SPRINKLING FOR DUST SUPPRESSION IN A CATTLE FEEDLOT

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THE IMPERIAL VALLEY in Southern California is extremely arid and warm, is characterized by less than 6 inches per year of average rainfall, and has afternoon temperatures which often reach 110 to 120°F in summer. While this area may seem somewhat hostile for the fattening of beef cattle, advantages include the availability of feed, the reasonable cost of land and its remoteness from heavily populated areas. The arid climate is also advantageous, since the large amounts of manure produced in these lots dries quickly—minimizing odors and reducing the number of animal pests, including flies. The major disadvantages of this operation in such a climate are that (1) any animal activity may raise significant amounts of dust, and (2) the animals may be subjected to heat stress during the summer.

The summer dust problem is increased because of the behavioral response of animals to the hot climate. Although movement is at a minimum during the day, activity accelerates during the cooler evening hours. Therefore, the maximum dust generation occurs when the nocturnal inversion is intensifying, thereby preventing appreciable vertical dispersion. In response to this problem, the feedlot operators and the California Cattle Feeders Association have initiated investigations of dust suppression. One technique is to sprinkle the pens with sufficient water to suppress dust generation when the animals become active in the early evening, while limiting the amount of sprinkling to avoid the other problems attributable to excessive wetness in the pens (odor, pests, etc.).

This report summarizes an investigation of the effectiveness of sprinkling open, unpaved, feedlot cattle pens for dust control, and the effect of sprinkling on the temperature and relative humidity. The purpose of the investigation was: (1) to evaluate the effectiveness of sprinklers in suppressing the amount of dust raised in a typical feedlot and (2) to assess the effect of sprinkling on the relative humidity and temperature in the pens. The major concern of feedlot operators—besides the expense of installing and maintaining an effective sprinkling system—is that any increase in the relative humidity associated with sprinkling (especially at the high temperatures during the summer) may seriously affect animal health or weight-gain efficiency.

Two feedlots

To accomplish this evaluation, an experiment was designed in which two comparable feedlots were monitored. One of these lots was not sprinkled and acted as a control, presumably typifying the dustiness, temperature, and humidity of a normal Imperial Valley feedlot. The second lot was of comparable size, located in the same general area, and presumably run with similar operational practices. This lot had an ongoing sprinkler program. Although the two lots were similar, all relevant variables could not be exactly duplicated. This is true both for conditions and activities within each lot and for conditions and activities in the areas bordering each lot. Therefore, a comparison of absolute numerical results between lots may be less significant than a comparison of relative trends within each lot.

The air temperature, humidity, and dustiness were measured simultaneously at several locations within each lot. Data recording was begun on June 25, 1970 and was terminated on September 9, 1970. The data consisted of 15-minute samples taken once each hour, 24 hours per day. Detailed analysis of these data was concentrated on those days which had high ambient relative humidities and high temperatures, since these conditions are most likely to cause serious heat and humidity stress for the animals. Sample data are presented in the graphs.

Unsprinkled lot

Graphs 1 and 3 show the hourly distribution of temperature and dew point temperature in the unsprinkled lot on two consecutive days. The most significant features of the two diagrams are the high degree of variability in the two plotted variables and the systematic temperature gradient within the lot. In most of the data analyzed, it was quite apparent that the center of the lot is consistently warmer, in some cases as much as 10°F warmer, than either of the two edges. It was also apparent that the dew point temperature remains more or less steady, on the average, during the day, while the smaller scale fluctuations are not usually correlated with the temperature variability. The distribution of dew point temperature also shows significant trends within the lot. The typical temperature cycle in the unsprinkled lot showed rapid rise in the morning, leveling off toward the middle of the day, reaching a peak between 2:30 to 4:30 pm (PDT), and decreasing rapidly in the evening.

Sprinkled lot

The temperature and dew point temperature for the same days in the sprinkled lot are shown on graphs 2 and 4. The shaded block on the horizontal axis represents the time during which the sprinklers were on. Like the unsprinkled lot, the sprinkled lot varies considerably in both temperature and dew point temperature as a function of location within the lot. These figures are typical of all the data analyzed. The temperature in this lot was quite similar to that in the unsprinkled lot in its distribution and daily cycle.

