to the Durban Container Terminal takes 16 – 24 hours (reefer trains tend to receive utmost priority from Transnet Freight Rail). The containers are then offloaded from the trains and placed directly into the reefer stacks at the terminal. The reefer trains either return empty reefer containers to City Deep to replenish stock, or they are used to transport full import containers.

In 2020 Agrigate One assessed over 100 reefer containers packed at the C. Steinweg Bridge facility. The assessment compared routing citrus to a cold store in Durban to packing at the C. Steinweg Bridge facility at City Deep. The findings indicated that as an average comparison, the product cold chain was enacted up to 24 hours less at the C. Steinweg Bridge facility. This was found to be mainly a result of transport delays entering the Durban facilities, where trucks stand for long periods, waiting to be offloaded. With better planning from all the stakeholders, the fruit can enter the cold chain even quicker, reducing the product's standing time. The analysis affirms the benefits of product-loaded ambient at a facility such as C. Steinweg Bridge. For example:

- 1. Cost reductions due to the elimination

Table 1. Volume by commodity, by country applicable for ambient loading

Sum of pallet quantity		Exit port	Year					
		Cape Town			Durban			Maputo
Country	Commodity group	2021	2022	2021	2022	2022	PE/Coega	2022
Russian Federation	Grapefruit	3 005	2 578	19 986	17 811		439	391
	Lemons	3 761	3 209	20 729	17 168		6 642	14 055
	Navels	2 323	2 479	7 456	10 455		5 481	13 290
	Valencias	3 292	2 055	48 269	41 964		3 824	1 647
Russian Federation Total		12 381	10 321	96 439	87 398		16 387	29 383
United Arab Emirates	Grapefruit	158	327	2 593	2 857		1 288	621
	Lemons	4 524	6 610	26 376	27 784	595	18 310	18 875
	Navels	4 415	6 033	19 540	14 511	460	14 254	18 068
	Valencias	4 032	6 007	33 759	25 680	1 620	9 084	8 895
United Arab Emirates total		13 130	18 977	82 268	70 832	2 675	42 936	46 459
Saudi Arabia	Grapefruit			631	441		62	
	Lemons	525	1 133	15 533	17 214	100	10 914	8 495
	Navels	3 419	6 796	11 657	10 898	80	14 121	12 758
	Valencias	1 141	1 136	21 437	14 665	1 075	4 959	4 060
Saudi Arabia total		5 085	9 065	49 258	43 218	1 255	30 057	25 312
Malaysia	Grapefruit	20	20	577	492			40
	Lemons	1 299	993	7 477	8 576	160	1 495	2 745
	Navels	4 042	2 623	10 527	11 640	491	1 947	4 570
	Valencias	2 905	1 956	12 967	12 997	1 560	249	3 334
Malaysia total		8 267	5 591	31 548	33 705	2 211	3 690	10 688
United Kingdom	Grapefruit	993	1 062	8 287	6 397		200	472
	Lemons	8 503	11 343	3 064	5 098		18 580	17 361
	Navels	9 641	8 130	3 011	3 393		8 248	7 476
	Valencias	8 279	8 797	16 795	17 481		7 633	11 804
United Kingdom total		27 416	29 332	31 157	32 369		34 661	37 112
Canada	Grapefruit	504	1 188	6 784	5 008		394	234
	Lemons	5 994	7 446	6 022	7 786		10 275	9 511
	Navels	7 899	10 581	4 692	5 076		4 514	4 992
	Valencias	6 491	5 533	5 349	4 919		3 752	2 731
Canada total		20 887	24 748	22 847	22 789		18 935	17 469
Hong Kong	Grapefruit	246	20	1 593	1 461		120	170
	Lemons	1 487	927	8 525	7 860	20	2 553	3 891
	Navels	2 770	2 436	4 821	9 142		3 746	6 900
	Valencias	1 386	1 075	2 920	2 777		422	718
Hong Kong total		5 889	4 458	17 859	21 240	20	6 841	11 678
Kuwait	Grapefruit	28	176	157	160		20	
	Lemons	376	958	4 330	4 065		3 250	2 042
	Navels	665	959	2 471	906		1 107	1 234
	Valencias	1 278	747	6 346	2 925	60	892	575
Kuwait total		2 348	2 840	13 304	8 056	60	5 268	3 851
Ireland	Grapefruit	135	130	420	411			
	Lemons	240	246	120	826		525	646
	Navels	680	779	427	261		806	944
	Valencias	85	1 168	2 068	1 211		454	535
Ireland Total		1 140	2 323	3 035	2 709		1 785	2 125
Grand total		96 543	107 654	347 716	322 316	6 221	160 561	184 078

