Government of South Australia
Department of Primary Industries and Regions

SARDI
SOUTH AUSTRALIAN RESEARCH AND DEVELOPMENT INSTITUTE

ACE FACT SHEET

Loxton weather and climate review during 2022–23 season

Almond production is influenced by weather conditions over the previous 18 months, starting with bud initiation and development during the previous summer followed by chill over winter to satisfy dormancy. Almonds blossom earlier than most other tree crops but are also one of the last crops to be harvested.

Temperature

At Loxton the mean temperature from December 2021 to April 2022 was much warmer than usual. (Figure 1 and Table 1). These warmer temperatures may have affected the number of floral buds available in the 2022/23 season. Warmer conditions continued until August with each month apart from May being much warmer than usual. These warmer conditions meant that the accumulation of 23 chill portions was later than usual (late June) and the total chill portions accumulated by 1st August was less than usual (45 chill portions). There is considerable year-to-year variation in both these metrics, but it is worth noting that since 1985 when the current Loxton meteorological station (station 24024) commenced, total chill portions have been declining at about 1 portion every 5 years, delaying the date that 23 chill portions are reached

The almond vegetative and fruit growing season (1st September to 30th April) for the 2022/23 season was one of the coolest for over 20 seasons (mean temperature of 18.9°C, Figure 2). These cooler conditions meant the accumulation of heat units (growing degree days) was lower than usual (Table 1).

While mean temperature in some months (September and November) was cooler than usual, what marked the 2022/23 season as being unusual was the absence of months that were warmer than usual. This cooler summer was likely due to the La Niña event and differs from the warming trend experienced over recent decades. Other consistencies with the influence of La Niña were the higher rainfall, and lower radiation and evapotranspiration (Figure 2).

Rainfall

Rainfall was higher in the 2022/23 season at 380 mm, well above the seasonal average of 179 mm (average period from 1957/58 season to 2022/23 season). Spring rainfall in particular was very much above average with several days recording in excess of 20 mm (Figure 1).

Radiation

Radiation was the lowest on record averaging 18.6 MJ/m^2/day (Figure 2), and the previous season averaged 19.4 MJ/m^2/day, both of which diverged from the long-term average (1957/58 season to 2021/22 season) of 21.6 MJ/m^2/day.

Evapotranspiration

The lower radiation may have contributed to reduced photosynthesis and kernel yield, but certainly contributed to the lower evapotranspiration. There were many more days with lower evapotranspiration than average for the time of year, in particular during spring and early summer (Figure 1). As a consequence, evapotranspiration in the 2022/23 season was 1239 mm, below the general trend of increasing evapotranspiration (associated with lower relative humidity as a consequence of warming temperatures) that has occurred in recent decades (Figure 2).

