NASSELLA TUSOCK CONTROL

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THE title of this paper is nassella tussock control, but before discussing this it is proposed to give a brief description of the weed, its main characteristics, and its distribution within New Zealand in order that the difficulties in its control can be appreciated.

Nassella tussock (*Nassella trichotoma* (Nees) Hack) has been recognised as a serious weed of the tussock lands, arable and waste lands of North Canterbury and Marlborough only in the last 15 years, but has been known to exist as far back as 1905. It is a native of South America and has been recorded in Australia, France, and Scotland. Its mode of entry into this country is obscure and several theories have been propounded.

The tussock is a perennial with a deep fibrous root system and when mature a basal diameter of up to 6in. and a height and spread of up to 2ft. It has narrow, rolled leaves, harsh to the touch, which are light green and upright when young and dull green and drooping when mature. A mature tussock is widespread and drooping, as distinct from the upright growth habit of the indigenous tussocks.

Nassella tussock produces a profusion of seed heads, carried on long flower stalks. The flowers are purple and give a characteristic purplish colour to heavily infested areas at the flowering stage.

The fruit or seed as it is called is small and rough-coated with a ring of silky hairs about the base and a terminal awn. In size and shape it is not unlike timothy seed, with which it can readily be confused if the hairs and terminal awn have been removed during harvesting operations.

Nassella tussock is often confused with silver tussock (*Poa caespitosa*) and fescue tussock (*Festuca novae-zelandiae*). It differs from silver tussock in that the latter has relatively broad, smooth leaves, but it is with fescue tussock that difficulty is experienced. At certain times of the year, particularly in late winter, the general appearance and colour of nassella is not unlike that of fescue tussock. The main points of difference are that nassella has no auricles at the base of the leaf shoot, and the bases of the leaf shoots are swollen and compacted.

The main reasons for the rapid and widespread distribution of nassella tussock are its prolific seed production and the ease with which this seed can be dispersed. Healy has recorded that an average mature tussock on North Canterbury hill country produced 100,000 seeds. The seed is produced on a long flower stalk, which when mature detaches readily from the plant and because of its light weight is particularly suited to wind dispersal. It is probable that a good deal of the seed is lost from the head before it is lifted by the wind, but seed heads containing viable seeds can be carried long distances by wind. The prevailing north-west wind, at the time when seed heads are mature, is the major factor in widespread dispersal. Other agencies of dispersal are also important: stock, farm produce, machinery, and man.

Nassella tussock has established itself over large areas of tussock grassland of North Canterbury and Marlborough and in most cases the original introduction could be traced to a weakening of the existing sward in some way. Almost without exception the tussock has established on the sunny facings of the hills which lie across the path of the prevailing north-west wind.

These sunny facings are subject to the drying effect of both sun and wind, are favoured by the grazing animal, and are difficult for the farmer to keep well covered. A weakening of the sward will allow the successful

introduction of nassella tussock and several factors are responsible for the inability of infested areas to withstand invasion. Overgrazing by sheep or rabbits and over-burning or burning at the wrong time of the year both tend to weaken the ground cover and once nassella establishes on the weak areas and seeds it produces sufficient seed in the immediate vicinity to invade the entire area. Outcrops of dry gravel soils on good quality hill country with their inability to maintain a good sward often provide points of entry.

Arable land and sown pasture are also invaded by nassella and in serious cases necessitate frequent and costly cultivation and regrassing. The main danger is an adjacent area of heavy infestation, which can quickly re-infest worked ground, and the point is reached where the top-soil becomes permeated with viable seed.

Riverbeds and waste lands in the heavily infested areas are readily invaded by nassella and seed dispersal by water occurs.

DISTRIBUTION

So far as is known nassella tussock is confined to the South Island and the major infested areas are located in North Canterbury and Marlborough. In 1941 a survey carried out by Healy and Barrer estimated that there were approximately 110,000 acres infested with the tussock to some degree and a further 260,000 acres liable to become infested in the absence of any control measures. No reliable figures are available for the area infested at the present time, but it is estimated that in the Amuri County the 20 acres of dense tussock in 1941 has increased to a total of about 300 acres today. In spite of widespread publicity and control measures it is considered that the area involved has increased significantly since the 1941 survey.

