EFFECTS OF TTME OF SOWING ON THE ESTABLISHMENT OF OVERSOWN LEGUMES

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Abstract

The establishment of oversown lucerne and white clover, in relation to time of sowing, was examined over two seasons on seven unimproved sites in the North Otago tussock grasslands — sunny and shady faces with lucerne at 450 m, with white clover at 880 and 1070 m, and a flat site at 1330 m. Seedling establishment showed an optimum at times associated with 3 to 7" C earth temperatures at 10 cm depth, with poorer results at both earlier and later times. Nodulation was high at times associated with temperatures up to 5 to 6° C, but fell with later sowings. Best plant establishment also occurred at times associated with 3 to 7" C, 10 cm earth temperatures. These results suggest that optimum sowing dates for the sites used would range from mid-August to October with earlier sowing dates on the sunny faces.

INTRODUCTION

WHEN ATTEMPTING to establish legumes from oversowing there are relatively few factors which can be manipulated to improve establishment.

Of these, the following are relatively well understood for many of the more common situations:

(1) Soil preparation — lime (Lowther, 1974) and fertilizer requirements (Cullen *et al.,* 1966; Ludecke, 1962, 1965; McLeod, 1974).

(2) Sward preparation for varying types of vegetation and cover (Cullen, 1971; Janson and White, 1971a, b).

(3) Seed preparation — inoculation and pelleting (Lowther, 1977; Musgrave and Lowther, 1976).

The only other major factor which is open to manipulation is the time chosen for oversowing. Brougham (1969), in reviewing the subject, concluded that time of sowing was likely to be important only in the colder, drier areas of the South Island. At Te Anau, Cullen (1966) demonstrated that time of sowing was not critical for grass establishment, but During *et al.* (1963) considered that sowing between July 15 and September 1 was critical for white clover establishment. Hence the convention of late winter/early spring oversowing, and sowing earlier than later if possible, has generally been adopted.

When Douglas (1970) first looked at the time of sowing requirements for establishing lucerne from oversowing, he obtained satisfactory establishment from both autumn and spring sowings and concluded that sowings should be confined to the moister winter season. Further work suggested that spring sowing tended to give more reliable results in both North and Central Otago (Musgrave *et al.*, 1974). The results showed that there were two important factors operating (Musgrave and Lowther, 1976) :

(1) That early seedling establishment was affected independently from the seedlings becoming nodulated.

(2) 'That there were strong sowing date × site interactions.

These observations prompted the more detailed investigations of time of sowing and its effect on legume establishment, which are reported here.

EXPERIMENTAL

LUCERNE

From July 26, 1974, a series of nine sowings at weekly intervals was carried out on adjacent sunny and shady faces at 475 m altitude near Omarama, North Otago. The sowings were made using Wairau lucerne seed which had been inoculated at five times the recommended rate with commercial peat-based inoculum and lime pelleted using gum arabic adhesive. A randomized block design was used, with 2 X 3 m plots and four replicates and a basal fertilizer dressing of 200 kg/ha of molybdic sulphur superphosphate (18% elemental sulphur) applied. A series of ten climatic variables was measured twice weekly or with a recording thermohygrograph and included soil and surface temperatures, soil moistures, rainfall, and humidity measurements.

Total plant counts were made at the seedling establishment stage (1st. true leaf stage) and of established plants in April 1975. From these data seedling establishment, nodulation percentage, and plant establishment were calculated, Since actual numbers were higher on the shady face, the numbers were converted to an arbitrary scale relative to the best sowing date on each site and by regression analysis were then compared with the climatic. variables.

Most of the comparisons mads were significant, and are summarized as follows.

(1) The conditions over the two weeks after sowing appear to be most important, as the relationships become weaker when taken over a longer period.

(2) Seedling establishment appeared to be related to all the climatic variables measured, except rainfall. However, the 10 cm earth temperature was significantly correlated with the other factors and thus reflected wide changes in the environment. Multiple regression with other factors did not significantly improve the relationship obtained and the 10 cm earth temperature alone allowed the two sites to be brought to correspondence, and a common pattern of seedling establishment (r = 0.95) was shown.

(3) A similar situation was found for both nodulation (r = 0.69) and plant establishment (r = 0.58), where the 10 cm earth temperature allowed the two sites to be brought to a common pattern.

