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

K. D. GOWANS · E. J. JOHNSON

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

AVERAGE TURFGRASS QUALITY RATINGS FOR EACH MATERIAL FOR EIGHT DATES WITH SUMMARY
Ratings for the three application rates and four replications for each date combined.
Materials listed with respect to Duncan's Multiple Range Test at 5% significance for average.

Plot no.	Material	Dates (1971–72) Sept. 7	Oct. 13	Nov. 24	Dec. 15	Jan. 21	Mar. 4	May 9	June 7	Ave.	Duncan's Multiple Range*
1	plastic coated NH_4	5.5	8.75	6.8	7.9	6.9	6.75	6.75	5.0	7.1	U
2	ammoniacal (1)	5.1	7.65	5.25	7.85	6.35	7.9	6.4	7.4	6.85	V
3	IBDU	8.35	7.6	5.25	5.25	4.25	4.1	3.9	3.0	5.75	W
4	sewage sludge (1)	7.85	7.35	5.1	5.3	4.5	4.25	4.25	3.5	5.7	WX
5	ureaformaldehyde	6.0	7.35	5.4	5.85	4.75	4.9	4.75	4.1	5.7	WX
6	chicken manure	5.85	7.0	5.1	6.0	5.1	4.65	5.15	3.9	5.7	WX
7	methylene urea	7.15	6.85	4.9	5.15	4.4	4.35	4.5	3.35	5.5	X
8	ammoniacal (2)	7.25	6.65	4.75	4.85	4.25	3.75	3.65	3.0	5.2	Y
9	sewage sludge (2)	5.85	6.65	4.7	5.1	4.5	3.9	4.0	3.1	5.0	Z
	LSD 5%	.08	.44	.39	.50	.38	.38	.39	.30	.22	

* Treatments followed by same letter are not significantly different.

which should soon leach from the sand. IBDU or isobutylidine diurea is slowly water soluble; ureaformaldehyde and methylene urea are partially dependent on bacterial action for the release of nitrogen; the plastic-coated ammoniacal and nitrate nitrogen source must be wet to release nitrogen through the plastic film. All these can be classed as *inorganic* nitrogen sources. Processed chicken manure and sewage sludge are *organic* nitrogen sources although the nitrogen content of the sewage sludges has been increased with an ammoniacal nitrogen.

The entire area was planted to Manhattan perennial ryegrass on August 2, 1971. Ratings of the turfgrass were three weeks after planting and made every other week or monthly until the first part of June 1972. Ratings were based on the percentage of stand, weediness, and color.

The average quality ratings for the four replications of each application rate have been plotted with respect to time in the graphs. In nearly all cases, the 9-lb rate of nitrogen gave the highest quality rating followed by the 6-lb rate with the 3-lb rate, the lowest (as expected). However, if a rating of six or greater on the graph is considered acceptable, then it is possible to determine in a general way the amount of nitrogen to apply to turfgrass on sand to obtain an acceptable turf.

A significant response was not apparent from ammonium sulfate until after the second application in mid-September. Much of the original ammonium sulfate was probably lost through leaching before the grass was sufficiently developed to utilize it. From September on, ratings were in an acceptable range but with fairly large fluctuations when compared to Agricoat.

All three rates of the plastic-coated ammoniacal and nitrate nitrogen (Agricoat) produced acceptable turf for a period of eight months after one application. The ratings peaked near the end of October then levelled off at an acceptable level until June when the nitrogen appeared to give out.

IBDU peaked out six weeks after application and rated well for the first three months. After that time, ratings steadily declined to very low levels by the end of the trial period.

The quality of the turf produced by ureaformaldehyde, methylene urea, and ammoniacal (2) were very similar. The high rate of ureaformaldehydes produced acceptable turfgrass through December or for a period of four months. The 3- and 6-lb rates of ureaformaldehyde and all rates of methylene urea and ammoniacal (2) produced acceptable turf until early November (3 months).