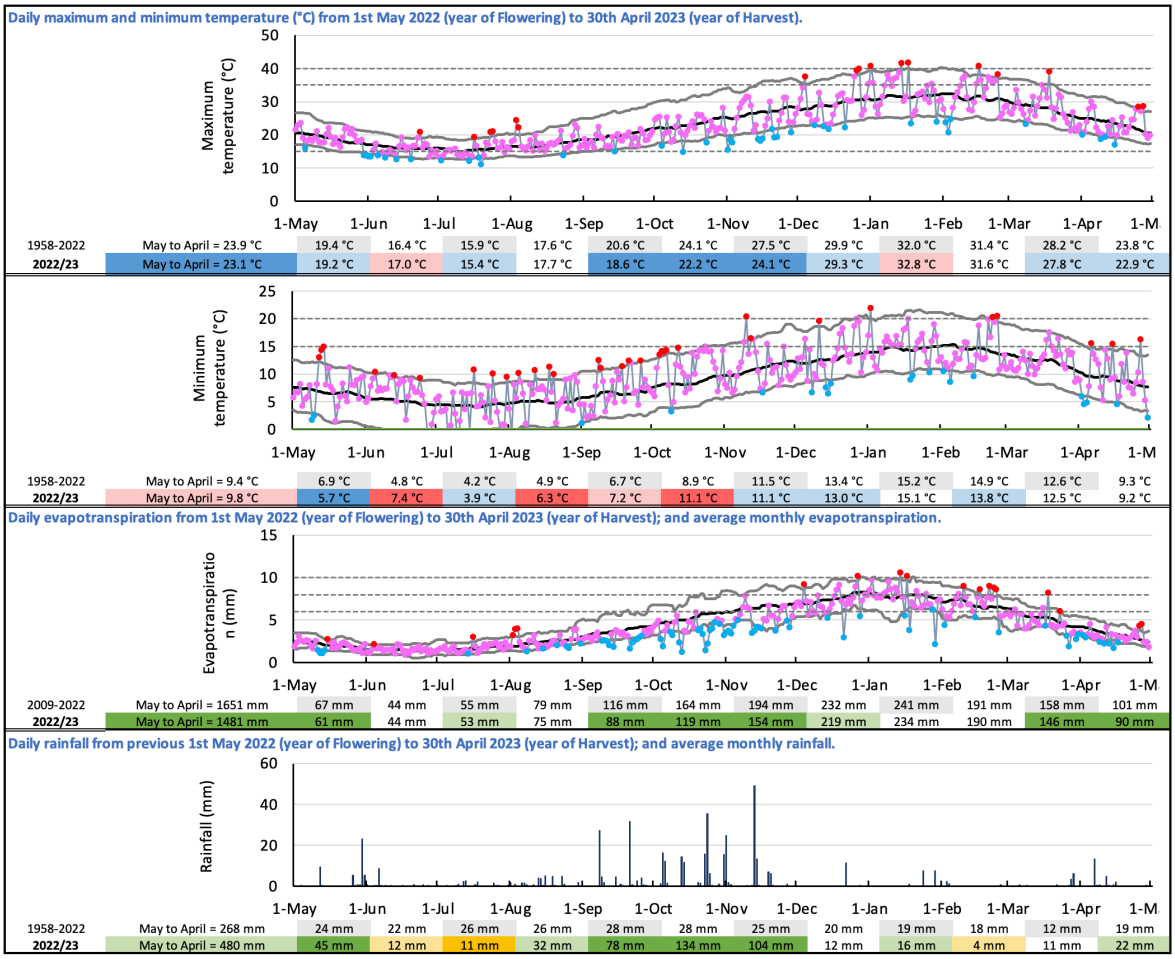

Figure 1 Daily weather data for Loxton from 1st May 2022 to 30th April 2023

Explanation to Figure 1

Daily weather graphs for the 2022/23 season. In individual graphs, the daily values are shown by individual points which are coloured red if they are warmer (or drier) than the long term 90th percentile for that day, blue if they are cooler (or wetter) than the long-term 10th percentile for that day or pink (others). The long-term median (black line), 10th and 90th percentile (grey lines) of the 7 days centred on each day are shown. Dashed lines are displayed as guides to define thresholds. The monthly averages are shown for the long-term history and for the 2022/23 season. The colours of the boxes for the months in the 2022/23 season designate the decile of those values. Months that were warmer than usual are coloured red while those that were cooler than usual are coloured blue; Months that had more evapotranspiration than usual are coloured yellow while those that had less evapotranspiration than usual are coloured green; months that had less rainfall than usual are coloured yellow while those that were wetter than usual are coloured green.

Table 1 Monthly climate data Loxton for the years since the establishment of the Almond Centre of Excellence

Growing season temperature (GST) calculated from 1st September to 30th April, and monthly temperature (°C).
Colours denote the corresponding decile (coolest shown in blue, middle 2 deciles having no colour, warmest in red).

	Growing Season Temperature	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
1958-2022	19.4	13.1	10.6	10.1	11.2	13.7	16.5	19.5	21.7	23.6	23.2	20.4	16.5
2017/18	20.8	12.3	9.3	10.7	10.8	14.7	18.0	21.8	22.0	25.4	24.6	20.8	18.9
2018/19	20.2	12.9	9.9	11.1	12.0	12.7	18.1	18.9	24.2	26.6	22.6	21.5	17.0
2019/20	19.6	13.6	10.2	11.5	10.7	14.0	17.6	19.0	24.4	23.3	22.4	19.8	16.1
2020/21	19.4	12.1	9.7	9.4	10.7	15.1	16.7	21.8	21.4	23.2	22.0	19.7	15.8
2021/22	20.0	12.7	12.0	10.3	12.3	14.1	15.7	18.7	22.4	26.3	23.1	21.9	18.1
2022/23	18.9	13.2	11.0	9.7	12.0	12.9	16.6	17.6	21.1	23.9	22.7	20.1	16.1

Growing degree days base of 10°C (GDD10) calculated from 1st September to 30th April) (°C days).
Accumulation of GDD10 from 1st September to end of each month (°C days).
Monthly totals shown for July and August; and May and June. Colours denote the corresponding decile (coolest shown in blue, middle 2 deciles having no colour, warmest in red).