In North Canterbury the area infested or likely to become infested stretches through the counties of Amuri, Cheviot, Waipara, and Kowai. The area involved is roughly bounded to the north by the Conway River and the South Kowai River to the south and to the west by a line running from Waiau through Waikari to the South Kowai River near Balcairn.

Because of the spread of seed by wind the important control areas are those dense areas of tussock farthest inland located at Waiau and the hills on the south bank of the Hurunui River near Balmoral Forest. The major area of tussock in Marlborough is located on the Wither Hills near Fairhall.

A complete survey of the Canterbury Province has not been undertaken, but isolated areas of nassella tussock have been located in recent years at Rangiora, Kaiapoi, Waimakariri River, Rakaia Gorge, and Lower Rakaia and near the mouth of the Ashburton River. Several instances of isolated tussocks appearing on farms outside the main areas have been reported. Some of these have been traced to the purchase of store lambs from infested areas.

CONTROL

It was not until the immediate pre-war period that nassella tussock was recognised as an important weed and that in face of its rapid spread control measures would have to be adopted. The war intervened and problems of labour shortage on farms prohibited any widespread campaign for the control of the tussock. Numerous farmers in North Canterbury were sufficiently concerned about the weed to take immediate steps to control the weed on their farms and the practice of grubbing the tussock became routine on many properties.

1. **Grubbing:** Hand grubbing and cultivation became the first methods of control adopted for nassella tussock. On unploughable hill

country hand grubbing is effective in keeping the tussock in check provided that the job is done conscientiously. It is the best-known method of controlling scattered nassella in grassland and is also the means of controlling small patches. The work is time consuming and it has been estimated that dense areas can take up to 22 man days per acre to grub by hand. To be effective the job requires to be done thoroughly; all country must be searched and as far as possible all tussocks removed before being allowed to set seed. The tussock needs to be grubbed cleanly with as little disturbance of the sward as possible. If too big a turf is taken with the tussock, it may under good conditions continue to grow and set seed and the large area of bare ground exposed can be a source of new infestation. The old adage of "One year's seeding is 7 years' weeding" still holds for nassella tussock and hand grubbing of the tussock requires annual repetition. Those farmers who have tackled the problem of nassella tussock by hand have discovered that the work involved has in many cases decreased each year until the stage is reached where the time spent on control work consists mainly of searching the country rather than in active grubbing. However, as long as re-infestation from outside can occur the work must continue. In spite of its big drain on available labour on the farm, hand grubbing is still the most efficient means of controlling light infestations of nassella and no matter what other means of control are devised it will probably always be the final operation in eradication.

2. Cultivation: Nassella tussock is readily killed by ploughing, and on arable land ploughing is by far the most economical method for areas heavily infested. Deep ploughing using a chain to bury the top growth completely, shallow ploughing followed by cultivation, or burning the top growth before ploughing are all suitable. Where re-infestation is unlikely the existing stand should be buried as deeply as possible by ploughing with subsequent cultivation kept shallow to leave the buried seed undisturbed. The degree of permanence of cultivation as a control depends upon the quality and management of the pasture established following cultivation, the degree of re-infestation, and the amount of seed in the soil itself. Hand grubbing is used extensively in conjunction with cultivation and pasture renewal in controlling nassella on arable land. In the early years of a pasture hand grubbing is resorted to in handling minor re-infestations to lengthen the life of the pasture and reduce the amount of costly pasture renewal.

3. Afforestation: In several areas in North Canterbury afforestation has been adopted as a control measure on areas heavily infested with nassella tussock, and in the absence of any other economical means has been the only one capable of controlling the seed spreading from such areas. Of all the species of trees which have been tried *Pinus radiata* has proved to be the most effective, with the most rapid rate of growth under the conditions obtaining in dense tussock areas. Several plantations have been established and some of these have reached the stage where they are suppressing tussock growth.

