CONTROL OF WEEDS IN IRRIGATION RACES

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WITHOUT water for irrigation Central Otago today would be an arid, thinly populated area with extensive sheep farming the only form of land utilisation. Available water would be required only for stock. Water in this district is essential for all phases of production; fruit, crops, and meat. The discovery of gold has undoubtedly been one of the major events in the development of this area to a system of farming based on irrigation. In the early days panning and in the later sluicing and dredging methods of recovering gold were adopted, but for our purposes sluicing has probably been the most important. Throughout Central Otago there are numerous creeks and streams. For effective sluicing an adequate supply of water was necessary; therefore many of the creeks were tapped and water was delivered by races to the sluicing claims. These races were brought many miles; some over 20 miles over the most difficult terrain. Rocky bluffs had to be negotiated, necessitating building up with rocks, occasionally concreted, flumed, or sealed with earth. Steep sidelings were benched and raced with water frequently being dropped into a gully and picked up further down.

When gold production declined and was restricted more and more to the technique of dredging and mining, which needed much capital but little labour, alternative means of livelihood were sought. Once sluicing claims were abandoned the labour force maintained itself to a small extent through irrigation-nurtured agriculture and horticulture which grew out of the technique of alluvial gold mining. The wonderful response to water, which turned parched lands to oases, led to the diversion of many creeks which up to that time were not suitable for sluicing to the service of irrigation.

This response to irrigation led to the construction of big schemes behind which water was stored in large dams capable of serving several thousand acres of country. River flow also was diverted to such an extent that with the storage in the dams many hundreds of miles of race were required to collect and distribute the water. The Ministry of Works controls and maintains 676 miles of race, a distance equal to that between Invercargill and Nelson, and if privately owned races could be estimated, this total would swell considerably. Further, there are many hundreds of miles of internal farm races.

The problem with all races is to keep them clean. Clean races in an area such as this where water supply cannot be guaranteed from season to season are essential, because a better delivery is obtained. Weed infestation impedes the flow of water, frequently allowing it to bank up, spill over, and be lost to irrigation. Growth is both rapid and prolific throughout the whole season on banks and race bottom. Growth is more pronounced where the race is infrequently used, but where used continuously water weeds are the problem. Bank growth will fall in and trail, creating a trap for floating debris, cause a block, and spill of water. In many cases a break occurs many miles away from reasonable access, and considerable time, effort, and water are lost. The problem then is to keep the shoulders, sides, and bottom of the race clear of weeds.

At this stage mention will be made of the weeds that cause the problem. They can be divided into three groups, water weeds, grassy and other, and access weeds.

WATER WEEDS

These, through their long trailing growth, are very troublesome during the summer months when irrigation is at its height. They can trap silt and floating material readily, and rapidly impede the flow of water. This silt must be a trap for seeds, and will perpetuate an already vital problem. The weeds which give the greatest concern in eradication are:—

Mares tail	<i>Myriophyllum elatinoides</i>
Poolburn Jack	<i>Potamogeton cheesmani</i>
Pine tree	<i>Ranunculus fluitans</i>
Watercress	<i>Nasturtium officinale</i>

GRASSY AND OTHER WEEDS

Grassy and other weeds are particularly numerous and troublesome in the internal race system of most farms, and to a less extent in the main race system. All plant growth can be classed as weed in irrigation races. As practically all known grasses and weeds present can be found in races in Central Otago, only the more troublesome will be mentioned.

Perennial ryegrass	<i>Lolium perenne</i>
Cocksfoot	<i>Dactylis glomerata</i>
Yorkshire fog	<i>Holcus lanatus</i>
White clover	<i>Trifolium repens</i>
Scotch thistle	<i>Cirsium lanceolatum</i>
Californian thistle	<i>Cirsium arvense</i>
Rush spp.	<i>Juncus lampocarpus</i>
Floating sweet grass	<i>Glyceria fluitans</i>
Hard brome	<i>Bromus sterilis</i>
Dock	<i>Rumex obtusifolius</i>
Flat weeds of all types	

These are the weeds we are mainly concerned with.

ACCESS WEEDS

Two specific weeds only have been included:—

Tutu	<i>Coriaria ruscifolia</i>
Bracken fern	<i>Pteridium esculentum</i>

In many of these outlandish areas races have followed the contour of the country for many miles. Along the banks of many of these, in varying degree of intensity, tutu is present, and frequently bracken fern reaching a height of 6ft., creating a difficulty of access. Access is important when turning water in at the beginning of the season; when required to mend a break in the race which frequently occurs on steep sidelings. For this reason these weeds have received special attention.