All rates of the organic nitrogen sources—chicken manure and sewage sludge — produced acceptable turfgrass until November. Sewage sludge (1) produced the highest rating, followed by chicken manure. The lowest ratings were produced by sewage sludge (2).

Average ratings for eight dates and a summary are shown in the table. The rating for each date in the table is a combination of the three rates of fertilizer and the four replications, or a total of twelve individual ratings.

Plastic-coated ammoniacal and nitrate-nitrogen produced the highest ratings. These ratings were significantly greater (5% level) than those produced by the ammoniacal (1) nitrogen applied bimonthly, but both materials produced turfgrass with an average rating above the acceptable level.

IBDU, sewage sludge (1), ureaformaldehyde, and chicken manure produced ratings significantly lower than the ammonium sulfate. Methylene urea was significantly lower than IBDU, followed by the ammoniacal (2), and finally the sewage sludge (2).

The ammonium sulfate, Agricoat, plots and initially the IBDU plots, had good color, became established quickly and were free of weeds. The other treatments were generally characterized by thin stands, off color, and invasion of annual clovers within 3 to 4 months after planting. The need for a good source of nitrogen during initial stages of plant development was very apparent in this trial.

The graphs suggest that most of the nitrogen from ammonium sulfate applied at planting was lost through leaching. This would indicate that it might be better to wait until the grass germinates before applying water-soluble nitrogen to grasses planted in sand. It was also apparent that bimonthly applications of water-soluble nitrogen cause large fluctuations in plant growth. It would appear that about 6 lbs of nitrogen per 1,000 sq ft per year from ammonium sulfate applied monthly should produce a desirable turf on sand.

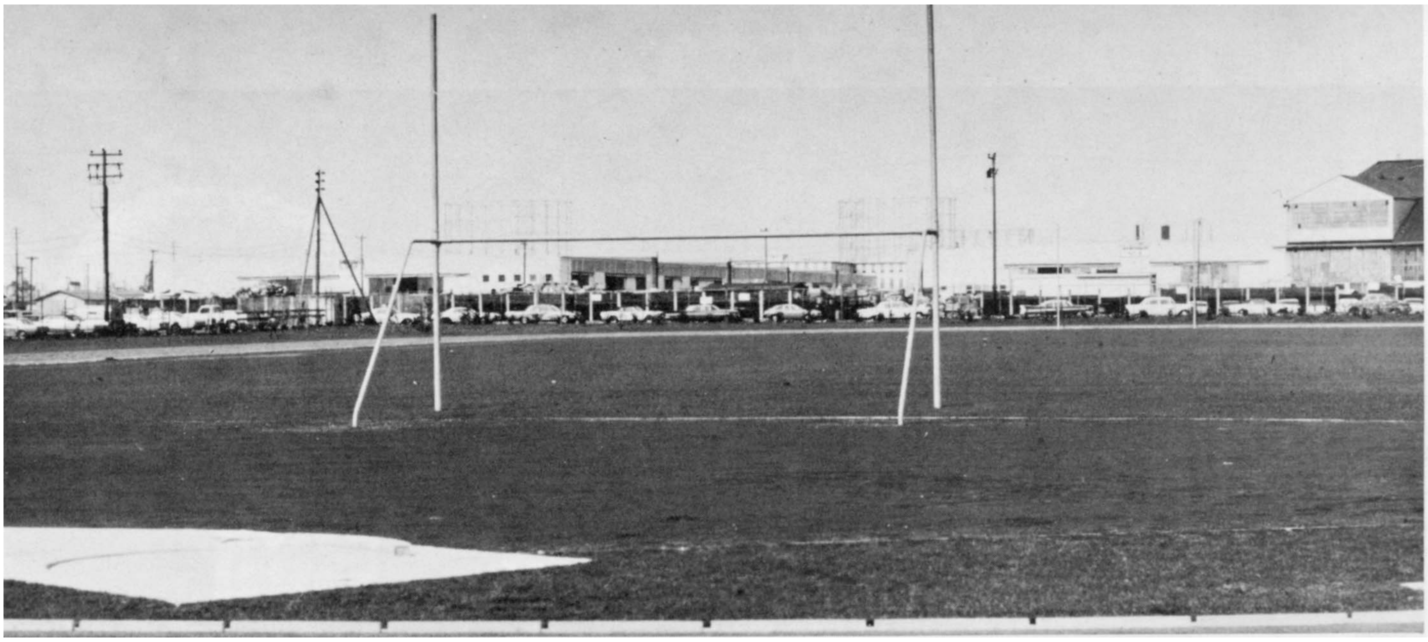
Release of nitrogen from the plastic-coated material depends on moisture diffusing through the plastic coat or membrane and the nitrogen solution diffusing out where the fertilizer becomes available to the plant. By controlling the thickness of the plastic coat as well as mixing pellets with different plastic thicknesses, a wide range of nitrogen release characteristics can be developed.