	Growing Season GDD	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
1958-2022	2273	100	38	28	51	112	315	599	961	1383	1754	2077	2273
2017/18	2604	78	11	46	42	142	390	744	1117	1593	2002	2337	2604
2018/19	2472	93	30	63	69	82	332	600	1039	1553	1906	2263	2472
2019/20	2334	111	36	52	38	121	357	627	1074	1486	1846	2150	2334
2020/21	2288	70	24	13	44	153	360	715	1068	1477	1812	2112	2288
2021/22	2428	95	65	40	77	123	299	561	944	1449	1816	2185	2427
2022/23	2150	101	43	22	67	87	293	521	866	1298	1654	1968	2150

Growing season evapotranspiration calculated from 1st September to 30th April, and monthly evapotranspiration (mm).
Colours denote the corresponding decile (lowest shown in green, middle 2 deciles having no colour, highest in yellow).

	Growing Season Evapotranspiration	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
1958-2022	1393	67	44	55	79	116	164	194	232	241	191	158	101
2017/18	1440	58	36	67	75	129	174	191	214	252	189	173	118
2018/19	1443	69	38	62	92	116	171	183	239	270	187	164	114
2019/20	1435	70	32	54	83	123	181	205	269	228	182	157	90
2020/21	1379	66	44	54	71	124	138	219	230	228	185	153	103
2021/22	1384	70	54	59	84	118	155	162	245	247	196	164	98
2022/23	1239	61	44	53	75	88	119	154	219	234	190	146	90

May to April Rain calculated from 1st May to 30th April, and monthly rain (mm).
Colours denote the corresponding decile (wettest shown in green, middle 2 deciles having no colour, driest in yellow).

	May to April Rain	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
1958-2022	268	24	22	26	26	28	28	25	20	19	18	12	19
2017/18	172	15	2	11	31	6	19	56	19	4	3	5	2
2018/19	175	15	30	12	38	2	10	18	41	5	3	4	0
2019/20	224	21	29	14	7	18	3	24	0	15	22	9	61
2020/21	177	12	15	6	31	29	40	11	9	13	3	7	0
2021/22	245	7	13	39	15	38	29	42	2	2	19	21	18
2022/23	480	45	12	11	32	78	134	104	12	16	4	11	22