After the weeds normally encountered are considered it suffices to say the normal method of cleaning is by shovel. Although mechanical methods are adopted, rotary hoes for small races, motor mowers, etc., the shovel has pride of place.

There are distinct disadvantages with these mechanical methods of cleaning. With continual side trimming races tend to widen and deepen over the years. The trend then is for the race to carry more water than originally it was constructed for. This aggravates the position. In the majority of cases the races constructed in country which is naturally free draining depend initially on silt to effect a seal. Any disturbance of this seal by weed and silt removal leads to considerable seepage, which takes some time to reseal. Probably of greater importance today is the question of labour. The Ministry of Works labour requirement to clean 676

miles of race is approximately 70; made up of 40 racemen and 30 others. This requirement is never reached, so the alternative is to consider other means. (The labour shortage applies to farms as well.)

The only effective alternative was to investigate the possibility of the use of weedkillers for the various types of weeds indicated. It can be stated quite confidently that except where a farmer by choice prefers to shovel his race clean there are no disadvantages, the advantages being:—

(a) They are easy to apply and no great physical effort is required to apply them.

(b) They are effective. They will do the job required of them.

(c) They overcome the problem of labour to a marked extent. What previously took hours to do now takes minutes.

(d) Of considerable importance, too, the race seal is maintained and no creep occurs.

(e) Siltation does not occur to any great extent.

With water, grassy, and access weeds under consideration thought had to be given to the various forms of weedkillers used for these specific purposes in initial work: for water weeds emulsifiable aromatics; for grassy and other weeds CMU, Polyborchlorate, TCA, and Atlacide; for access weeds the butyl ester of 2,4,5-T, and polyethylene glycol ester of 4-C.

CONTROL OF WATER WEEDS

One gallon of emulsifiable aromatics is mixed with a gallon of water. One gallon of this mix is released per hour into the race for every head or cusec of water flowing in—1 gallon per cusec per hour. Normally, drums containing this mix are spaced approximately 1 mile apart, and work commences at the top of the race.

No great difficulty is experienced in the control of mares tail and pine tree, but Poolburn Jack and watercress are difficult. However, if the race is allowed to drain following application, allowing for desiccation in the hot sun, reasonable success is achieved with the eradication of Poolburn Jack. At least it is severely checked. In the flush of the irrigation season the draining of the race is not desirable; water must be delivered. The control of watercress is possible. It would necessitate initial mechanical clearing of the race, and dosing with emulsifiable aromatics once the fresh young shoots of cress come away. This would need to be carried out at least three times per season.

It may be asked what would be the effect on stock and pasture. Stock will not touch the water so treated, and with the concentration mentioned clovers will show quite a burnt tip. With the increasing dilution normally experienced there is little danger of pastures being eliminated. A point of interest is the possible use of this material in the control of willows (*Salix* spp.) and broom (*Cytisus scoparius*).

CONTROL OF GRASSY WEEDS

Work has been carried out under variable conditions of weed density. The accompanying slides will show the application of CMU, Polyborchlorate, and TCA on one of the toughest races likely to be dealt with. All chemicals were applied about 6 weeks prior to the irrigation season. The bottom of the race is covered with the small rush (*Juncus lampocarpus*) in association with floating sweet grass, ryegrass, scotch and Californian thistle, Yorkshire fog, legumes, and flat weeds. In such

a race as this water flow is impeded and could readily be spilt and lost to irrigation.

CMU was applied at the rate of 25, 50, and 75lb. per acre in 100 gallons of water. The relatively big quantity of water enables the material to by-pass the foliage and get down into the soil. All rates severely checked all but the rushes, which, although severely affected, recovered rapidly.

Observations indicated that an earlier application would be warranted to allow this material a longer time in which to act. In all probability leaching has occurred, reducing its effectiveness. That this is so could reasonably be assumed, because spot spraying of a specimen of *Juncus vaginatus* gave a very successful control. Further work in other races showed that following two full irrigation seasons effective control is being maintained. This is particularly so when a greater time elapses from application to irrigation. The potential value of CMU cannot be overstressed because it may be the answer to the weed problem. Effective control without bulk is a big factor in transportation.

