

Field monitoring of inoculant temperature in tractor-mounted applicator tanks in northern Mexico



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Introduction

Inoculating forage crops for silage making is common in many regions of Mexico, but the methods of application vary greatly. While direct application through the forage harvester machinery is strongly recommended, this is often not the norm. Instead, inoculants are commonly applied using makeshift spraying equipment mounted on the tractors responsible for packing or distributing forage in the silo. Since most tractors do not have a dedicated structure or space for these tanks, they are typically mounted on the front counterweights. However, this setup poses a significant risk to the viability of bacteria in silage inoculants because the heat radiated from the tractor engine can raise and sustain the tank's temperature above the critical threshold of 35°C (Mulrooney and Kung, 2008). This risk is further exacerbated by high ambient temperatures during the first harvest season in this arid region of Mexico. Based on these conditions, we hypothesized that silage inoculants in this type of tanks quickly gain temperature above the viability threshold and that many farm operators are unaware of this issue. Consequently, the objectives of this field study were to evaluate producer awareness of the effect of temperature on the viability of inoculant bacteria and to monitor the temperature progression in tractor-mounted applicator tanks.



Figure 1. Examples of tractor-mounted inoculant tanks.

Materials and Methods



Figure 2. Data loggers, programmed to record temperature every 5 minutes, were placed in the inoculant tank.



Figure 3. Temperature data were recorded during 3-4 consecutive days under regular operating conditions.



Figure 4. Data loggers were retrieved at the end of the evaluation period, recording was stopped and data were downloaded.