The time taken to give a complete smother depends on the soil and climatic conditions and on the spacing and may be 10 to 15 years or longer in unfavourable localities. Much depends on the weather conditions in the first year of planting and on the efficiency of the planting operation. Instances have been recorded in North Canterbury of mortality of trees up to 90 per cent. in the first year and in some cases areas have required extensive replanting for several years. Under such conditions where the most unsuitable areas are infested with nassella, control by trees can be extremely slow and costly. However, before a complete smother is obtained the trees will be effective in providing a barrier to wind-blown seed.

Apart from the difficulty in obtaining a strike of trees in unfavourable areas the fire hazard is a serious one and one which is looked on with disfavour by many of the neighbouring farmers.

Attempts made to introduce various tree species by sowing the seed have been unsuccessful. *Pinus* and acacia species were sown, both broadcast and spot sown, in nassella areas, but although a strike was obtained, competition from the tussock was too severe and no seedlings survived the first season.

4. **Burning:** Nassella tussock will readily take a fire, but unlike the native tussocks can withstand repeated burning. Fire is adopted as a means of control of seeding and nassella will carry a fire during many months of the year when indigenous tussocks will not. The tussock burns with great heat, which is detrimental to other species and repeated burning will eliminate all but nassella tussock. It does, however, give control of seeding, but regrowth following burning is extremely rapid, and the effect of burning is to promote germination of nassella seed and will thicken up a stand of tussock. Although as long as the tussock will carry a fire a control of seeding can be achieved, no eradication takes place.

5. **Spelling and Oversowing:** Trials involving the oversowing and spelling of areas infested with nassella tussock were commenced in 1950 in North Canterbury. Pasture species used included ryegrass, cocksfoot, tall oat grass, *Phalaris tuberosa*, subterranean clover, white clover, Montgomery red clover, and lucerne. Half of each trial was fenced off and annual dressings of superphosphate were applied. In all cases the clovers struck and established fairly readily, but establishment of the grasses was slow and sparse, except where burning was practised before sowing.

On the grazed portions of the trials sown species were eaten out rapidly by stock and no degree of control of the tussock was achieved. On the spelled areas the rate of increase of the tussock has been retarded and the heavy growth is giving some control of seed dispersal. In most of the trials cocksfoot has become the dominant species on the spelled blocks and the majority of this cocksfoot was present when the trials were established. The spelled areas have been closed for 4 years and no instances have yet been recorded of tussock mortality.

6. **Grazing:** Farm animals with the exception of the horse do not readily graze nassella tussock, although cattle will occasionally graze portions of mature tussock, and both sheep and cattle graze young plants and regrowth following a burn.

A large-scale trial on the control of nassella tussock by grazing was commenced on the Wrekin area near Blenheim in 1950 and another at Waiau in North Canterbury in 1951. It is proposed to describe only the Waiau trial in this paper.

Two hill country properties at Waiau totalling 2300 acres were resumed by the Lands and Survey Department in 1951 for the purpose of conducting a large-scale trial on the control of nassella tussock by grazing. The properties were badly infested with rabbits and carrying capacities had seriously declined. With the removal of the rabbit nassella appeared over large areas and it was proposed to fence these infested areas into small blocks with electric fencing and concentrate cattle to graze the tussock and prevent seed setting.

Following preparatory development work including burning and oversowing the infested areas, fencing, and water supply grazing commenced in spring 1952 on one of the two properties. The area suitable for control by grazing totalled approximately 120 acres and 65 2½-year steers were purchased. Cattle were rotated around the blocks from September onwards. Owing to the wet season experienced growth of the sown grasses and clovers was so prolific that cattle had to be held on the

blocks for a long period before they readily grazed the tussock. Most tussocks, but in particular the young tussocks and those burned the previous season, received attention from the cattle, but they did not graze sufficiently close in the first blocks to eat off those seed heads not emerged from the shot blade. The number of cattle was insufficient to handle the area in a good growth year.

