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CHEMICALS FOR PASTURE RENOVATION AND IMPROVEMENT OF HERBAGE QUALITY

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Abstract

Research into chemical pasture renovation was pioneered by NZ scientists in the 1960's but the technique was not widely adopted at that time. Subsequent work has confirmed that white clover (*Trifolium repens* L.) is a poor competitor against browntop (*Agrostis capillaris* L.) for phosphate. This has implications regarding nitrogen fixation. Pasture renovation also provides an opportunity to introduce preferred pasture grasses, free of competition from resident grass species.

White clover is now recognised as a high-quality feed for livestock. Work is reviewed showing the correlation between liveweight of ewe hoggets and subsequent breeding performance and that white clover-dominant pasture was superior to ryegrass-dominant pasture for flushing breeding ewes.

In field-scale testing, the plant growth regulator mefluidide suppressed seedhead formation in pasture grasses and gave substantial, though regionally variable, liveweight gains in lambs, beef cattle and deer. In limited evaluation with dairy cows changes in pasture herbage have not been matched by improved milk or milkfat yield.

Keywords: Chemical pasture renovation, fertiliser utilisation, pasture quality, chemical plant growth regulator.

INTRODUCTION

The term agricultural chemicals has traditionally covered, not fertilisers as might be expected, but herbicides, insecticides, fungicides and bactericides. As these titles indicate, they have been used mainly to protect crops and pastures from weed competition, insect pests or plant diseases. Herbicides, however – and more recently plant growth regulators – have another role with respect to pasture. This is in the improvement of pasture composition, productivity and quality as a feed for grazing livestock.

PASTURE RENOVATION

Early work

Probably because of the importance of pastoral exports to the New Zealand economy, coupled with a high proportion of non-arable pasture land, interest in finding an alternative to cultivation dates back many years. In a recent review of pasture renovation, Leonard (1964) described pioneering work by Department of Agriculture research workers and how interest was restimulated by the introduction of paraquat (Gramoxone®) in the 1960's. In addition to predictable herbicidal activity, its main features were inactivation on contact with soil and its selectivity toward white clover (*Trifolium repens* L.).

A technique was developed which, as seen by its authors, controlled grasses such as browntop (*Agrostis capillaris* L.) and Yorkshire fog (*Holcus lanatus* L.) which competed with white clover for topdressed fertiliser. White clover was released to perform its function of nitrogen fixation while sown grass seedlings could establish relatively free from competition (Williams 1966).

A modest level of promotion in the early 1970's failed to persuade the majority of pastoral farmers to adopt this method of pasture improvement. Some farmers, especially in South Otago and Southland, have since used paraquat on a regular basis but use elsewhere has been sporadic.

Meanwhile, the presence of volunteer perennial grasses, readily seen in summer-moist areas, has been documented by Palmer (1970) and Round-Turner (1970). Also, the finding of Jackman (1960) that white clover is a weak competitor against grasses for phosphate and possibly potash was confirmed by Harris (1973) and Mouat (1983).

This work helped to explain the results previously reported by Williams (Fig. 1) showing increased response from topdressed fertiliser by the use of paraquat spraying.

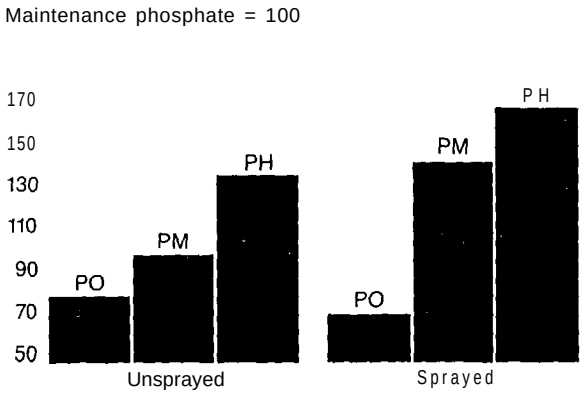

Figure 1: Comparison of dry-matter production on sprayed and unsprayed pastures at *various levels of fertiliser application — second year yields. PO = No phosphate since trial established; PM = Maintenance phosphate each year; PH = High phosphate each year. Source: Williams 1966.*

Sowing of seed

Pasture renovation generally includes the sowing of grass seed, if not clover as well. Seed sowing was a feature of early research though, with the selectivity of the herbicide towards white clover, grass seed only was usually sown. Where comparisons were made between sowing into sprayed and unsprayed pasture (Fig. 2) the unsprayed plots were prepared by controlled grazing. The advantage of using herbicide to control competition when broadcasting or direct drilling pasture seed has also been highlighted by Williams (1967), Kunelius *et* a/(1982), Sithamparanathan et a/ (1984) and M.L. Smetham, Plant Science Department, Lincoln College (*pers. comm.* 1984).