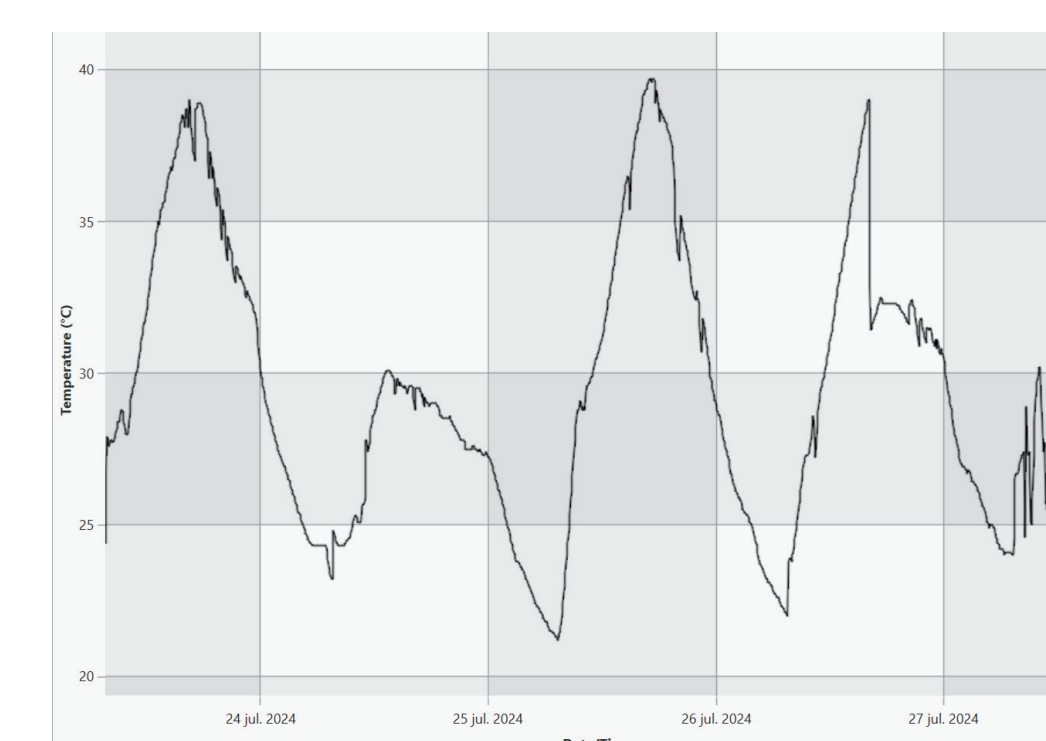
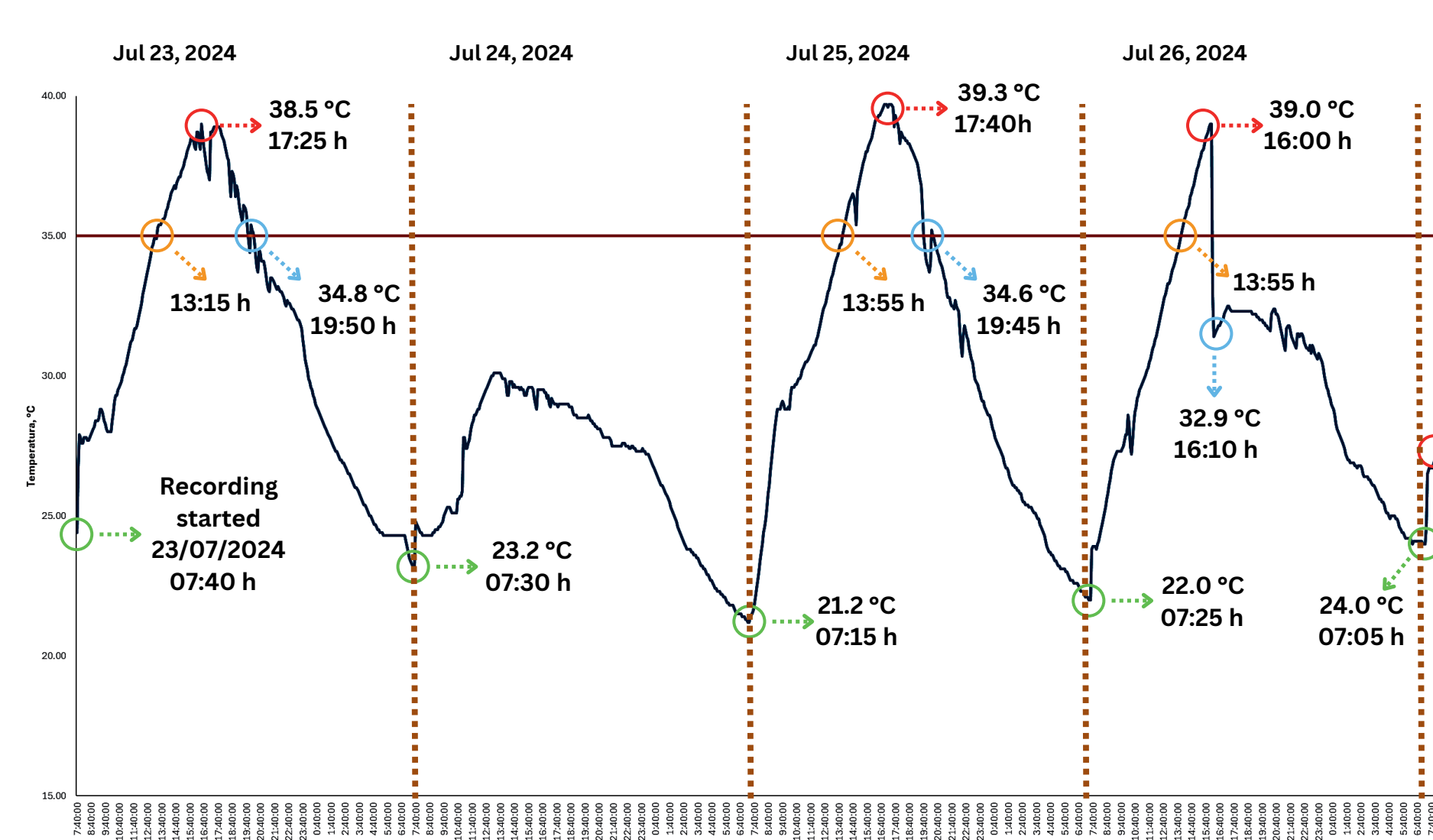


Figure 5. Data inspection and analyses were carried out individually for each farm.