In the following year 200 steers were used for grazing control and grazing commenced in July with the feeding of ryegrass and clover seed hay on the nassella blocks. During the spring the heavy growth of other species was handled by sheep moving ahead of the cattle, which were forced to graze the tussock. The cattle still showed a tendency to avoid mature tussocks and concentrate on the younger growth. Older tussocks were grazed back to within 3 to 6in. from the crown and young tussocks almost to ground level in some cases. More cattle enabled a better control to be achieved and blocks grazed early were again grazed after the seed heads appeared. An inspection in December showed that results varied from block to block with the best showing 90 per cent. control of seeding. On the better soil type the inter-tussock spaces are well covered and no great increase in tussock density is apparent.

It is early yet to form definite conclusions regarding the efficiency of grazing as a control measure. The cost can be high when the number of cattle is considered, and the long-term effect of concentrated grazing on hill country will need to be studied. The cattle involved kept their condition well throughout the grazing period and few deaths occurred as a direct result of the work.

7. Chemicals: Investigation of the chemical control of nassella tussock has been carried on for a number of years and most of the known herbicides have been tested.

None of the hormones has given any degree of control at rates up to 10lb. a.e. per acre. At the highest rate some initial burning of the leaf tips occurred, but the plants recovered quickly.

Pentachlorophenol at 66 gallons per acre gave an initial browning off of the top growth, but recovery from the crown was rapid.

Sodium chlorate applied at 7 and 10cwt. per acre gave in most trials a complete kill of all plant growth. As the material leached from the soil the first plants to reappear were nassella seedlings. There is evidence to suggest that the effect of sodium chlorate on the seed on the soil surface is to promote germination by rendering the hard outer seed coat permeable to moisture. Not being selective in its action sodium chlorate would appear to have a limited use in nassella control.

CIPC at rates ranging up to 20lb. per acre on burned and unburned tussock gave only a temporary scorching of the leaf tip. No seedlings were present in the trial area and the effect on seedlings is unknown.

CMU is being used in trials at present at rates up to 80lb. per acre. At present, 3 months after treatment, a burning back of the leaf tip is the only effect shown.

Of all the herbicides tried to date TCA has given the most promising results. Trials with TCA were commenced in 1951 on a stand of mature nassella near the mouth of the Waipara River. Treatments were at 25, 50, and 100lb. per acre and the first application was applied in November 1951. With the first treatment all top growth was burnt off back to the crown at all rates but within 2 months regrowth from the crown appeared. By the time the second spraying was applied in April this regrowth had reached about 4in. at the 100lb. rate and 10 to 12in. at the 25lb. rate. The second application was a repetition of the first and a small amount of regrowth had appeared by September, when the third spraying was applied. This again burnt off all regrowth

and inspection confirmed that all tussocks at the 50 and 100lb. rates were completely killed. On the 25lb. plot a kill of 90 per cent. of tussocks was obtained.

In the early autumn following the final treatment seedling tussocks appeared on the 50 and 100lb. plots together with annual clovers, weeds, and a proportion of grasses such as cocksfoot and bromus species. On the 25lb. plot a dense sward of *Poa pratensis*, cocksfoot and annual clovers appeared, which prevented any mass strike of nassella seedlings.

As a result of this trial other trials have been established and results have been variable, but the selectivity of TCA especially at the lower rates was established. Silver tussock appears to be unharmed at rates up to 100lb. and fescue tussock appears to be almost as tolerant as silver tussock. Clovers have a high tolerance and cocksfoot survives the highest rates. However, at the higher rates a weakening of the sward is apparent.

Burning of the tussock prior to the application of TCA has given variable results. In one trial good control of tussock has been achieved by burning prior to treatment and in other trials no advantage accrues from burning.

Not all the trials conducted have given as conclusive results as the first trial and the reasons can be looked for in the variations in soil types and in weather conditions both before and after treatment. TCA gains entry to the plant through the roots and there must be sufficient moisture to carry it into the root zone. Soil type will affect results and trials have confirmed this fact. On moisture-retentive soils trials have shown that a kill of tussock cannot be obtained with three applications of TCA at rates as low as 25lb. per acre as on thin soils. Either the plant is more vigorous and better able to withstand the chemical on the better soils or the TCA does not enter the root zone quickly enough in quantity to affect the plant. Further trial work is being conducted to test the reaction of nassella on the major infested soils.