Where the land contour allowed, drilling of seed gave better establishment than broadcasting (Fig. 2) but design of seed drills was a constraint on early development. Overdrilling into pastoral land was not uncommon in the 1960's but drill designers seemed more preoccupied with the need to cope with the contour and nature of untilled land than with the agronomic welfare of establishing seedlings. However, concurrent research and development work on the direct drilling of arable crops prompted interest in coulter design and the robustness of the drills themselves (Taylor 1969, Baker 1981).

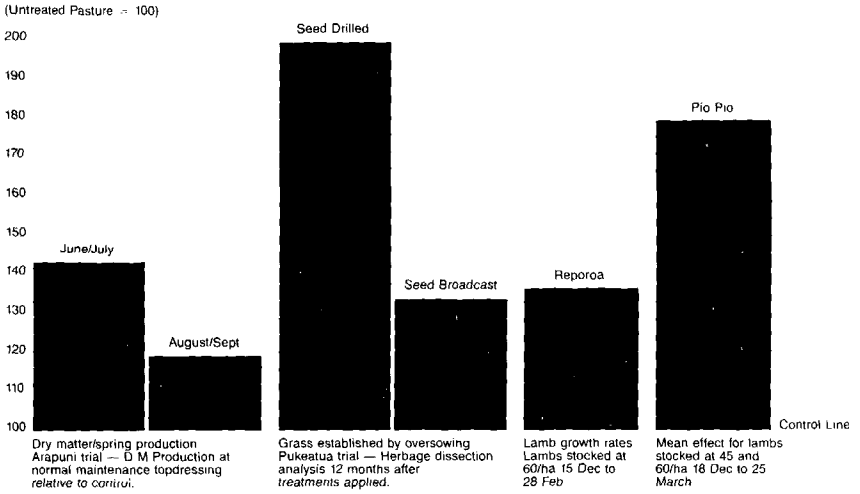

Figure 2: Summary of grass establishment, pasture production, and lamb growth rates. Source: Williams 1968.

Changing Attitudes

In 1982 a survey was done (Leonard — unpublished), aimed at determining whether changes in circumstances and attitudes might have rendered pasture renovation, (and some other techniques) more relevant to agriculture today than when it was first developed. Views were sought from 98 selected people including government and university research staff, farm advisors, farmers — some of whom had been users and some who still were — stock and station agency staff, drill manufacturers and agricultural contractors.

The principal changes identified with respect to pasture renovation were:-

1) The principle of drilling seed into untilled ground has been accepted and drills are regarded as reasonably satisfactory.
2) The high cost of fertilisers has generated increased awareness of the need to gain maximum economic return from topdressing.
3) Farmers are interested in utilising new pasture species and strains, if possible without the inconvenience and rising cost of cultivation.
4) Advisors are now more interested in pasture renovation as an integral part of farm management.
5) A greater appreciation appears to exist, especially among scientists, of the need for something more than just grazing to protect establishing seedlings from competition.

Products

The first chemical found to be really suitable for pasture renovation was paraquat. Subsequently the broad spectrum herbicide glyphosate (Roundup@) was introduced.

Like paraquat, it is inactivated on contact with soil (Upchurch & Baird, 1972) and in terms of herbicidal activity, paraquat and glyphosate have important complementary properties. The main differences are that glyphosate is more effective against certain perennial grasses such as paspalum (*Paspalum dilatatum* Poir), whilst white *clover* recovers more quickly after treatment with paraquat.

In 1983 a special paraquat/diquat product (Spraygrow) was introduced for use on pasture.

CLOVER AS A FEED CROP

Agronomic and Liveweight Studies

Research work with paraquat on pasture renovation covered the testing of a wide range of rates at several seasonal times of application. By relating these to plant growth patterns it was found that low rates of paraquat (150/200 g/ha a.i.) on pastures in late spring produced summer clover dominance.

