SPRINKLING CATTLE FOR CONTROL OF HEAT STRESS

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Sprinkling cattle, under shades, during the summer in the Imperial Valley for 1 minute every 30 minutes when the temperature was above 80°F (27°C)—resulted in significantly higher feed consumption and rate of gain, compared with cattle under shades but not sprinkled. Efficiency of feed conversion was not significantly improved over that of uncooled cattle (although the sprinkling treatment was favored). Sprinkling was as effective as a refrigerated air conditioned barn at 75°F (24°C) in one trial, and was more effective during a second trial. Sprinkling and refrigeration promoted greater comfort, as indicated by the prevention of increases in respiratory rate and body temperature observed in the afternoon with control cattle. Both uncooled and cooled cattle consumed more feed and gained more weight when alloted 40 sq ft per head of space than with 20 sq ft.

SPRINKLING OF CATTLE has consistently improved cattle performance in the Imperial Valley of California, according to research reports from work done in 1947, 1948, and 1953. Because of the low energy level of the rations, however, the actual performance achieved was low; and there were problems with muddy pens, humidity, and application of water. The mud created by the surplus water possibly prevented greater response to the sprinklers, because mud has been reported (in 1970 tests) to have a pronounced adverse effect upon cattle performance.

These tests were conducted because it appeared desirable to study sprinkling of cattle being fed rations capable of promoting higher levels of gain and housed on slotted-floor pens to avoid the problem of mud. Slotted floors are increasingly being considered for use in manure management systems, and spray or sprinkling systems can be readily adapted to these floors.

Such floors can be more easily justified economically if sprinkling results in better cattle performance. A factor to be considered in determining the economics of slotted floors is the space required per animal. Work in 1970 with solid concrete floors in the Imperial Valley indicated that reduced performance resulted (with heavy animals under summertime conditions) when the space allotment was below 40 sq ft per animal. During cooler periods, smaller allotments sufficed.

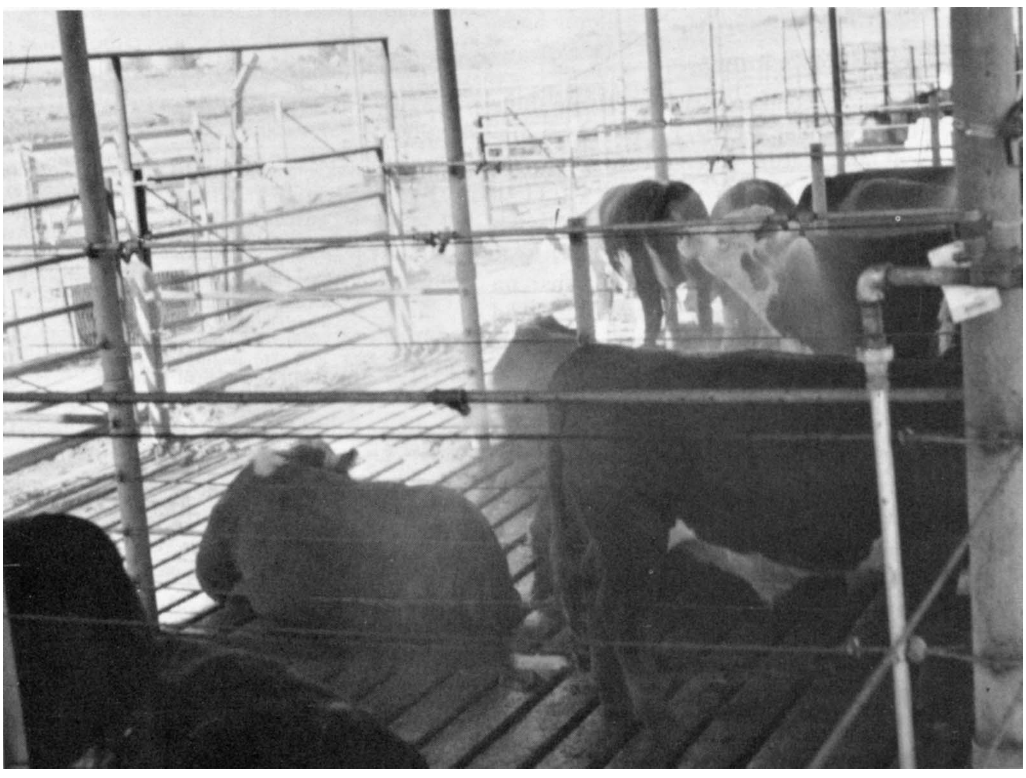
The two studies reported here were conducted at the Imperial Valley Field Station, El Centro. The first extended from July 1 to September 30, 1970 during which time the mean ambient temperature was 91°F (33°C) and the range was from 57 to 115°F (14 to 46°C). Twenty-four Angus and Angus x Hereford steers, each weighing about 450 lb (204 kg) were assigned to four slotted floor pens of 160 sq ft (approximately 15 sq m), six head per pen. All pens were covered with aluminum shades. One pen was equipped with eight sprinkler nozzles controlled by a thermostat and timer to wet the cattle for 1 minute every 30 minutes, when the air temperature was 80°F (27°C) or above. Animals in nonsprinkled pens served as controls for the sprinkling test, as well as for 18 steers kept in three comparable, slotted-floor pens housed in a refrigerated barn maintained at 75° ± 2°F (24°C).