Because of the relationships shown between lucerne establishment from oversowing and the soil temperatures existing over the sowing period, the possibility that soil temperatures could be used to put widely varying sites on a common time scale as a basis for predicting the optimum time of sowing for clovers was investigated in spring 1975.

WHITE CLOVER

From August 4, 1975, a series of nine sowings at two-weekly intervals was carried out on five sites at Tara Hills, near Omarama. The sites were on adjacent sunny and shady faces at 880 m (sites 1 and 2) and 1070 m (sites 3 and 4) and on a flat site at 1330 m (site 5) with resident vegetation of unimproved hard tussock (*Festuca novae-zelandiae*) and snow tussock (*Chionochloa rigida*) associations. Inoculation, pelleting, trial design and fertilizer treatments were the same as for lucerne. The climatic data were taken from adjacent, previously established meteorological sites. Total plant counts were made at the seedling establishment stage and 20 to 40 seedlings marked with wire pegs and survival assessed in May 1976. From these data seedling establishment, nodulation percentage, and plant establishment were calculated, and converted to an arbitrary scale relative to the best sowing date at each site, before regression

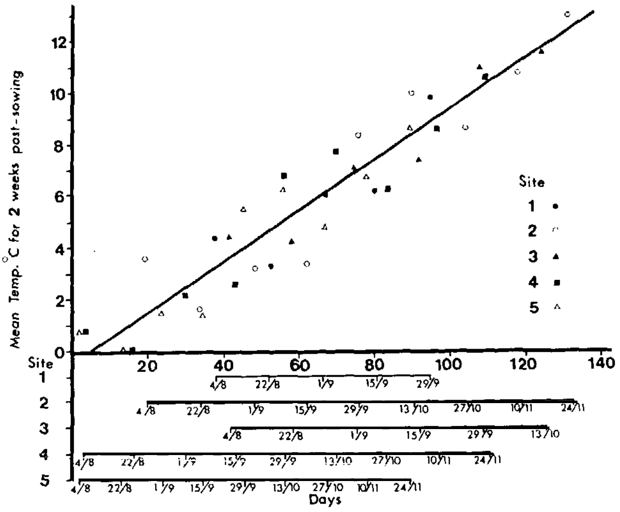

FIG. 1: *The corrected time scales produced by placing the five sites on a common relationship with respect to the mean 10 cm earth temperatures over the two weeks following each sowing.*

analysis involving the climatic variables. As with the lucerne sowings, the 10 cm earth temperatures averaged over the two weeks following sowing gave the closest relationships. Regression of soil temperatures on time over the period considered was approximately linear at all sites, and the regression lines -were used, to bring the time scales for the sites into correspondence as shown in Fig. 1. Using the time correspondence established in this way allowed the five sites to be brought to common curves for seedling establishment (r = 0.76), nodulation (r = 0.88) and plant establishment (r = 0.50) (Figs. 2, 3 and 4, respectively) with a highly significant improvement in the correspondence between sites.

DISCUSSION

The seedling establishment pattern showed that close to optimum establishment was obtained at times involving temperatures in the 3 to 7°C range (Figs. 1 and 2). At both earlier and later times, or higher and lower temperatures, seedling establishment was usually considerably lower than the maximum. It seems likely that much of the increase in seedling establishment could be due to the increased germination rate associated with increasing temperature (McWilliam *et al.*. 1970). As germination rate increases up to approximately 20° C (*loc.* cit.) the fall with later sowings was probably due to other factors associated with increasing temperatures, such as falling moisture levels.

Nodulation percentage on the other hand remained at high levels until times associated with temperatures of 5 to 6° C, but then fell. Again, the fall seems likely to be due to the factors associated with the increasing temperature, such as falling soil moisture levels, reducing rhizobia survival.