McLean et al (1965) reported that young sheep grew better on white clover than on grass. Palmer (1967) showed that paraquat-stimulated clover gave significantly greater liveweight gains than pasture specially prepared by conventional management for weaned lambs. More wool was grown by the lambs grazing clover and, in a facial eczema-prone year, there was less facial eczema in lambs grazing clover.

Also, the time of application and low rate of paraquat needed to give summer clover dominance appeared to do little more to perennial ryegrass (*Lolium perenne* L.) than hasten summer dormancy. As the seasonal growth of white clover declined in autumn, the perennial ryegrass growth cycle resumed.

Breeding potential

The economic value of increased liveweight gains was being evaluated in terms of carcase weight of lambs for slaughter. However, at the MAF Whatawhata Research Station a correlation between hogget bodyweight and the onset of oestrus was already being demonstrated (Hight & Sinclair 1965). Subsequent research showed that, whether mated as hoggets or not, hoggets which had cycled became more prolific breeders (McMillan & McDonald 1983).

As well as confirming this finding, Rattray et *al* (1983) demonstrated that white clover-dominant pasture was superior to ryegrass-dominant pasture for flushing ewes. Also, Smeaton et *al* (1984) showed that to use ewes to produce a pasture suitable for flushing, involved a cost in ewe liveweight.

Attitudes

In the survey of attitudes already mentioned, two points came out strongly with regard to the use of clover as a feed crop.

These were, the acceptance of white clover as a high quality feed and the correlation between ewe hogget bodyweight and breeding performance.

PLANT GROWTH REGULATORS

Feeding Value

Ulyatt (1981) explained that feeding value is a function of both intake and nutritive value and showed wide differences in feeding value over a range of pasture species. He referred to work by Minson et *al* (1964) and others showing the animal intake of grasses was highest in early spring and declined as herbage matured. He went on to say that at least 50% of differences in feeding values between herbage species can be attributed to differences in voluntary intake.

Physiological Manipulation

In recent years increasing effort has been devoted to the development of chemicals which affect the growth and development of particular plant species. These products are generally known as plant growth regulators and they vary widely in their effects.

The chemical mefluidide (Embark™) was discovered by the 3-M Company of USA, tested against a range of graminaceous species and developed initially to reduce mowing of amenity grasses. Since then it has been widely tested in New

Zealand and USA for suppression of flowering in pasture grasses. Lower rates of mefluidide than used for growth control of amenity grasses were found by Kentucky State University workers to suppress flowering in several pasture grasses (Glenn et *al.* 1980).

Trials during 1978-1980 at Ruakura Agricultural Research Centre showed that spraying mefluidide on perennial ryegrass/white clover pastures reduced dry matter but increased the density of perennial ryegrass and white clover (Goold et *al.* 1982). Annual poa (*Poa annua* L.) was reduced whilst analysis showed decreased fibre and increased nitrogen content and digestibility of the ryegrass component. The authors pointed out that individual growth rates of ewes and lambs grazing treated pastures were spectacular though fewer animals were carried on the treated pasture during the initial phase of growth inhibition.

As a follow-up to the detailed work at Ruakura, ICI Tasman began a programme of field evaluation and development. This included some observational and some quantitative studies on farms in most pastoral areas of New Zealand. Detailed results will be presented elsewhere (S.J. Bruce, *pers. comm.*) but, in summary, are so far as follows:-

In 1982-1983 emphasis was placed on studying lamb liveweights on 35 farms in the greater Waikato region. At a stocking density of between 35 and 50 lambs per hectare, growth rate improvement with mefluidide ranged from 12 to 45 grams per head per day over a period of about 40 days (ICI Tasman, 1983). In 1983-1984 20 farm scale lamb-finishing evaluations were carried out on farms located from South Auckland to Southland.

The greatest responses came from the South Island where in all 10 trials, lambs on treated pasture gained more weight. Over 40 days at 42 lambs per hectare, those on treated pasture gained an average of 247 grams per head per day (range 195-295) whilst lambs on untreated pasture gained 197 grams per head per day (range 126-258). From the five trials in which numbers were available, more lambs were drafted for slaughter from the treated than from the untreated pasture.

