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CLOVER — WHAT TYPES FOR DRY HILL COUNTRY?

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Abstract

Subterranean clover and white clover plant material was collected from 85 sites located in summer-dry northern North Island hill country. Plants of both species originating from this collection were grown and typed at Whatwhata Hill Country Research Station. Using several cultivars and selections as standards, measurements were made of morphological, flowering and reseeding characteristics.

The subterranean clover population consisted of 44% Mt Barker type, 28% Tallarook type and the remainder an undetermined intermediate type. Mt Barker types in the collection tended to flower later and for longer than their Mt Barker standard, while Tallarook types tended to flower earlier and for longer than standard Tallarook. White clover plants were smaller and more densely leaved than 'Grasslands Huia', the population mean being similar to 'Grasslands Tahora'. A vast majority (7035%) of plants flowered earlier and yielded more seed than Huia and Tahora.

An apparent shift in plant type has occurred within clover populations in summer-dry hill country, the most notable being the development of a more flexible reseeding pattern. This type can be a future guide to breeding clovers suitable to these environments.

Keywords: white clover, subterranean clover, flowering, seeding, morphology, type hill country.

INTRODUCTION

The inherent variability of physical, climatic and management factors in hill country is well recognised (Suckling, 1975). To persist and produce, legume populations must have the flexibility to cope with this variation that occurs both within and between properties.

Moisture deficits in dry hill country can be due to any combination of low rainfall, low effectiveness (slope, soil texture) and/or high water loss. In such conditions, subterranean clover ***(Trifolium suberraneum*** L.) and white clover *(T. repens* L.) often occur together. White clover may dominate the legume population following a sequence of moist seasons, but prolonged dry periods will favour a shift towards sub-clover. This population flexibility (in reseeding, flowering and plant density) is an important feature of dry hill country legumes, enabling the best to be made of the prevailing conditions.

Regeneration of the annual sub-clover is dependent on adequate reseeding before the onset of dry conditions and the successful establishment of seedlings following drought conditions. The variable onset and break of dry conditions, typical of dry hill country, requires flexibility in flowering and germination patterns. Similarly, a combination of hard grazing and droughts of variable intensity may result in marginal perennial persistence of white clover and the need to re-establish populations from surviving stolons or seed. Cultivarsfor such environments must possess flexibility to overcome these conditions.

Populations of sub-clover, originating from sowings of Mt Barker and the later flowering Tallarook cultivars, have been established in New Zealand for many decades (Saxby, 1956). Similarly, old populations of white clover originating from early uncertified introductions (Davies & Levy, 1931) and later sowings of New Zealand Certified White Clover and 'Grasslands Huia' (Corkill, 19491 can be readily found in hill country. Genetic shifts within these populations may have occurred as a result of local environmental pressures (Corkill ***et al., 1981;***

Suckling et *al.,* 1983), the present plants being better adapted than those originally introduced or cultivars currently available for introduction. If common genetic movement has occurred in similar environments that are geographically separated, this could indicate a desirable characteristic for persistence under such conditions, and as such, be a guide to breeding material for such environments. It may also indicate the likely suitability to dry hill conditions of sub-clovers and white clover currently available or pending release such as 'Grasslands Tahora', a small, dense-leaved cultivar bred from material collected in moist hill country (Williams *et al.,* 1982).

To identify adaptable features that may have developed in sub-clover and white clover populations, plant material was collected from 85 sites located in summer-dry areas of the northern North Island. Plant habit and reseeding characteristics of these collections were established relative to standard cultivars. This paper outlines some of the distinctive features of the collected populations; and also presents data from a clover evaluation trial at Whatawhata Hill Country Research Station, that illustrates the significance of some of these features in dry hill country conditions.

METHODS AND MATERIALS

Plant Typing

Five sub-clover communities (2 x 3m) were selected within each of 17 farms that were located in summer-dry areas of the northern North Island (Fig. 1). The