Rates of application up to 150lb. per acre have been tested, and taking into consideration the damage to other species the lowest effective rate has been found to be below 50lb. per acre. Further trial work is being done to test rates of application between 20 and 60lb. per acre.

Extensive areas heavily infested with nassella tussock are being treated with TCA by the North Canterbury Nassella Tussock Board. The material is being spread by air in a liquid form and in most instances the areas are not being burned prior to treatment, mainly because of the difficulty in preventing fire from spreading to adjacent clean country. The rate of application of TCA has been 50lb. per acre, which has been reduced to 25lb. for the second treatment, and new areas are receiving 30lb. per acre. Results in the past season have been variable. Those areas which received a substantial rainfall following the first spraying in November and December 1953 have shown good results, but others have been disappointing following a very dry season.

Experience with TCA on nassella tussock to date indicates that a control of seed production in the following season can be achieved by treatment in the previous winter and spring. For this reason alone TCA gives some control measure, and at the same time weakens the parent plant.

After the eradication of the tussock by TCA in most areas oversowing and spelling will need to be carried out to thicken up the sward and hold out the strike of nassella seedlings. In one trial oversowing after the first spraying has given good results, but subsequent sprayings affected the vigour of the pasture. Further trials are to be laid down with oversowing just before and after the final spraying.

8. Legislative action: Legislative action has been taken in the control of nassella tussock and the Nassella Tussock Act became law in 1946. This act deals with the establishment of two boards, one for

Marlborough and one for North Canterbury, charged with the control and eradication of nassella tussock. The boards are financed for their work by local body contributions and State subsidies. Powers under the act are widespread and the boards endeavour to control the weed by ensuring that farmers eradicate the weed from their properties, and for this purpose employ rangers for property inspection and wherever possible grubbing gangs. Subsidies are available to farmers for planting and fencing of trees for tussock control and in the case of the North Canterbury board for the control of tussock by TCA.

In an attempt to overcome the spread of nassella seed as an impurity in small seeds the Nassella Tussock Seed Regulations were gazetted in 1949. All lines of grass and clover seeds produced within the infested areas must be certified free from nassella tussock. Samples of all seeds are examined by the Seed Testing Station and infested lines of seed must be re-dressed to remove the impurity or be destroyed.

SUMMARY

The evidence from trials and field observations have indicated that nassella tussock can be kept under control by the following practices:—

1. Prevention of seed setting is the first step in controlling nassella tussock.
2. Maintenance of a vigorous sward is essential for prevention of infestation.
3. Hand grubbing is still the best means of controlling scattered infestations.
4. Afforestation is a suitable control measure in certain localities.
5. Grazing with cattle gives some control of seed production.
6. TCA can give good control of small areas of tussock and is showing promise in controlling large areas.
7. Regrassing and careful management are necessary following eradication by grubbing, cultivation, or herbicides to prevent re-infestation.

More experimental work is necessary before definite recommendations on nassella control can be made, but until the final picture emerges adoption of the practices outlined will at least hold the weed in check.

DISCUSSION

Q.—How long do seeds remain viable?

Comment: Some seeds of nassella in a 10-year-old sample were still viable.

Q.—Has any work been done with Dalapon?

A.—We are awaiting supplies for experimental work.

Q.—Have seed and fertiliser been aerially applied to the sprayed area?

A.—No.

Comment: If nassella is killed with TCA, can we replace it with a vegetative cover on dry, wind-swept north-west faces that will keep out infestation of nassella? Prior to the infestation of nassella, very little grew on these faces.

A.—Agreed. It is going to be difficult to find suitable plants for replacement.

Q.—How old must a nassella plant be before it can produce seed?

A.—Plants resulting from seed shed in the autumn will produce seed the following summer.