Because turf quality appears directly related to solubility with IBDU, the size of the particle may make a difference in release of nitrogen. Of the two sizes available, the smaller particle size was used in this trial.

Besides stand, color and weed invasion, there are important management factors such as cost per ton of nitrogen and labor costs and skill that were not looked at here. Which product is best will depend on the individual management situation.

The results of this trial should only be interpreted in relation to the establishment and maintenance of perennial ryegrass on sand. In a heavier soil, such as a clay, nitrogen might leach more slowly. Likewise, when grown in sand, a slow germinating variety like Kentucky bluegrass may not make as efficient use of nitrogen fertilizers applied at planting as would perennial ryegrass, a much faster germinating species.

K. D. Gowans is Area Farm Advisor in Alameda, Contra Costa and Santa Clara counties. E. J. Johnson is Farm Advisor in San Mateo and San Francisco counties. *The East Bay Regional Park District cooperated in this trial.*



Alameda College football field with a perennial ryegrass Kentucky bluegrass mixture planted on a sand fill. Information trom the nitrogen source trials discussed here was used to establish the turf on this field.

TURF QUALITY SCORES FOR MANHATTAN PERENNIAL RYEGRASS GROWN ON SAND, RATING NINE NITROGEN SOURCES FOR A PERIOD OF ELEVEN MONTHS*