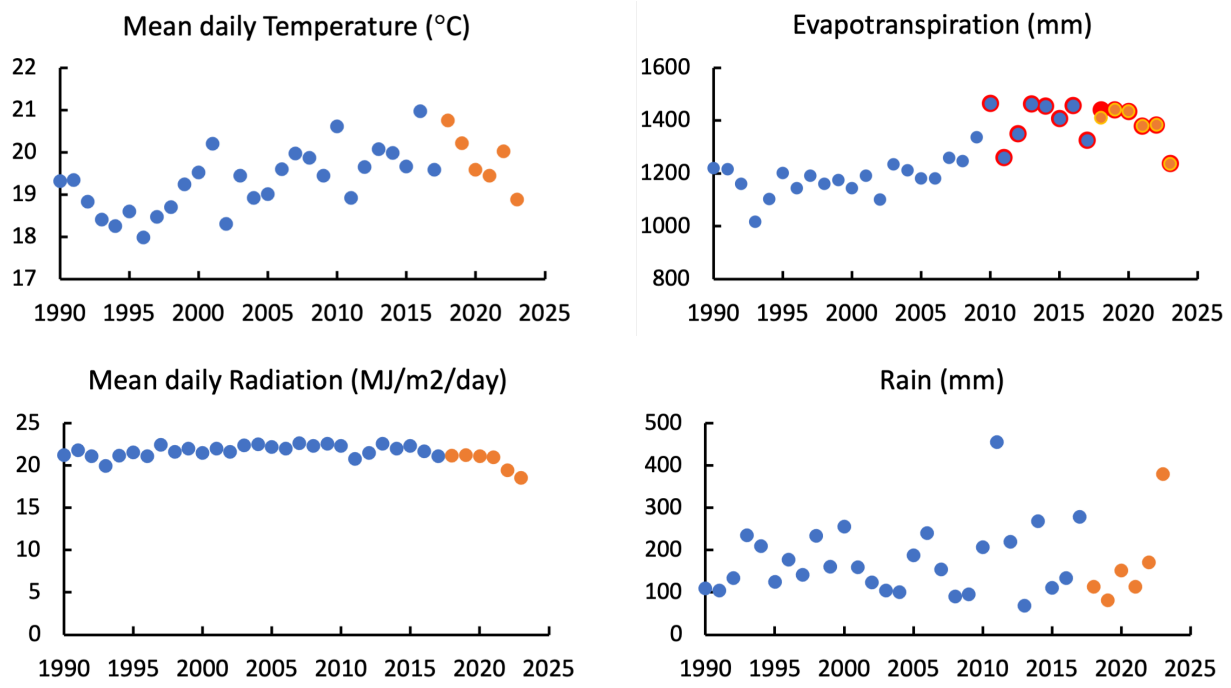

Figure 2 Annual climate data for Loxton since 1990

Explanation of Figure 2

This figure shows the mean daily temperature, daily radiation and total evapotranspiration (measured according to FAO-56) and rainfall during the growing season (1st September to 30th April in following year). Data has been plotted against the year of harvest with the seasons since 2018, when almond first planted at ACE, shown in orange. Temperature, rainfall and radiation sourced from SILO (longpaddock.qld.gov.au/silo/) as patched point data for station 24024 (Loxton Research Centre). Evapotranspiration data sourced from AWRA from 1975 and from Bureau of Meteorology from 2009.

Weather and Climate at ACE

The ACE property benefits from knowledge of daily weather observations and long-term climate information.

Weather station at ACE

A weather station was installed at the ACE property in 2018, soon after the initial plantings at ACE in 2017. These daily weather observations can be found at the Landscape Weather Network (awsnetwork.com.au). They are a valuable source of information that can be related to Almond production and irrigation requirements at the ACE site. These observations supplement the daily weather observations collected by the Bureau of Meteorology, but do not yet have the required long-term history to be used for detailed climate analysis. It is for this reason that we currently obtain daily weather information from other sources.

Historic climate

Long term climate information and daily weather can be obtained from several sources including the Bureau of Meteorology's weather station at Loxton Research Centre (5 km south). This station (24024) has been in operation since 1984 and replaced the previous station (24023) which was also located at the Loxton Research Centre and had been in operated since 1963.

It is possible to generate daily weather information for the site that interpolates missing data when observations were not collected, either because individual days were missed or because that particular aspect of weather was not recorded. These 'Patched' products are available from SILO (longpaddock.qld.gov.au/silo). Daily weather data is also available as a gridded product both from SILO and as a Bureau of Meteorology product. These gridded data are available for each 5km x 5km land area of Australia. Both the 'patched' products and gridded data are of high quality and created using rigorous methods.

Evapotranspiration

One important aspect of weather for irrigators is evapotranspiration (ET_0). Evapotranspiration is a complex relationship influenced by many aspects of weather. As noted by others, "The primary weather factor controlling Evaporation and Evapotranspiration is solar radiation. Solar radiation is the ultimate source of almost all energy required to vaporize water. Other important weather factors are humidity and wind speed. Air temperature also affects the Evaporation or Evapotranspiration rate, but it has a minor direct impact, although it is highly correlated with both solar radiation and Evapotranspiration." (Jenson and Allen, 2016).

Because long-term historic records of wind speed are not available SILO calculates ET_0 using a wind speed of 2m/s, which is a light breeze. This has the benefit of providing a long history of ET_0, but at the detriment of these ET_0 values being approximations. Fortunately, there are alternatives. One of these is a gridded product available since 1975 from the Bureau of Meteorology that uses daily wind speed. Another are actual observations since 2009 at the Bureau of Meteorology's station (24024) located at the Loxton Research Centre. On occasions, when all aspects of the weather were not observed at station 24024 (which means the Bureau of Meteorology will not provide ET_0), we have calculated ET_0 using the same method (FAO-56) and replacing the missing weather observations with 'patched' data from SILO. Using this approach, we are able to create a continual daily ET_0 record from 1991 that predominantly consists of observations including wind speed.

Further information

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SARDI projects conducted at the ACE experimental orchard have been funded by Hort Innovation using the almond research and development levy with co-investment from the South Australian Government and contributions from the Australian Government. For more information on these funds and strategic levy investments visit horticulture.com.au.