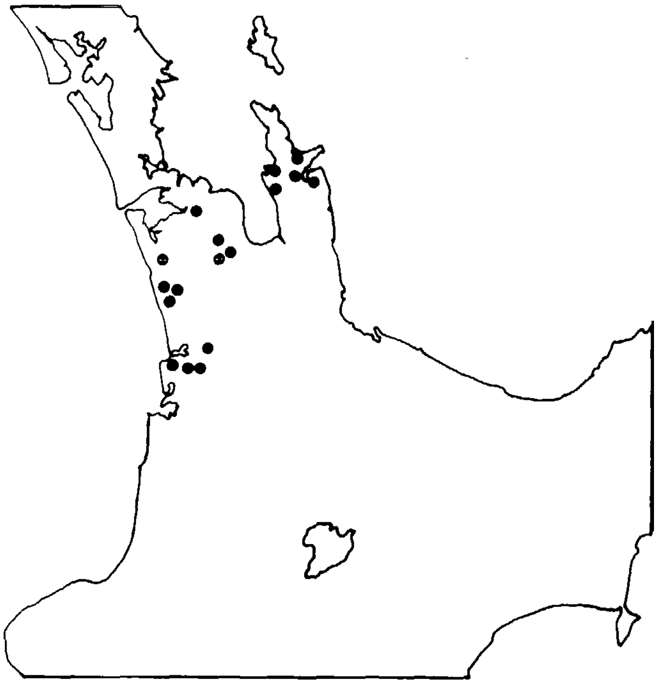

Figure 1: Location of sample farms.

majority of sites were of low to moderate fertility (O-150mm depth: pH 4.9-5.5; Olsen P $\leqslant 9$ at 64 sites). During January, 1981, buried sub-clover seed was collected (10 random cores) from these 85 sites. White clover stolons were collected from adjacent areas and for each site they were grown together in separate boxes for two years. All white clover collections were allowed to open-pollinate each summer and seed wascollected from individual boxes. Maternal percentage of collected seed was therefore known.

Plants were established from these seed pools, the sub-clover collection (1580 Plants) being typed from January-December 1981, and the white clover collection (1800 plants) from January 1982 – February 1983. For both species and each collection site, 20 plants were grown in separate planter-bags of soil (4 litres). Standard cultivars (20 plants per cultivar) were also established, these being 'Mt Barker', 'Woogenellup' and 'Tallarook' sub-clover; 'Grasslands Huia', 'Grasslands Tahora', 'Kent', 'Clarence Valley' and Whatawhata early flowering type white clover. All plants were grown outside at Whatawhata Hill Country Research Station and were regularly watered to avoid plant wilt. Watering of sub-clovers ceased in early December, but continued throughout the summer for the white clover typing.

Flower numbers were counted at weekly intervals from the beginning to end of flowering for sub-clover; and between early September and early February for white clover. Seed was collected from individual plants in January, and seed numbers determined. Leaf width, length and density measurements of white clover plants were also made during January.

Cultivar Evaluations

Small plots (60 x 75cm) of sub-clover and white clover cultivars were established in April 1981 on a summer-dry, NW-facing hillside (23-30° slope) at Whatawhata Hill Country Research Station, as part of a MAF/DSIR national series. Sub-clover cultivars exhibited a range of flowering dates and plant habits, and white clovers a range of leaf and stolon densities and reseeding potential. Paddocks in which the plants were located were rotationally grazed with sheep down to a height of 2-3 cm. Selected data from some cultivars (Tables 1 and 2) are used to illustrate reseeding differences and effects. Estimates of reseeding ability and seedling establishment (soil coring and fixed quadrat counts, sub-clover; flower counts and seed collection, white clover) were made from September 1981 to June 1983.

RESULTS AND DISCUSSION

Data from the collections are presented as histograms showing the percentage of the total population occurring within each measurement range of a specific characteristic. Mean values for each standard are super-imposed to indicate their relativity to each population.

Sub-clover

Principally on the basis of calyx marking (red – Mt Barker; no red – Tallarook; indistinct pink/maroon – undetermined type), 44% of the population was typed as Mt Barker, 28% as Tallarook, and the remainder an undetermined intermediate. No plants within the population started flowering earlier than Woogenellup standard, the majority commencing at or between those dates of Mt Barker and Tallarook (Fig. 2a). Those plants that flowered earlier than Mt Barker were predominantly of the Mt Barker type, but plants that commenced