Lot comparisons

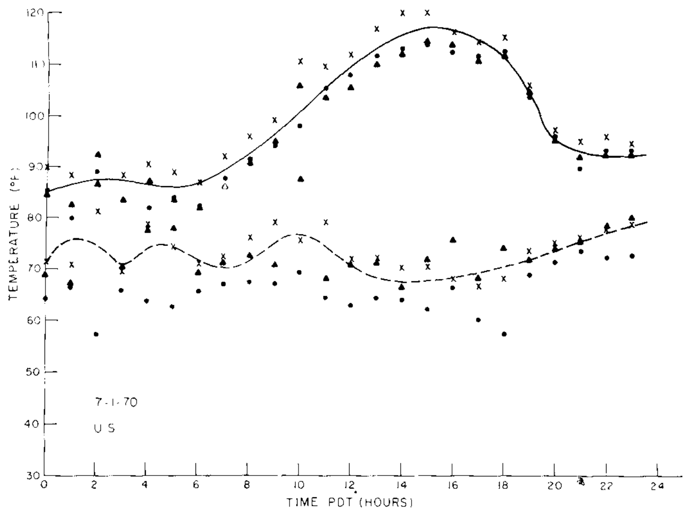
The dew point temperatures in the examples shown appear anomalous, with the unsprinkled lot showing a higher ambient moisture level than the sprinkled lot. This was probably due to the fact that the unsprinkled lot was surrounded on three sides by irrigated fields, whereas the sprinkled lot was not. However, the effect of sprinkling can still be evaluated by examining the variations of the dew point in relation to sprinkling activity.

On most test days the average dew point temperature tended to increase after initiation of sprinkling, though in most instances the increase was rather small. For example, in graph 2 a slight increase in the dew temperature occurred shortly

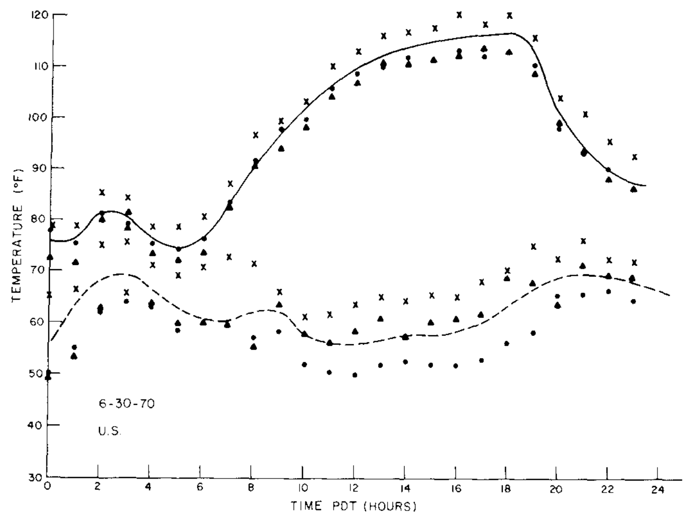
An investigation of the effectiveness of sprinkling to suppress dust and of its effect on the temperature and relative humidity in open cattle feedlot pens is reported here. One sprinkled feedlot and one unsprinkled feedlot, located in the Imperial Valley of California, were studied. Typical values of temperature and dew point temperature, as a function of time of day, are presented which illustrate their variability within each lot and between lots. The results indicate that:

(1) A program of sprinkling the pens for 2 hours, beginning at 1 pm PDT and again for 1½ hours beginning about 5 pm PDT, should reduce the total dustiness by at least half.
(2) Sprinkling appears to reduce the maximum temperature reached for the day ($< 10°F$) while raising the ambient relative humidity by not more than about 10%.
(3) No deleterious effects on animal performance, morbidity, or mortality resulted from sprinkling.
(4) No increase in fly or odor problems could be traced to sprinkling.

GRAPH 1. DEW POINT TEMPERATURE AND AIR TEMPERATURE VERSUS LOCAL TIME FOR THE UNSPRINKLED LOT ON JUNE 30, 1970.