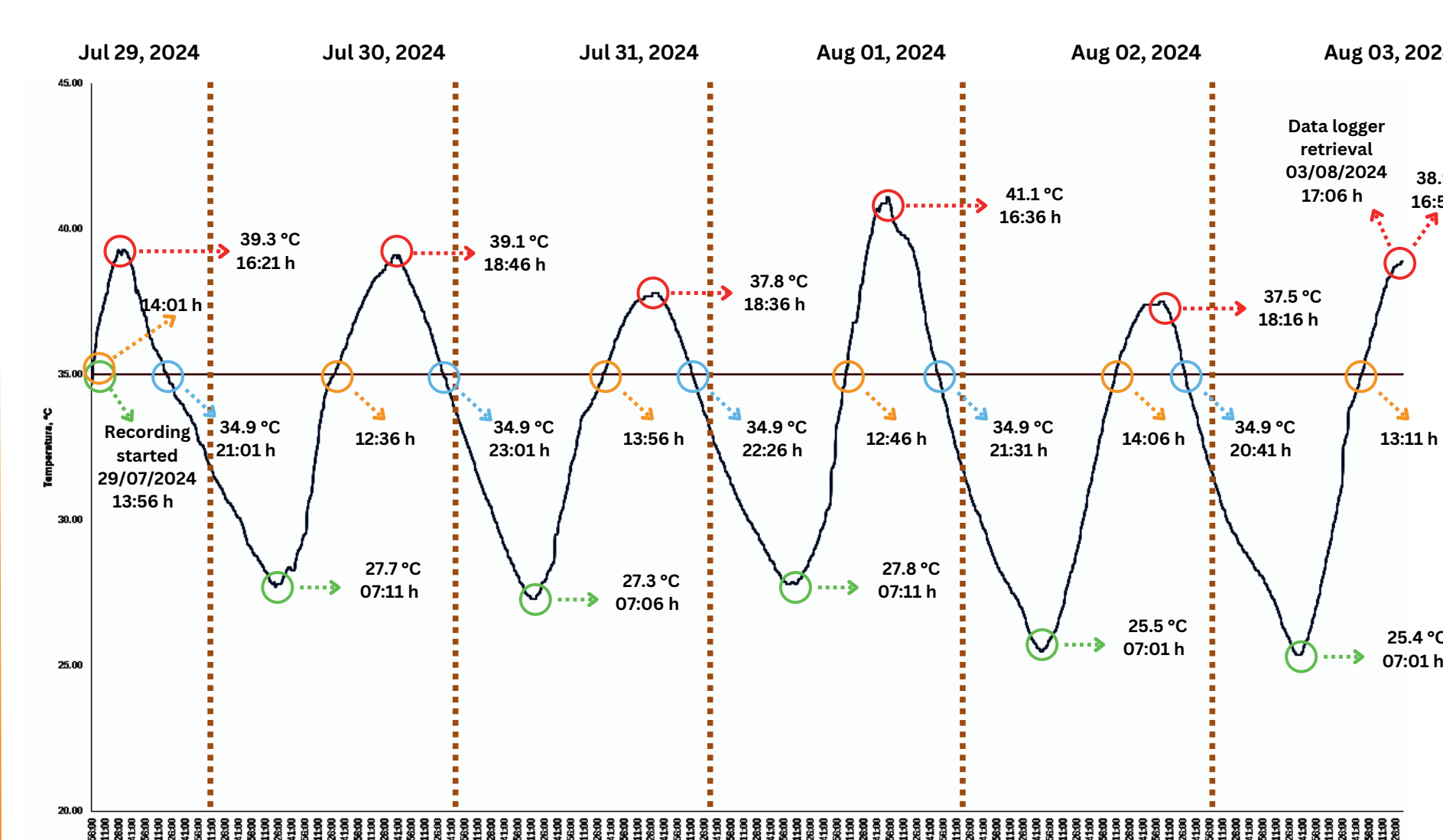
Results



Temperature parameters in a tractor-mounted inoculant tank in Northern Mexico

Parameter	23/07/2024	24/07/2024	25/07/2024	26/07/2024	27/07/2024
Minimum ambient temp.	18.9	19.5	17.7	18.0	17.1
Time of minimum ambient temp.	4:00	5:00	5:00	5:00	5:00
Initial temp. in tank (min)	24.4	23.2	21.2	22.0	24.0
Time of initial temp. in tank	7:40	7:30	7:15	7:25	7:05
Ambient temperature when tank temp. ≥ 35 ¹	32.4	NA	30.1	31.2	NA
Time when tank temp. ≥ 35	13:15	NA	13:55	13:55	NA
Maximum temp. in tank	38.9	30.1	39.3	39.0	NA
Time of maximum temp. in tank	17:25	13:15	17:40	16:00	NA