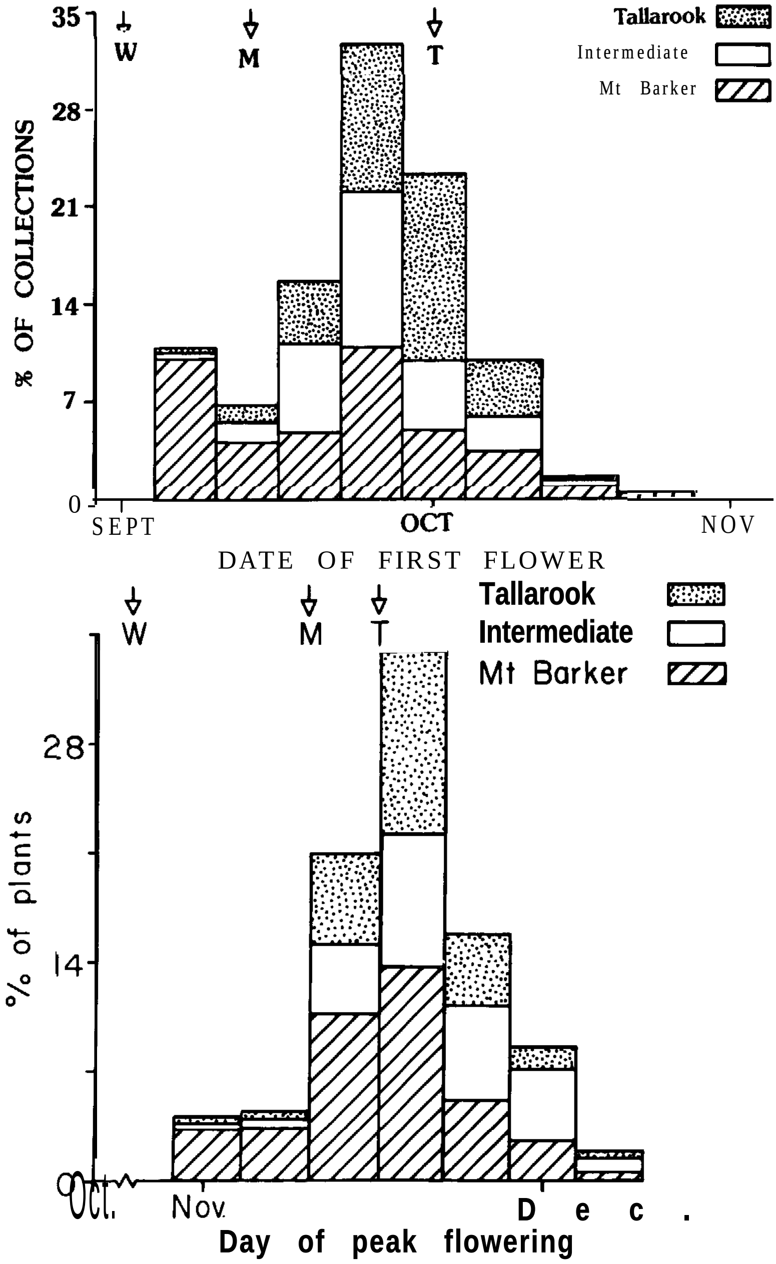

Figure 2: Distribution of first la) and peak (b) flowering date for plant types within the collected sub-clover population, relative to standard cultivars. (W — Woogenellup; M — Mt Barker; T — Tallarook).

Table 1: RESEEDING AND GERMINATION CHARACTERISTICS OF SUB-CLOVER CULTIVARS ON DRY HILL SIDES.

	Seeds/m² Dec '81	Seedlings as percentage of maximum 12 Jan	25 Feb	1 Mar	22 Mar	26 Apr	28 May	Plants/m² June '82
Woogenellup	391	59	1	22	16	21	35	45
Howard	3564	55	3	74	59	54	60	139
Nangella	364	62	0	19	9	15	15	22
Tallarook	4662	22	1	77	34	52	72	156
SED	989							62

Table 2: RESEEDING AND GERMINATION CHARACTERISTICS OF WHITE CLOVER CULTIVARS ON DRY HILLSIDES.

	Cumulative Flower No. (/m²)	Seed Yield (g/m²)	Seedling Numbers (/m²)
Huia	60	3.0	44
Tahora	110	3.0	48
Whatawhata	330	9.7	128
Kent	50	1.0	27
SED	32	2.5	21

after Tallarook were of all three types. However, the general trend was for Mt Barker types to commence flowering at or later than the associated standard date; and Tallarook types at or before their standard's date, i.e. the population had moved to an intermediate position, particularly the Mt Barker types.