All cattle were fed a 90% concentrate ration *ad libitum*, with fresh feed offered twice daily. Initial and final weighings were made after the cattle had been held about 12 hours without feed or water. Once each week (from mid-July until mid-September), respiratory rates and rectal temperatures were recorded in the morning and afternoon. At the start of the experiment, 10 steers were selected at random and slaughtered to determine initial body composition from carcass specific gravity. Half the cattle from each treatment were slaughtered at the conclusion of the test to determine changes in body composition.

First experiment

Results of this first experiment showed cattle cooled by either refrigeration or by sprinkling ate significantly more feed and gained weight significantly faster than did the uncooled control cattle (table 3). However, efficiency of feed conversion was not greatly affected. The increases in weight of 0.53 lb (0.24 kg) per day from refrigeration and 0.66 (0.30 kg) from sprinkling were considerably greater than those that had been reported in earlier studies. Freedom from mud and an effective method of water appli-

Cattle under sprinklers, and shade, on slotted flooring at Imperial Valley Field Station.



cation were probably responsible for this improvement. The system used in these studies provided sufficient water to wet nearly the entire surface of all steers to the drip point, although there were areas on some cattle which were only slightly wet or not wet at all. Thirty minutes after sprinkling the skin usually appeared dry again.

Control cattle

The control cattle were under some degree of heat stress even in the morning, as their respiratory rates and body temperatures were significantly higher than those of animals cooled by refrigeration or sprinkling. The morning measurements were made at 6:30 am and data accumulated at this station indicate that the coolest time of day during the summer months is usually between 5 and 6 am. At 4 pm, when the afternoon measurements were made, the respiratory rates and body temperatures of the uncooled cattle indicated a marked increase in heat stress. Refrigeration prevented the increases in both respiratory rate and body temperature. Sprinkling, however, did not completely prevent these increases, although it significantly reduced them. This increased stress did not adversely affect the performance of the sprinkled cattle, as indicated by the feed consumption and weight gains. Although differences were not statistically significant, the cattle subjected to cooling tended to have slightly lower body fat and higher protein than the control cattle. This observation supports earlier ones made in a trial comparing cattle cooled by refrigeration to uncooled controls. The findings, however, need further verification.

Second experiment

In the second experiment (from June 9 to September 29, 1971), the mean ambient temperature was 89°F (32°C), and the range was from 51 to 118°F (11 to 48°C). Grade Hereford steers with an initial weight of 640 lbs each (290) kg), were assigned to each of three pens: no cooling, refrigeration, sprinkling, and either 20 sq ft or 40 sq ft space allotment. A view of one of the sprinkler pens is shown in the photo. All outside cattle were under shade. Morning and afternoon measurements of respiratory rates and rectal temperatures on four randomly selected cattle from each treatment were made once each week. The ration was the same as in experiment 1. All cattle were on slotted floors except the control an-

TABLE 1. PERFORMANCE OF CATTLE ON SLOTTED FLOORS VS DIRT PENS

Treatment	No. of steers	Duration of trial	Daily feed		Daily gain		Lb Feed/per lb gain
		days	lb	(kg)	lb	(kg)	
Fall experiment							
Slotted floor	12	56	20.90	(9.49)	3.46	(1.57)	6.04
Dirt pen	12	56	19.08	(8.66)	3.54	(1.61)	5.39
Winter experiment							
Slotted floor	12	141	20.24	(9.19)	3.47	(1.58)	5.83
Dirt pen	12	141	21.03	(9.55)	3.46	(1.57)	6.08