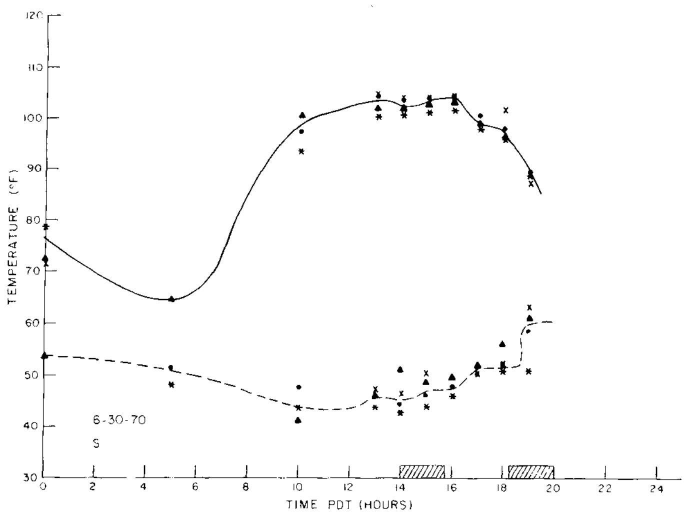


GRAPH 3. DEW POINT TEMPERATURE AND AIR TEMPERATURE VERSUS LOCAL TIME FOR THE UNSPRINKLED LOT ON JULY 1, 1970.

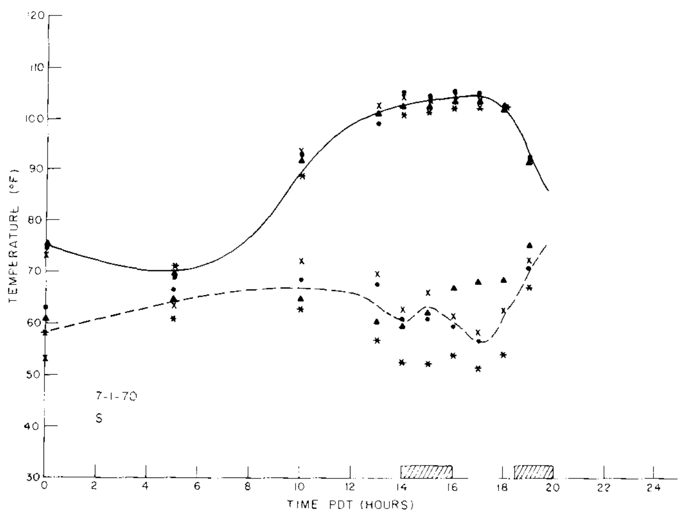


o = south edge, × = middle, △ north edge, — = temperature, - - - = dew point

GRAPH 2. DEW POINT TEMPERATURE AND AIR TEMPERATURE VERSUS LOCAL TIME FOR THE SPRINKLED LOT ON JUNE 30, 1970.



GRAPH 4. DEW POINT TEMPERATURE AND AIR TEMPERATURE VERSUS LOCAL TIME FOR THE SPRINKLED LOT ON JULY 1, 1970.



* = south edge, △ = middle, × = northeast edge, o = northwest edge, — = temperature, - - - = dew point, /// = sprinkle operation

DUST COLLECTION DATA AT DIFFERENT DATES IN SPRINKLED AND UNSPRINKLED FEEDLOTS

Location	6/25–7/1	7/1–7/8	7/8–7/15	7/15–7/22	7/22–7/29	7/29–8/5	8/5–8/12	8/12–8/19	8/19–8/26	8/26–9/2	9/2–9/9
Sprinkled:	Dust Grams Collected										
South	1.9	0.9	0.7	2.5	0.2	0.9	0.6	0.5	1.1	2.1	0.6
Middle	2.9	0.1	0.8	1.1	0.1	0.4	0.3	0.3	0.7	1.0	0.4
Northeast	2.7	0.8	1.3	0.8	0.6	0.6	1.4	0.3	1.8	1.7	0.6
Northwest	1.6	0.9	0.5	0.4	0.2	0.6	0.3	0.6	1.4	1.3	0.1
Average dustiness ($\mu gm/m^3$)	517	89	108	160	37	86	86	61	165	202	62
Unsprinkled:	Dust Grams Collected										
South	3.2	0.8	0.4	2.4	0.1	0.6	0.5	0.5	0.1	0.7	0.8
Middle	4.3	2.2	2.0	6.4	2.0	2.2	2.2	1.2	0.7	0.8	1.4
North	1.7	0.6	0.7	2.2	2.1	2.3	0.2	2.7	0.7	1.8	0.6
Average ($\frac{\mu gm}{m^3}$)	708	160	136	492	184	221	128	197	62	145	123