In contrast, date of peak flowering was not intermediate of the standards Mt Barker and Tallarook (Fig. 2b). This was a consequence of the Mt Barker standard and its population type peaking at a date close to that of Tallarook. Peak flowering date for 90% and 70% of the population was at or later than that of Mt Barker and Tallarook respectively. Those plants that peaked earlier than Mt Barker were predominantly of Mt Barker type, while those that were later than Tallarook included all three types. Of interest was the large number of Mt Barker type plants that peaked at or after the standard Tallarook.

The occurrence of early flowering Tallarook types and late flowering Mt Barker types, as well as a large number of indeterminant types within the collection, suggests that very diverse populations are to be found in summer-dry hill country. Agronomically, optimum flowering is a compromise between continuing vegetative leaf growth and achieving adequate reseeding before dry conditions are encountered. In response to this compromise, there appears to have been a shift towards a later date of peak flowering within the Mt Barker type population, and an earlier start to flowering within the Tallarook population. Both moves extend the period of flowering and provide greater flexibility to cope with the variable and unpredictable onset of dry conditions.

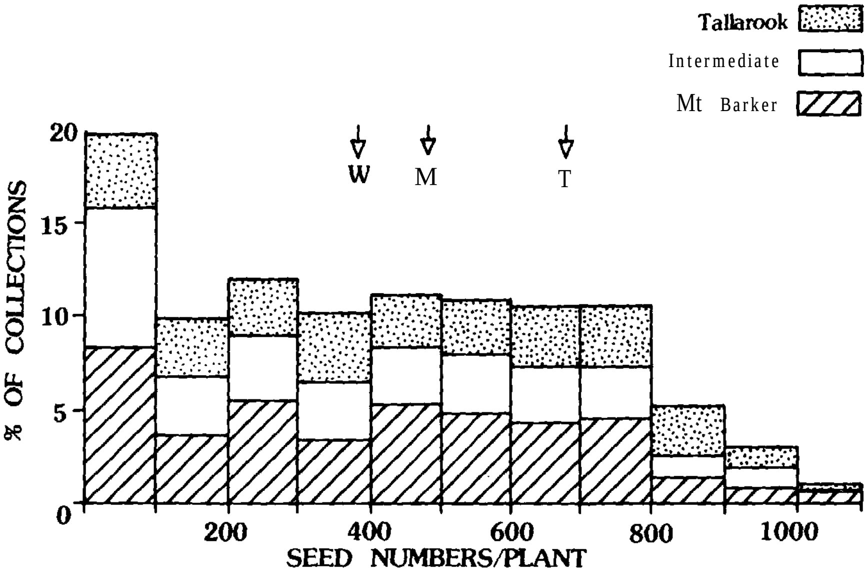

Figure 3: Distribution of seed number per plant for plant types within the collected sub-clover population, relative to standard cultivars. (Key as for Fig. 2)

Sufficient water was applied to allow the full expression of reseeding potential, yet 50 and 70% of the plants produced less seed than the Mt Barker and Tallarook standards respectively (Fig. 3). Seed production from Tallarook type plants was equally distributed through the range recorded, but there was a disproportionately greater number of Mt Barker type plants at the low end of the production range. The low reseeding ability of much of the population may reflect a move to smaller, less vigorous plants better adapted to difficult growing conditions, but as evidenced by the variation encountered, there is considerable scope for improving reseeding potential above that of existing populations and available cultivars. In hill pastures the minimum level of reseeding required to achieve satisfactory regeneration has not been clearly defined, but it will obviously depend on the content of sub-clover sought and the success of seedling establishment. Sub-clover seed number present at the collection sites in January 1981 ranged between 1000-15,000/m^2, with a mean of 4500/m^2.

While reseeding provides the basis of annual regeneration, sub-clover densities in winter also depend on the successful establishment of seedlings in autumn. Premature germination of seed before there is adequate moisture to maintain seedlings through the autumn (false striking), can deplete effective seed reserves. Seed germination and seedling establishment patterns were not evaluated for the collection population; however data from a current sub-clover evaluation trial located on steep (25-35° slope) NW facing hillsides at Whatawhata Hill Country Research Station illustrate the problems of false seed strike (Table 1). In response to early summer rains, relative germination was high in Nangella, Woogenellup and Howard, yet by the end of February most of the resultant seedlings were dead. For those with low seed set (Nangella and Woogenellup), this false strike combined to produce low final plant densities. However, as illustrated by Howard, false strikes can be adequately compensated for, if reseeding levels are high. In hill country where reseeding can be restricted (eg. overgrazing, early moisture stress) and/or ineffective summer' rains are common, plants with high reseeding ability and a low propensity to false strike should be sought to ensure reliable annual regeneration.