TABLE 2. PERFORMANCE OF THE CATTLE IN EXPERIMENT 1

	Treatment					
	No cooling		Refrigerated barn		Sprinkled	
Daily feed intake, lb	13.64^a	(6.19)*	15.20^b	(6.90)	16.01^b	(7.27)
Daily weight gain, lb	2.40^a	(1.09)	2.93^b	(1.33)	3.06^b	(1.39)
Feed per pound gain, lb	5.68		5.19		5.23	
Respiration rate, No. per min:						
AM	79^b		59^a		58^a	
PM	109^d		63^a		90^c	
Rectal temperature, °F:						
AM	102.5^c	(39.2)	101.9^{ab}	(38.8)	101.5^a	(38.6)
PM	104.4^d	(40.2)	102.1^b	(38.9)	102.9^c	(39.4)
Body fat, %	24.5		22.9		22.1	
Body protein, %	16.6		16.9		17.1	

a,b,c,d Values within appropriate comparisons having different superscripts are significantly different at $P < .01$.
* Values in parenthesis are kg or °C as appropriate.

TABLE 3. PERFORMANCE OF CATTLE IN EXPERIMENT 2

Item	Treatment							
	No cooling		Refrigerated		Sprinkled		Means	
Daily feed intake, lb:								
20 ft per head	15.79	(7.17)*	17.13	(7.78)	18.56	(8.43)	17.16	(7.79)
40 ft per head	16.47	(7.48)	17.35	(7.88)	19.05	(8.65)	17.62	(8.00)
Means	17.13^a	(7.32)	17.24^b	(7.83)	18.80^c	(8.54)		
Daily weight gain, lb:								
20 ft² per head	2.40	(1.09)	2.50	(1.14)	2.85	(1.29)	2.58	(1.17)
40 ft² per head	2.47	(1.12)	2.74	(1.24)	3.02	(1.37)	2.74	(1.24)
Means	2.44^a	(1.11)	2.62^b	(1.19)	2.94^c	(1.33)		
Feed per unit gain								
20 ft² per head	6.58		6.86		6.52		6.65	
40 ft² per head	6.68		6.33		6.30		6.44	
Means	6.63		6.60		6.41			
Respiration rate, no per min:								
20 ft² per head								
AM	68^{ab}		55^a		55^a			
PM	102^c		61^{ab}		59^a			
40 ft per head								
AM	66^{ab}		57^a		73^b			
PM	101^c		60^{ab}		61^{ab}			
Rectal temperature °F:								
20 ft² per head								
AM	101.9^{ab}	(38.8)	102.2^{bc}	(39.0)	101.9^{ab}	(38.8)		
PM	103.1^d	(39.5)	102.2^{bc}	(39.0)	102.1^b	(38.9)		
40 ft per head								
AM	102.4^c	(39.1)	101.9^{ab}	(38.8)	102.2^{bc}	(39.0)		
PM	103.4^d	(39.7)	101.7^a	(38.7)	102.1^b	(38.9)		

a,b,c,d Values within appropriate comparisons having different superscripts are significantly different at $P < .01$.
* Values in parentheses are kg or °C as appropriate.

TABLE 4. SUMMER SPACE ALLOTMENTS ON SLOTTED FLOORS

	No. per treatment	Daily feed		Daily gain		Lb feed/ lb gain
20 ft²/head		lb	(kg)	lb	(kg)	
1968, No cooling	8	14.20	(6.46)	2.38	(1.08)	5.97
1969, No cooling	8	16.58	(7.54)	2.42	(1.10)	6.85
1971, Refrigerated barn	8	17.13	(7.78)	2.50	(1.14)	6.86
1971, Sprinkled	8	18.56	(8.43)	2.85	(1.29)	6.52
Means		16.62^a	(7.56)	2.54^a	(1.15)	6.55
40 ft²/head						
1968, No cooling	4	15.70	(7.14)	2.74	(1.25)	5.73
1969, No cooling	4	16.81	(7.65)	2.51	(1.14)	6.70
1971, Refrigerated barn	8	17.35	(7.88)	2.74	(1.25)	6.33
1971, Sprinkled	8	19.05	(8.65)	3.02	(1.37)	6.30
Means		17.23^b	(7.84)	2.75^b	(1.25)	6.27

a,b Values in the same column having different superscripts are significantly different ($P < 0.05$).

imals with 40 sq ft of space, which were housed in a conventional dirt pen. This difference in type of pen was not considered important, because results of two earlier experiments (table 1) indicated no significant difference in either feed consumption or weight gain whether cattle were maintained on a slotted floor or in a dirt pen.