Plant establishment, being a combination of both seedling establishment obtained and nodulation percentage of the seed-

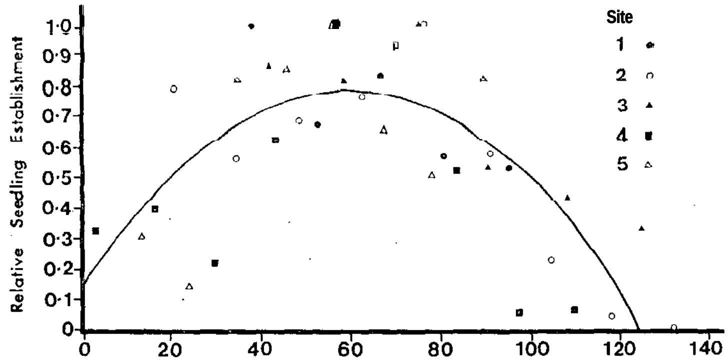

FIG. 2: The *relationship between seedling establishment and the earth* temperature *udjusfed time scale.*

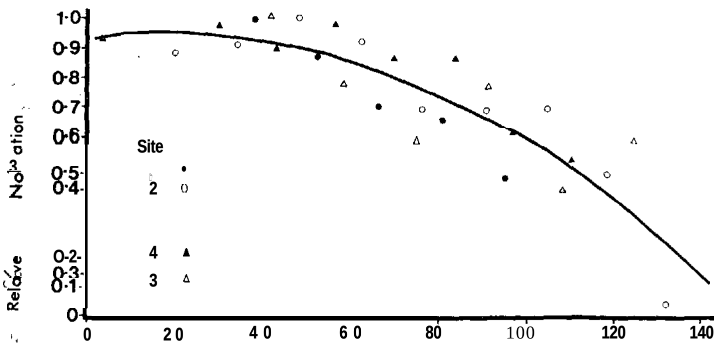

FIG. 3: *The relationship between nodulation percentage and the earth temperature adjusted* time scale.

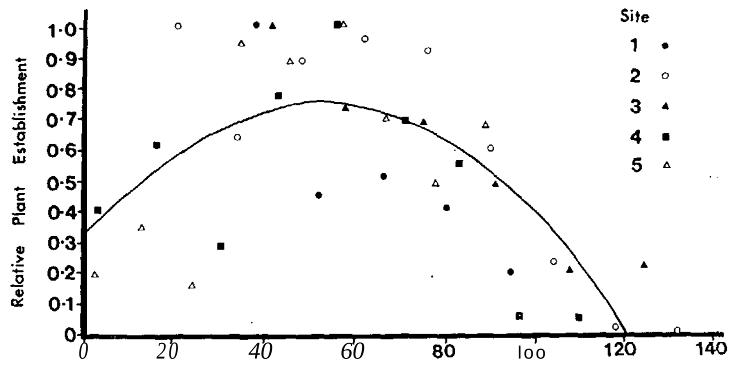

FIG. *4: The relationship between plant establishment and the earth temperature adjusted time scale.*

lings, reflected both these factors and showed an optimum at times associated with temperatures of 3 to 7" C. Although the results of During ef *al.* (1963) did not suggest that speed of germination was important, these results also suggest that rapid germination is important for good establishment (Brockwell, 1962). As neither the lucerne nor clover results showed much difference between optimum times for seedling establishment and plant establishment, changes in nodulation relationships which may occur with improved seed treatment technology should not greatly affect the optimum time for sowing.

Using the range of 3 to 7" C as the optimum temperatures associated with plant establishment, the mean times of sowing at the five sites used, taking the long-term data available (sites 1 and 2 — 4 years, sites 3, 4 and 5 — 9 years), are shown in Table 1. Since the temperatures at site 5 change at approximately

TABLE 1: MEAN TIME OF SOWING FOR FIVE SITES TAKEN FROM LONG-TERM METEOROLOGICAL RECORDS

Site	*Aspect*	*Altitude (m)*	*Optimum Times*
1	sunny	880	1st wk Aug.-1st wk Sep.
2	shady	880	1st wk Sep.-1st wk Oct.
3	sunny	1070	2nd wk Aug.-2nd wk Sep.
4	shady	1070	3rd wk Sep.-4th wk Oct.
5	flat	1330	4th wk Sep.-1st wk Nov.

0.8” C/week over the spring, these results suggest that time of sowing should be less critical than at the warmer sites, where the soil temperatures increase at approximately 1.0° C/week.

The optimum sowing dates suggested by these results are generally somewhat later than those recommended by During et al. (196.3) and commonly used, but the results indicate that attention to time of oversowing is essential for best results.

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