White Clover

While leaflet width ranged between 3-22 mm, 85% of plants had values between 7-12 mm (Fig. 4a). For the majority, leaflet width was smaller than Huia, while the general population mean was similar to Tahora and the Whatawhata early flowering type. Similar population trendswere evident for petiole length (Fig. 4b), although Tahora was relatively closer to Huia. On the basis of visual scores (Fig. 4c), leaf density of most of the population was greater than Huia, but of greater interest was that 75 and 30% of the plants were denser than Tahora and Kent respectively. Morphologically the popuintion was smaller and more densely leaved than Huia; and on average was generally centred around Tahora and the Whatawhata early flowering type. These morphological characteristics are similar to those of other populations collected from hill country (Davies & Levy, 1931; Suckling & Forde, 1978). This may well reflect the hard grazing pressures to which the population had previously been subjected for many years.

Date of first flower of the majority of the population was distinctly different from Tahora, Huia and Kent (Fig. 5a). Relative to these standards, 85% of plants commenced flowering earlier, with over 50% being at least 4 weeks earlier. The mean of the population was much closer to the free-seeding Australian type, Clarence Valley, and the early flowering/free-seeding type selected from an earlier Whatawhata collection.

Peak flowering dates of the standards were closer than commencement dates, and the general trend of the population was to peak at dates closer to those of

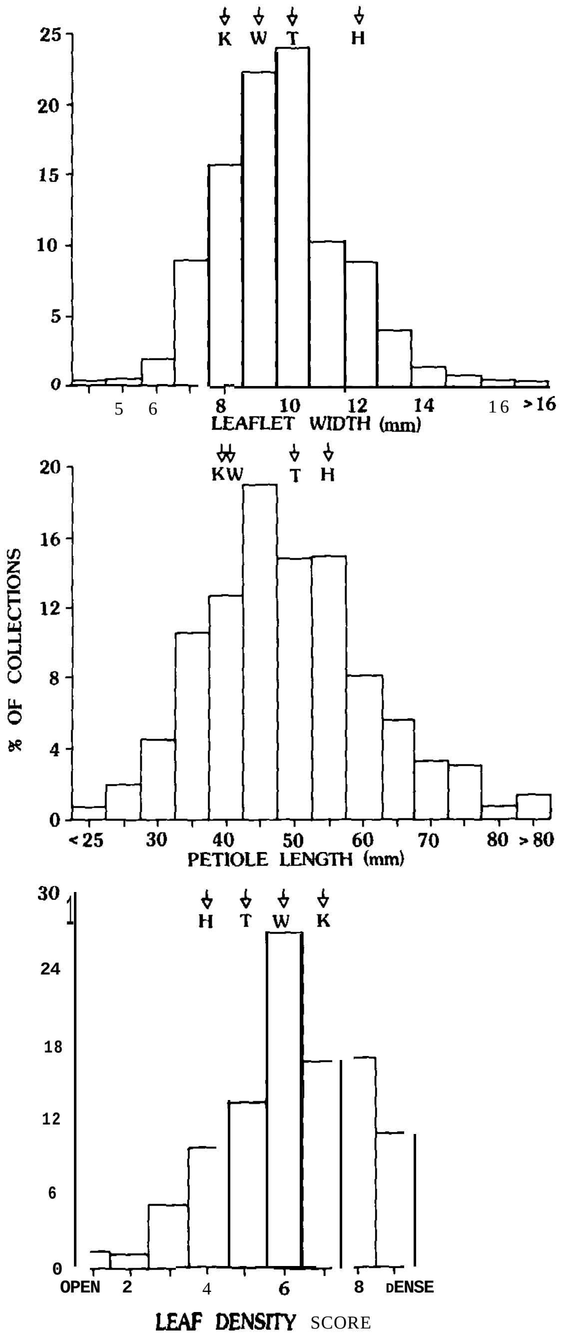

Figure 4: Distribution of leaflet width (a), petiole length (b) and leaf density (c) within the collected white clover population, relative to standards. (H – Huia; T – Tahora; K – Kent; W – Whatawhata early flowering type).