In experiment 2, as in experiment 1, cooling cattle either by refrigeration or sprinkling significantly increased feed consumption and weight gain, but did not greatly affect the efficiency of feed conversion (table 3). Contrary to results in experiment 1, however, sprinkling significantly improved feed consumption and weight gains over refrigeration. A possible explanation for this was the failure of one of two blowers in the refrigerated facility during the last month of the trial, resulting in poor ventilation during that period.

Physiological benefit

The physiological benefit from sprinkling is again indicated by the prevention of the afternoon increases in respiratory rates and rectal temperatures of the uncooled cattle. In contrast to experiment 1 the afternoon respiratory rate of the sprinkled cattle was the same as that of the cattle in the refrigerated barn.

Results of two previous summer tests comparing 20 *vs.* 40 sq ft per animal on slotted floors with no cooling are presented, along with those from the 1971 test, in table 4. Performance of animals in the larger space allotment was slightly better in all trials, with differences in feed consumption and rate of gain being statistically significant. In the 1971 test (table 3) the no cooling rate of gain at 20 sq ft was a little less compared with 40 ft^2 (2.40 vs. 2.47 lb/day). With sprinkling the decline of rate of gain at 20 vs. 40 ft^2 was even more (2.85 vs. 3.02 lb/day) and likewise with refrigeration (2.50 vs. 2.74 lb/day). Thus the conjecture that cooling might reduce space needs was not verified. It is unlikely that the value of the small increase in rate of gain and feed efficiency at 40 ft^2 in any of these tests would offset the cost of the additional space.

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Manhattan perennial ryegrass planted in sand at Alameda Memorial State Park Beach. Darker areas of turfgrass are plots treated with ammonium sulfate or Agricoat in four replicated treatments.

NITROGEN SOURCE *in relation to* TURFGRASS ESTABLISHMENT IN SAND

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One application of plastic coated nitrate and ammoniacal nitrogen produced acceptable turfgrass for a nine-month period in these tests. This was comparable with turf produced by six low application rates of ammonium sulfate over the same period. One application of all other nitrogen sources produced acceptable turf for three to four months. Further work is needed with different grass genera and soil types.

SAND IS BEING USED for construction of highly trafficked turfgrass areas because certain uniform sands allow water to enter and drain at high rates after compaction. When constructed from these sands, areas such as football fields and golf greens remain usable even during heavy fall and winter rains. Because the sands do drain rapidly, nitrogen fertilization during establishment becomes critical.

Nine nitrogen sources were evaluated on an unamended, coarse sand, dredged from San Francisco Bay. Sand depth above the compacted land fill varied considerably but appeared to average greater than 12 inches but less than 24 inches.

Before the area was seeded, all the fertilizers were applied and lightly raked into the surface an inch or two. Twenty pounds of single super phosphate per 1000 sq ft was applied over the entire area to provide adequate amounts of phosphate and sulfur, which have been found to be deficient in these sands. Each nitrogen fertilizer was applied to 50-sq-ft plots at rates of 3, 6, and 9 lbs of nitrogen per 1000 sq ft and replicated four times. The entire amount of fertilizer from each nitrogen source was applied before seeding with the exception of ammonium sulfate (labeled ammoniacal (1)). This material was applied at the same annual rate as the other fertilizers but was divided into six equal parts and applied every other month.

The nine nitrogen fertilizers used in the trial included:

MATERIAL	DESCRIPTION
ammoniacal (1)	Ammonium sulfate (21-0-0)
ammoniacal (2)	Best (16-4-5) ammonic nitrogen.
IBDU	Par-Ex (31-0-0) isobutylidine diurea.
ureaformaldehyde	Nitroform (38-0-0) ureaformaldehyde.
methylene urea	Scott Proturf Starter (18-24-6) methylene ureas + urea.
plastic coated NH_4	Agricoat (21-5-5) plastic coated ammoniacal and nitrate nitrogen.
chicken manure	Super Grow (3-3-3) processed chicken manure.
sewage sludge (1)	Evergreen (6-4-2) fortified sewage sludge.
sewage sludge (2)	Triple Six (6-6-6) fortified sewage sludge.

Several kinds of nitrogen sources have been included. Ammoniacals are the highly water-soluble nitrogen sources