PRELIMINARY RESULTS OF TRIALS USING POTASSIUM CARBONATE TO ACCELERATE LUCERNE HAY DRYING (II) PALMERSTON NORTH

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ABSTRACT

The results are presented of two preliminary trials in which the effect of K_2CO_3 spray on the rate of field drying of lucerne hay was examined. Weather typical of summer in the Manawatu prevailed during the experiments. In both cases the sprayed hay could have been baled a day earlier than the unsprayed control. This reduction, on average, increases the probability of rain-free drying by about 10%.

MATERIALS AND METHODS

The first trial near Palmerston North occurred over 20th-22nd January 1982, and the second over 15th-18th March 1982. The lucerne (cv. Wairau) had a standing yield of nearly 3 t/ha for the first experiment whereas the regrowth for the second experiment had reached only 1.7 t/ha (Table 1). In both experiments, the crop was at 25% bloom and at a water content (in g water/g dry matter) of about 4 (Table 1).

TABLE 1: Crop yield and standing water content.

	Yield (kg/ha)	Standing Water Content (g/g)
Jan 20	2699 (± 650)	3.91 (± 0.10)
Mar 15	1715 (± 300)	3.99 (± 0.12)

Crops were cut by a 2 m wide disc mower that left a swath covering about 60% of the ground area and standing nearly 10 cm above the soil surface (Table 2). Each treatment consisted of an area 100 m long and 3 swaths wide, with a one untreated swath either side. The potassium carbonate spray was applied immediately prior to cutting. The spray rate was set at 300 *l*/ha so that potassium carbonate was put on at 10 and 7 kg/ha in the two respective trials. A conventional spray boom with vertical cone nozzles at a 0.38 m spacing was used and the height of the spray bar set just above the canopy of the standing crop. To ensure that the spray penetrated the lucerne canopy to cover the all-important stems, another bar was set at two-thirds the crop height, some 0.3 m ahead of the spray boom. This had the effect of brushing back the lucerne leaves to permit good spray penetration into the canopy. Because the disc mower left a shallow swath covering such a large fraction of the ground area no further tedding or raking of the hay was deemed necessary (Clothier, 1978; Clothier and Taylor, 1980). The drying of the control treatment verified this.

The drying of the hay was monitored by sequential weighing of swath samples. Six samples per treatment were obtained by removing a 300 mm wide section through the entire swath. Samples were weighed fresh and dried in a forced-draught oven at 95 °C for 18-24 hours. All hay moisture contents (X) are expressed on a dry weight basis, as this most accurately reflects the rate at which water is being lost from the swath. The percent of dry matter can be found simply from

$$DM = 100/(1 + X).$$

The hay was considered baleable at moisture contents below about ⅓, or a DM of 75%, which corresponds to a moisture content (on a wet basis) of 0.25. This level of dryness (DM 75-80%) is often considered sufficient to permit safe storage of hay since it is in equilibrium with air at a relative humidity of about 80-90% (Nash, 1978). At higher moisture contents, both fungal and plant respiration can raise the temperature of the baled product. (Nash and Easson, 1977).

TABLE 2: Swath architecture.

	Standing Water Content (g/g)
Cut width	2m
Swath width	1.13 (± 0.19) m
Fractional ground cover	0.57 (± 0.10)
Swath height	0.093 (± 0.02) m

RESULTS AND DISCUSSION

The weather data for the duration of both experiments are shown in Table 3. On average, the weather patterns were typical of the mid and late summer season in the Manawatu although some days were obviously better drying days than others. The soil was quite dry for both experiments however the surface was moist because of the significant shade offered by the lucerne canopy.

TABLE 3: Weather data for both experimental periods.

	Hours of sunshine (hr)	Maximum temperature (C)	Minimum temperature (C)	Mean daylight vapour pressure deficit § (kPa)	Windrun (km)
20 January*	8.1	19.3	6.7	1.24	170
21 January	6.6	20.4	7.3	1.06	623
January norm	7.1	19.0	14.2	1.27	328
15 March**	5.7	16.7	9.4	0.90	254
16 March	2.9	17.4	9.4	0.82	198
17 March	10.0	20.2	8.1	0.83	177
18 March	8.2	19.8	7.3	1.05	190
March norm	4.6	18.9	14.6	1.26	239

* Previous substantial rain: 7 January (29.4 mm)

** Previous substantial rain: 3 March (37.7 mm)

§ Found as (e^* [(T_{MAX} + T_{0900})/2] - e) where e^* (T) is the saturation vapour pressure-temperature relation and e is the vapour pressure at 0900 hrs.

Experiment 1:

The hay was cut just prior to midday on the 20th January and by mid-afternoon (1500 hrs) a small, but non-significant difference between the treatment and control was apparent (Fig. 1). By dusk (1930 hrs) the K_2CO_3 treated swaths were significantly drier than the control, having achieved this by drying 11% faster. The rate of water evaporation from the hay swaths (about 0.15 mm/hr) was less than half the rate of free-water evaporation (about 0.45 mm/hr) yet the hay in both cases had lost nearly 75% of their total water. The moisture content difference at dusk on the first day was maintained over the next two days so that the sprayed swath was ready to bale at dusk on the second day whereas the control could not have been baled until the end of the third day.