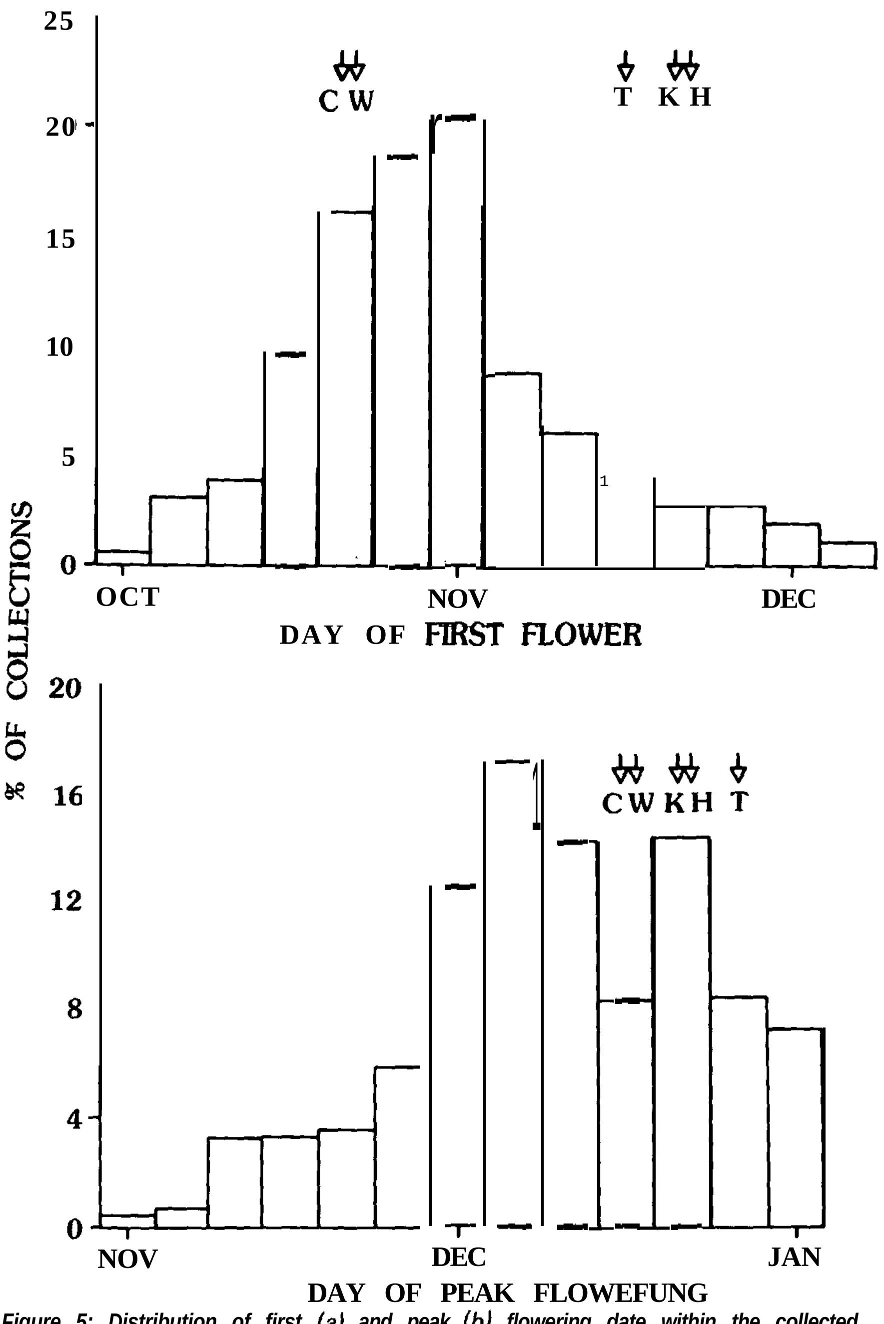

Figure 5: Distribution of first (a) and peak (b) flowering date within the collected white clover population, relative to standards. (Key as for Fig. 4, plus C — Clarence Valley).

Grasslands Huia and Grasslands Tahora (Fig. 5b). The majority of the population peaked 45-55 days after the commencement of flowering, compared with 30 days for 'Grasslands Huia', 35 for 'Grasslands Tahora', and 55for Clarence Valley and Whatawhata. With an earlier start to flowering and later peak dates, the general population tended towards a broader flowering-time base, as was also evident within the sub-clover population.