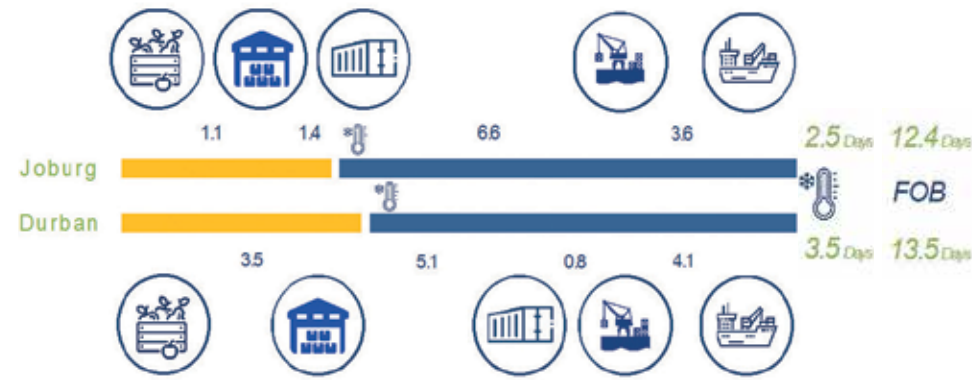


Illustration 2. Agrigate One assessment of cold chain comparison between routing citrus from packhouses to Durban cold store, and from the Steinweg Bridge City Deep facility to the harbour

of cold store precooling costs, and naturally lower cost to pack containers from ambient conditions. The cost variance will only increase in tandem with cold storage costs, due to high increases in the price of electricity.

2. During peak citrus season: Port delays and congestion are mitigated, as containers are railed to terminal stacks, thus omitting road congestion and potential delays.

3. The routing of trucks between packhouses and City Deep is more efficient and cost-effective than transporting to Durban, for example. Transport rates from packhouse to City Deep remain constant throughout the season. Whereas the transport rates from packhouse to Durban, for example, increase significantly during the peak season.

- The product cold chain is potentially enacted more timeously when containers are packed within a short timeframe at City Deep, resulting in longer, better product shelf life.
- Carbon emission reductions: Cold store energy is eliminated; and rail transport energy is primarily electricity-driven, a significant benefit for growers.
- All of the major South African port terminals, including DP World Maputo, can be accessed by rail from City Deep.
- During the citrus season, in the winter months, the ambient warehouse temperature at City Deep is considerably cooler. This renders the fruit cooler at load-out.

Clearly, ambient loading of citrus into reefer containers packed directly from packhouses or from facilities located inland, potentially holds significant benefits. These are well documented through research and conducted trials.

Loading at C. Steinweg Bridge from City Deep represents an ideal rail solution that paves the way to rapid expansion of ambient loading, and for more citrus to be railed to ports for export. This is particularly significant in the wake of increased road transport demands due to the growth forecast in coming years. ▶

Research conclusion

This study investigated the effect of loading temperatures and package designs (A15C and E15D cartons from 2018) on the cooling performance of ambient-loaded citrus fruit in refrigerated containers (RC). Although, a high degree of cooling variability was observed both between and within each container during the cool-down process. These were largely inconsequential after roughly four days of cooling, when the container was at a steady-state (stably cooled down).

The study further showed that each container's unique airflow distribution and corresponding cooling behaviour were attributed to slight differences in the gaps between the pallet stacks and the container walls. These gaps are caused by unavoidable geometric differences in each pallet stack, resulting from variations in carton placement, stack tilting, pallet loading, and general stack distortion. Importantly, certain gap combinations could either increase or decrease cooling rates and uniformity. These insights highlight the importance of following best practice loading protocols such as correctly installing the void plug.

In terms of quality, ambient loading did not increase decay incidence or negatively influenced quality, further validating this approach for citrus fruit. The study showed that partially pre-cooled fruit was less susceptible to chilling injury (in the case of chilling injury-sensitive varieties) than fruit loaded at warmer temperatures. Consequently, ambient loading offers notable advantages in terms of quality and reductions in hot spots when shipping partially pre-cooled citrus fruit to export markets.

Follow-up studies showed that improving packaging porosity (ventilation) significantly reduced cooling variability and allowed for a "softer", more controlled cool-down process. This is due to the airflow being more uniformly distributed throughout the container versus cold airflow being concentrated to the fruit near the refrigeration unit. The industry adoption of the new A15C-S2 carton thus, uniquely and optimally positions itself to utilise ambient loading.

Cost reductions, mitigated port delays and reduced carbon emissions are amongst the benefits of using ambient loading.

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