FIG 1

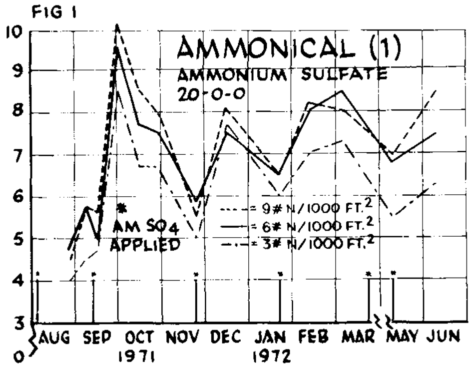


FIG 4

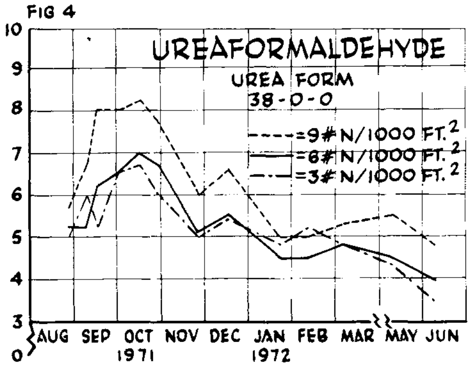


FIG 7

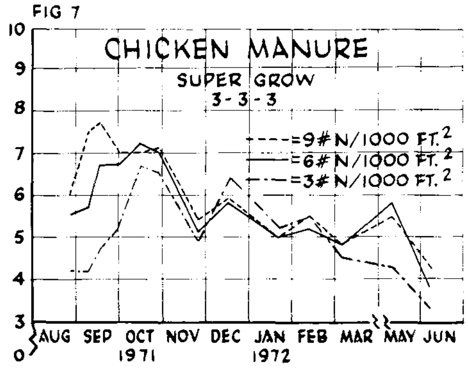


FIG 2

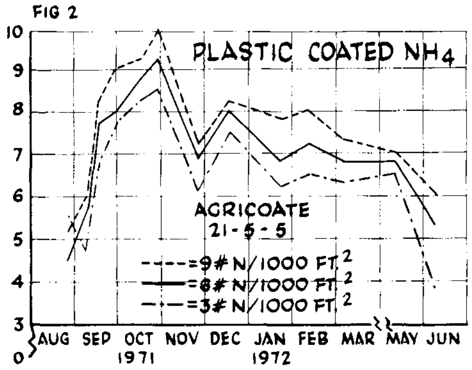


FIG 5

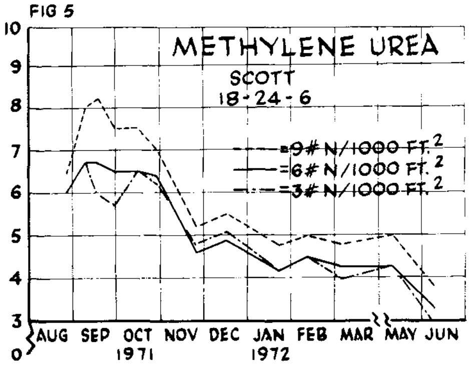


FIG. 8

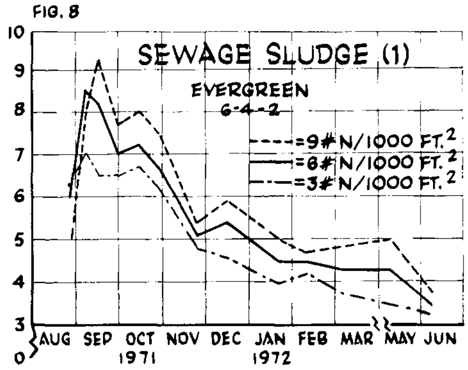


FIG 3

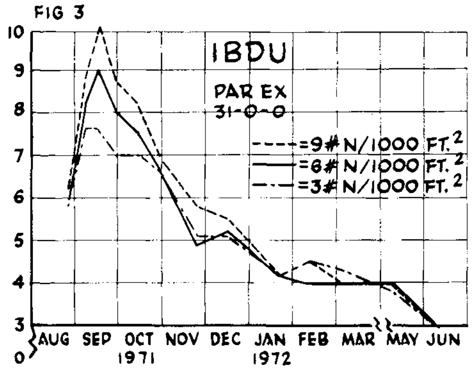


FIG 6

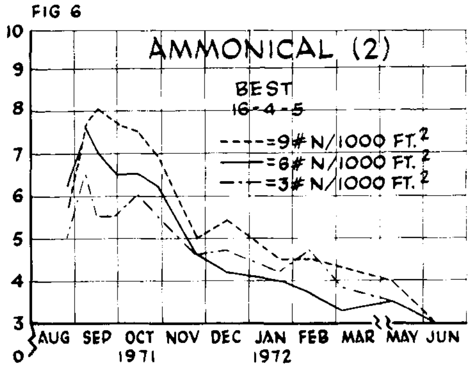
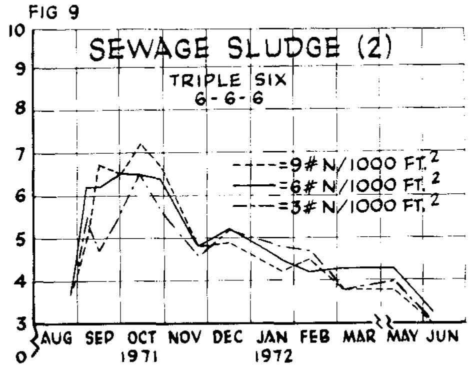


FIG 9



*10 = excellent turf quality; 6 = acceptable turf; below 6 = unacceptable turf