The total number of seeds produced per plant was related to total number of flowers. Seed numbers ranged between 100 and 13,600 per plant, with more seed generally being produced by plants that flowered early and peaked late. Of the population, 85% of the plants produced more seed than Grasslands Huia, and 70% more than Grasslands Tahora (Fig. 6). Because of the non-limiting water regime, all plants were given the opportunity to fully express potential seed production, therefore the data may not adequately reflect the relative seed production patterns if moisture limitations had occurred. The impact of dry conditions on seed yields and resulting re-establishment from seed is indicated from a white clover field evaluation study located on dry NW facing hillsides at Whatawhata (Table 2). Earlier and prolonged flowering in the Whatawhata early flowering type, represents more closely the common type of the collection population.

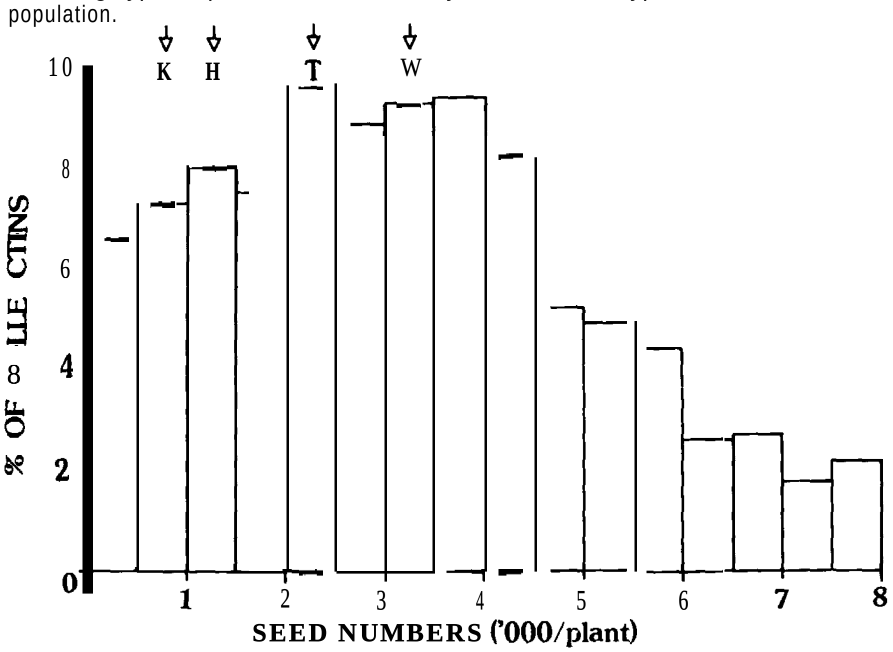

Figure 6: Distribution of seed number per plant within the collected white clover population, relative to standards. (Key as for fig. 4)

Early flowering and high seed yield potential is hypothesised to be an adaptation for population survival following summer-dry conditions. Early flowering enables seed set to occur before the onset of dry conditions. This provides the opportunity for vegetative perenniation if climatic conditions allow, or population regeneration from seed if droughts occur. Furthermore, strong reseeding may also act as an essential population buffer where white clover is lost through insect attack or gross mismanagement of pasture.

In linking the characteristics of long-term populations to the development and availability of white clover material more suitable to hill country conditions, it is likely that Tahora will fulfil the need of a more prostrate, densely leaved plant. However, if the reseeding potential of the collected population is an indication of a further adaptation to provide longer-term population stability and security, Tahora may still be inadequate for dry hill country, because of its later and shorter flowering time period, and consequently poorer reseeding ability. While there appears to be a need for plants that provide a basis for re-establishment following drought, they must also have the capacity to maintain stolon density and herbage growth, if conditions allow. This combination has not been apparent in the free-seeding types commercially available from overseas (Louisana S1; Clarence Valley), but preliminary investigations would suggest that they exist within our own hill populations.

CONCLUSIONS

Satisfactory persistence and production of clovers in dry hill country required in-built flexibility within the populations to cope with the variable onset and intensity of moisture stress. This is achieved by ensuring a broad plant base is present to form a species mosaic that adjusts with climatic changes. A white clover-subclover mix is therefore a basic necessity. However, within both species further security in long-term persistence can be gained by developing a broader flowering and reseeding base that allows the re-establishment of populations following droughts. Within the dry hill country sites that were surveyed, this has been achieved by developing earlier and more prolonged flowering characteristics. In combination with satisfactory herbage production, these reseeding criteria should be sought in clover cultivars that are to be more suited to dry hill country conditions.

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