This maintenance of an almost constant difference in water content between the treatment and control (below water contents of about 2) implies that although both are losing water at the same rate at any given time, the spray treatment is managing to do it at a lower water content. The physiology of this phenomenon awaits further study.

Experiment 2:

Whereas the result of the mid-summer trial appears quite clear-cut, the outcome of the late-summer experiment in March was more equivocal. Such variation again highlights the limited physiological understanding we have of the processes of hay drying. Following midday cutting on 15th March, the treated swath dried at a rate of 0.07 mm/day, some 13% faster than the control (Fig. 2). Even though this was not an exceptional drying day, as reflected in the lower first day drying rate, both hay swaths managed to lose about half of their water. The following day was an even worse drying day with the treated swath remaining drier. On the third day, a much better drying day, both swaths dried at the same rate (about 0.01 mm/hr). However, by dusk the treated swaths had reached X = 0.37 (± 0.07) whereas the control swaths were at only X = 0.51

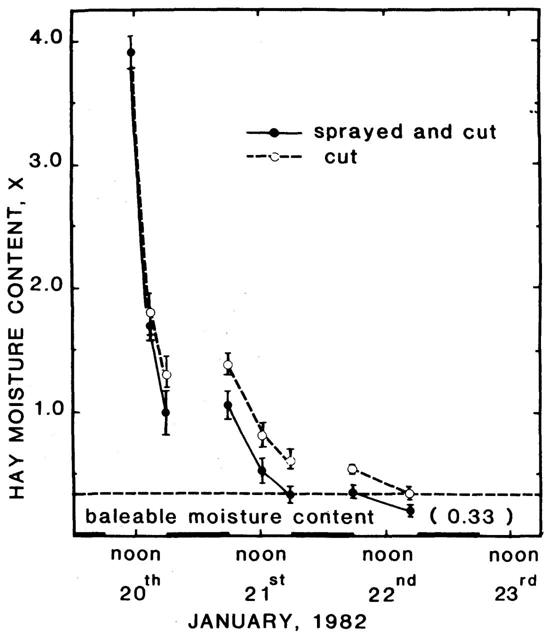

Figure 1: **Hay moisture contents (on a dry weight basis) of the spray treatment and the control over the 3 days, 20th-22nd January 1982. The vertical bars give the standard deviation about the mean.**

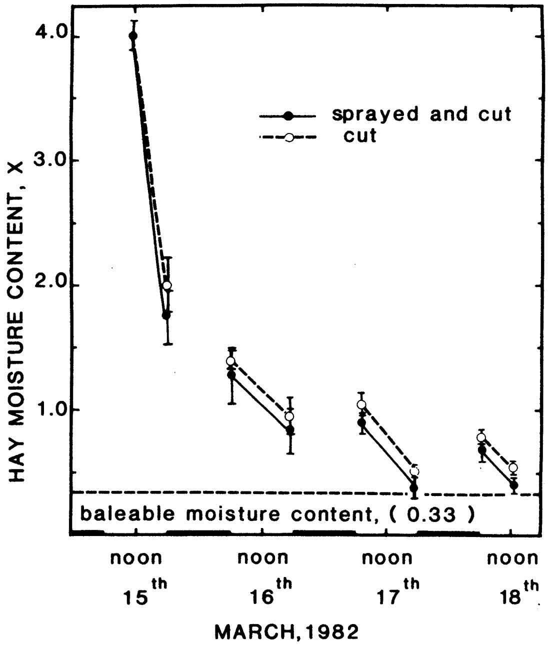

Figure 2: Hay moisture contents (on a dry weight basis) of the spray treatment and the control over the 4 days, 15th-18th March, 1982. The vertical bars give the standard deviation about the mean.

($\pm$0.03). As in the first experiment, a constant difference in moisture content between the treatment and the control appears to have been maintained from dusk on the first day.

By dusk on the 17th, the spray treatment could possibly have been baled, since the water content in late afternoon (1600 hrs) was 0.37 ($\pm$ 0.07). The control swaths required further substantial drying. However the nocturnal deposition of water by dewfall from above and distillation from below, doubled the moisture content. The sprayed swath required another 4-5 hours drying on the 18th March to become baleable again. The control treatment finally reached baleable water content on the afternon of the 18th, the fourth day of drying. In this case, the potassium carbonate spray theoretically shortened the drying period by only a few hours: in practice however, it may have made it possible to have had the hay in the barn 24 hours earlier.

CONCLUSIONS

Weather conditions during the mid and late summer trials were seasonally typical of Manawatu conditions. The potassium carbonate spray shortened the drying period from cutting to baling from 3 to 2 days for the January experiment. Such a reduction, would on average, increase the probability of rain-free drying from 0.63 to 0.77 (Clothier, 1978). For the March experiment the sprayed hay could have been baled after 3 days, as against 4 days for the control treatment. The probabilty of successful rain-free drying in this case would, on average, increase from 0.57 to 0.68.

The variability in the results of the spray treatment between the two trials in the Manawatu and between these and the ones carried out in Canterbury clearly demonstrate a weakness in the understanding of the physiology of hay drying as well as highlighting the inadequacy of engineering and agronomic aspects of the use of spray accelerants for hay drying. The combined results do suggest that further study is warranted.

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