Ambient temp. when tank temp. reached max ¹	28.8	28.4	24.0	29.8	NA
Period tank temp. ≥ 35	13:15 – 19:45	NA	13:55 – 19:40	13:55 – 16:05	NA
Duration of tank temp. ≥ 35	6:30	NA	5:45	2:10	NA
Maximum ambient temp.	32.4	28.4	30.1	31.2	NA
Time of max. ambient temp.	13:00	13:00	14:00	14:00	NA
Internal temp when returned < 35	34.8	NA	34.6	32.9	NA
Time of internal temp returned < 35	19:50	NA	19:45	16:10	NA
Ambient temp. when internal temp. returned < 35 ¹	24.5	NA	22.8	29.8	NA

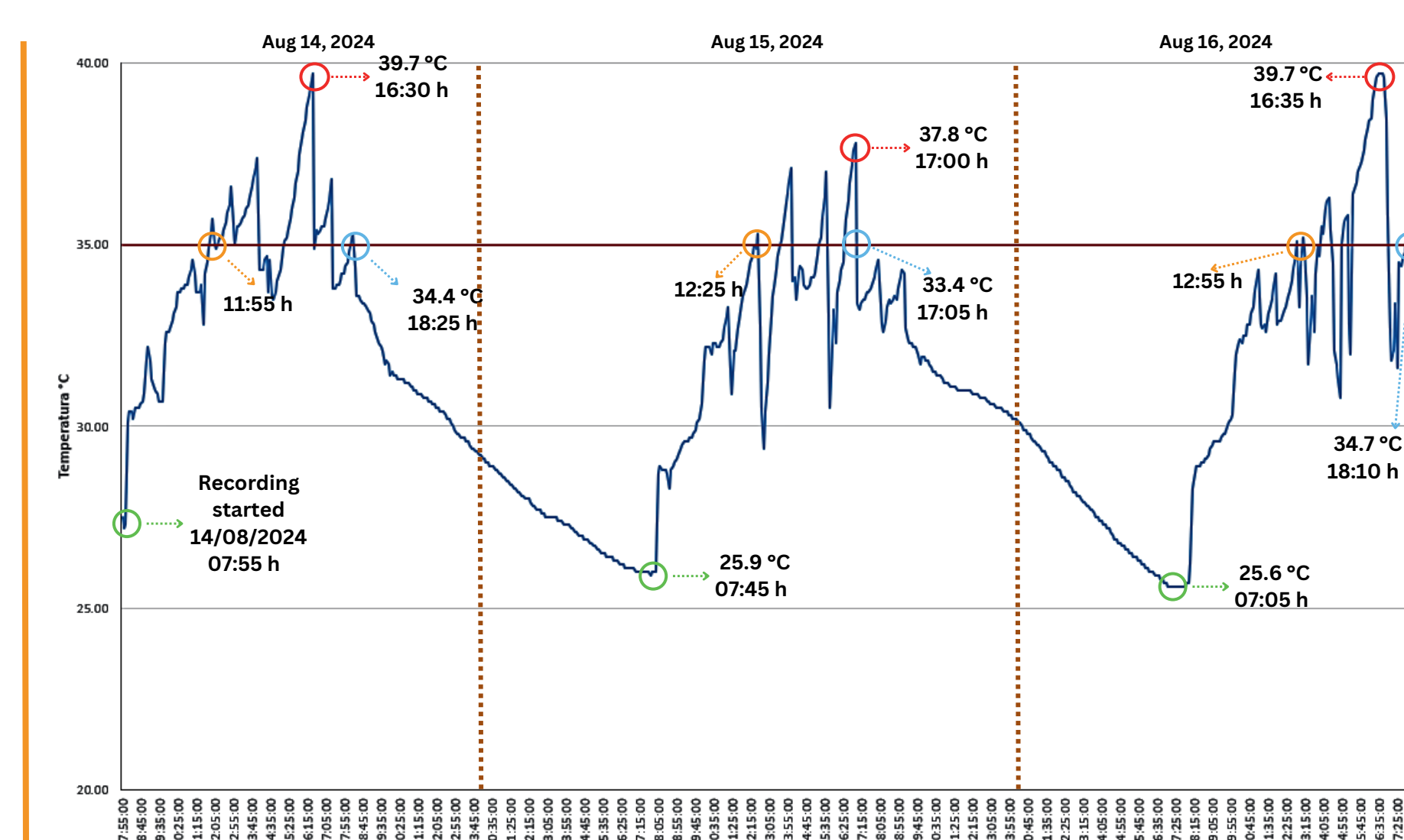
¹ Closest temperature from the weather database relative to the actual time of the data logger was considered for this item