In three dairy production trials the expected herbage changes in pasture were not reflected in increased ***milk*** or milkfat production. ***In a limited*** number of ***trials,*** however, with bull beef and deer encouraging liveweight gains have resulted.

Associated observations have shown a high level of control of seedhead formation in grasses, increased leafy herbage, reduction in some annual grasses and preference by livestock for treated pasture.

DISCUSSION

Species composition of pasture changes with time and management. Pasture renovation is a way to free white clover from damaging grass competition and restore or introduce the preferred grass and/or clover component.

On sheep and beef farms at least, fertiliser is the largest item of cost next to interest payments (NZ Meat and Wool Boards' Economic Service 1984). In our clover-based system of providing nitrogen for pasture growth, vigorous clover is necessary if full long-term value is to be gained from applied fertiliser.

Seasonal reduction in palability and nutritive value of pasture grasses can limit the growth and performance of livestock. White clover as a feed crop can be readily and cheaply produced from existing pasture which can then resume its pastoral role. A possible alternative means of maintaining pasture feeding value by the use of the plant growth regulator mefluidide is also **being** evaluated.

REFERENCES

Baker, C.J. 1981. *Proc. IVth Int. Grass/d Cong:* 542-44.
Glenn, S.; Rieck, C.E.; Ely, D.G.; Bush, L.P. 1980. ***J. Agric. Food*** *Chem.* ***28 (2):*** 391.

Goold, G.J.; Jagusch, K.T.; Farquhar, P.; MacLean, KS. 1982. NZ *Soc. An. Prod. 42:* 169-71.
Harris, W. 1973. *Proc.* NZ Grass/d Ass. 35: 101-9.
Hight, G.K.; Sinclair, D.P. 1965. NZJ. agric. Res. *8:* 1079-96.
ICI Tasman Ltd 1983. The *Pasture Manual:* 13-20.
Jackman, R.H. 1960. *Sheepfming Ann.: 75-84,*
Kunelius, H.T.; Harris, W.; Henderson, J.D.; Baker, C.J. 1982. NZ *J. exp. Agric. 10:* 253-63.
Leonard, W.F. 1984. NZ Agric. Sc. November. In press.
McLean, J.W.; Thomson, G.G.; Jagusch, K.T.; Lawson, B.M. 1965. *Proc. Ruakura Fmrs' Conf. 34-42.*
McMillan, W.H.; MacDonald, M.F. 1983. NZ *J. agric. Res. 26: 437-42.*
Minson, D.J.; Harris, C.E.; Raymond, W.F.; Milford, R. 1964. *J. Br.* Grass/d *Soc.* 79: 295.
Mouat, M.C.H. 1983. NZ *J. agric. Res. 26: 327-32.*
NZ Meat and Wool Boards' Economic Service. 1984. Paper No. 1895: App. II.
Palmer, P.C. 1967. *Proc.* NZ *Weed & Pest Cont. Conf. 20:* 50-7.
_____ 1970. *Ibid 23:* 51-6.
Rattray, P.V.; Jagusch, K.T.; Smeaton, D.C. 1983. *Proc. Sheep and Beef Cattle Soc. 13th Sem. Waikato University.*
Round-Turner, N.L. 1970. *Proc.* NZ *Weed &* Pest *Cont. Conf. 23: 57-65.*
Sithamparanathan, J.; MacFarlane, M.J.; Richardson, S. Effect of treading, sward treatments and seed coating on germination and early seedling survival of grasses and legumes oversown into easy North Island hill country: Unpublished.
Smeaton, D.C.; Wadams, T.K.; Mackisack, B.D.; Winter, R.D.; Miller, C.M.; H-U.P. Hockey 1984. *Proc. NZ Soc. An. Prod. 44:* In press.
Taylor, R.; 1969. *Proc. Massey Univ. Farm Mach. and Eng. Sem.: 45-52.*
Ulyatt, M.J., 1981. NZ *J. agric. Sci. 15 (4):* 200-5.
Upchurch, R.P.; Baird, D.D. 1972. *Proc. West. Soc. Weed. Sci. 25:* 41-3.
Williams, P.P. 1967. *Proc. NZ Weed & Pest Cont. Conf. 20: 58-66.*
_____ 1968. *Ibid 21:* 128-137.

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