Average dustiness Summary:	Sprinkled	Unsprinkled
6/25–8/19	143 $\mu gm/m^3$	278 $\mu gm/m^3$
8/19–9/9	143 $\mu gm/m^3$	110 $\mu gm/m^3$
6/25–9/9	143 $\mu gm/m^3$	232 $\mu gm/m^3$

after sprinkling began at 1400 hours, with a leveling off somewhat between 1600 and 1800 hours. The dew point again increased when sprinkling was initiated, shortly after 1800 hours. What appears to be more significant, however, was the increased difference in humidity from one edge of the lot to the other. For example, the readings taken at 1900 hours (graph 2) showed that the dew point temperature at the southern edge was constant after the sprinklers went on, whereas at the center and the northern edge there was a marked increase in the dew point temperature—while the maximum increase occurred at the northeast edge. Without reliable wind data, the only reasonable assumption was that the observed distribution of the dew point temperatures is indicative of a southerly wind direction.

Response

Another example (graph 4), shows there was an obvious response to sprinkling at 1500 hours. The data from the southern edge was not correlated with the sprinkling activity, whereas the central and northern edge showed a marked increase in dew point when sprinkling began. Similarly, the sudden increase in water vapor content, detected at 1900 hours, was presumably attributable to the sprinkling begun at 1830 hours.

In all the data analyzed, the maximum temperature occurring at any location within the sprinkled lot was less than that observed for the unsprinkled lot on the same day. It was also apparent that the maximum temperature for the day in the sprinkled lot was usually reached earlier than in the unsprinkled lot. More specifically, the time of maximum temperature was usually the time when the sprinklers were actuated for the first time that day. Therefore, the initiation of sprinkling apparently has the effect of cooling, or of at least preventing further heating, of the lot environment.

Summary

In summary, all of the data analyzed indicate that the maximum temperature reached within the sprinkled lot is reduced by 5 to 10°F. Concurrent with this cooling, a small increase in ambient humidity occurs. A typical value of relative humidity during the hottest part of the day is 20% with no sprinkling. The observed decreased temperature and increased dew point with sprinkling would increase the relative humidity to about 30% which is still a low value. Furthermore, the increase in humidity and the decrease in temperature are mutually compensating effects, which suggests that sprinkling has no significant effect on the evaporative cooling of the animals. This conclusion is supported by the fact that no significant trends due to sprinkling could be found in the weight-gain efficiency, mortality, or morbidity of the animals.

Dustiness

A summary of the feedlot dust collection data is shown in the table. The tabulations are the weekly totals of dust collected at each of the stations within each lot. The "average dustiness" tabulations summarize the weekly totals for each lot in terms of ambient concentrations (micrograms of dust per cubic meter of air). During the first eight weeks, June 25 to August 19, the unsprinkled lot was up to 2½ times more dusty than the sprinkled lot. The cause of the very high dust concentration for the first week has not been determined.

The reversal of this trend during the 9th (August 19 to 25) and 10th (August 26 to September 2) week can be traced partly to a sprinkling schedule change during the 9th week—from twice per day (approximately 2:00 to 4:00 pm and 6:30 to 8:00 pm PDT) to once per day (6:00 to 8:00 pm PDT). In addition, heavy local rains occurred on August 26, so sprinkling was suspended through September 1.

The very low dust level in the unsprinkled lot for the 9th week appears questionable. One possible explanation is that the filter housings may not have provided sufficient protection from the rain so that some of the collected material may have been washed off. A second possibility is that cattle processing and, therefore cattle-alley traffic, was greatly reduced during this period. Management practices are an uncontrolled variable and probably account for part of the variation in the dust collection data. In spite of these variables, the data for the 9th and 10th weeks seem to indicate that, when sprinkling was reduced or stopped, the average dustiness of the two lots was comparable.

In summary, sprinkling lots during the first eight weeks clearly reduced dustiness by about one-half. During the period following rain, the dustiness of the unsprinkled lot was also reduced by at least half, providing further support for this conclusion.

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