Temperature parameters in a tractor-mounted inoculant tank in Northern Mexico

Parameter	29/07/2024	30/07/2024	31/07/2024	01/08/2024	02/08/2024	03/08/2024
Minimum ambient temp.	21.5	20.2	22.0	19.5	21.3	NA
Time of minimum ambient temp.	4:00	4:00	5:00	4:00	4:00	NA
Initial temp. in tank (min)	NA	27.7	27.3	27.8	25.5	25.4
Time of initial temp. in tank	NA	7:11	7:06	7:11	7:01	7:01
Ambient temperature when tank temp. ≥ 35 ¹	33.2	36.8	36.4	36.0	34.0	NA
Time when tank temp. ≥ 35	14:01	12:36	13:56	12:46	14:06	13:11
Maximum temp. in tank	39.3	39.1	37.8	41.1	37.5	38.9
Time of maximum temp. in tank	16:21	18:46	18:36	16:36	18:16	16:56
Ambient temp. when tank temp. reached max ¹	32.3	27.9	27.4	35.7	NA	NA
Period tank temp. ≥ 35	14:01 – 20:56	12:36 – 22:56	13:56 – 22:21	12:46 – 21:26	14:06 – 20:36	13:11 – 17:06 ¹
Duration of tank temp. ≥ 35	6:55	10:20	8:25	8:40	6:30	3:55
Maximum ambient temp.	33.8	36.8	36.4	36.1	NA	NA
Time of max. ambient temp.	12:00	13:00	14:00	14:00	NA	NA
Internal temp when returned < 35	34.9	34.9	34.9	34.9	34.9	NA
Time of internal temp returned < 35	21:01	23:01	22:26	21:31	20:41	NA
Ambient temp. when internal temp. returned < 35 ¹	24.7	24.6	24.4	23.3	NA	NA

¹ Closest temperature from the weather database relative to the actual time of the data logger was considered for this item



Temperature parameters in a tractor-mounted inoculant tank in Northern Mexico

Parameter	14/08/2024	15/08/2024	16/08/2024
Minimum ambient temp.	20.3	21.4	20.9
Time of minimum ambient temp.	5:00	5:00	5:00
Initial temp. in tank (min)	27.5	25.9	25.6
Time of initial temp. in tank	7:55	7:45	7:05
Ambient temperature when tank temp. ≥ 35 ¹	33.7	35.5	33.8
Time when tank temp. ≥ 35	11:55	12:25	12:55
Maximum temp. in tank	39.7	37.8	39.7
Time of maximum temp. in tank	16:30	17:00	16:35
Ambient temp. when tank temp. reached max ¹	32.3	32.5	32.9
Period tank temp. ≥ 35	11:55 – 17:20	12:25 – 17:00	12:55 – 17:00
Duration of tank temp. ≥ 35	5:10	5:25	4:05
Maximum ambient temp.	33.8	35.4	33.9
Time of max. ambient temp.	13:00	13:00	14:00
Internal temp when returned < 35	34.4	33.4	34.7
Time of internal temp returned < 35	18:25	17:05	18:10
Ambient temp. when internal temp. returned < 35 ¹	30.9	32.5	32.7

¹ Closest temperature from the weather database relative to the actual time of the data logger was considered for this item

Key Findings

In most cases, the inoculant solution reached 35° C between 12:00 and 14:00 h, approximately 5 hours after initial filling of the tank

Adding freshly prepared inoculant to a partially filled tank lowered the temperature by 3-4°C

Practical recommendations included:

- Preparing a low concentration solution to increase application rate and refill more often
- Maintain cold water in storage for tank refilling
- To utilize insulated tanks to maintain more stable temperature of the prepared inoculant