Polyborchlorate was tried out at the rates of 300, 600, and 1000lb. with 320 gallons of water per acre. The higher rate of water was necessary for a suitable mix for spreading, owing to the bulky material. In initial work Polyborchlorate was more effective than CMU, probably because of leaching of CMU. The higher rate was very effective in suppressing growth, but the 300lb. application would be satisfactory. The *Juncus* spp. were severely checked, but recovered fairly rapidly and were back to normal the following season. One notable feature of this chemical is that it appears to be more effective against thistles than either of the others. For this reason alone it could be important for isolated infested areas. Except for the thistles, recovery is fairly fast, and its main disadvantage is its bulk.

TCA has been very effective. The most effective rate from these varying between 25lb. to 300lb. per acre is one ranging between 100lb. to 150lb. per acre. Beyond this rate no greater advantage is derived, as the degrees of suppression and recovery are almost identical. It appears that TCA does not have much lasting effect against Californian and scotch thistle and flat weeds, particularly the plantains. These are usually the first to recover, and grow prolifically, creating a fresh problem. The use of 2,4-D formulations would readily attend to this.

Atlacide at 500lb. per acre gave very good suppression, but recovery was far too rapid at this rate. Heavier applications may be warranted, but handling the bulk of material will be a handicap.

Any of the chemicals discussed can be used to clear weeds. Their use and concentration will depend on the normal density of growth in any particular race. Care must be taken when treating races on steep country that the outer shoulder is not denuded of vegetation. This can create an erosion hazard.

CONTROL OF ACCESS WEEDS

The butyl ester of 2,4,5-T at the rates of 1lb. and 2lb. acid equivalent per acre in 20 gallons of water is very effective in the control of tutu. The applications were made at the full berry formation and a complete kill was achieved. Calm but very hot conditions existed. There has been no sign of regrowth. The polyethylene glycol ester of 4-C was tried at 3lb. and 6lb. acid equivalent per acre in 15 gallons of water. Both have been successful, but a much delayed period elapsed before control was achieved by the heavier dose. The lighter application was made in an area which gave protection from the direct sun and this may have influenced its effectiveness.

In an attempt to control bracken fern two methods were adopted: Firstly, the standing bracken was burnt during late winter to dispose of unnecessary foliage and sprayed in early summer; secondly, spraying without burning, but during the same period. The concentrations used were 3lb. and 6lb. acid equivalent per acre of polyethylene glycol ester of 4-C, the unburnt area being 2ft. 6in. high.

Owing to the length of time over which the fronds emerge the spray was applied when the bulk had reached the true leaf stage, allowing for the greatest amount of time for fronds to appear. Both applications were successful. The burnt area was more successfully and effectively controlled. The material was applied when the weather was cool.

It would be necessary to repeat spray for total elimination because of the continued appearance of fronds for several weeks following initial spraying. A satisfactory control was achieved on the unburnt area and this technique of spraying could be used to advantage in the development of bracken fern country to pasture. There are indications that lighter applications with similar repeats will suffice to control.

COSTS

In one particular race with conditions for hand cleaning very tough an estimate of costs relative to the use of weedkillers, using CMU at 25lb. per acre as a comparison, have been fairly accurately assessed. The CMU applied worked out at 16lb. per mile, and was very successful. Contract costs have been used in both cases. Using the weedkiller at 45s. per lb., tractor, equipment, and labour, the total is £40 8s. 6d. per mile or a per chain cost of 10s. The time per mile of operation is 2½ hours. With hand cleaning, costs have been loaded in its favour, but per mile costs approximately £45 or 11s. 3d. per chain. The time per mile is 120 hours. Under normal conditions costs are no greater comparably. Weedkillers can do an equally effective job of cleaning races and the problem of a labour shortage is reduced considerably, and the saving of time not inconsiderable.

DISCUSSION

Q.—Have you noticed that application of CMU to races results in breakdown of the sides. Since the soil structure is broken down resulting in erosion of sides, should not application be made to the bottom of the race only?

A.—Care should be taken in the application of sterilants. The soil structure is broken down, forming fluffiness and loss of soil. It is necessary to determine exactly how much to apply to control the growth in a particular race.

Q.—Have any aromatic emulsifiable products been used?

A.—Aromatic emulsifiable agents applied to drains kill the fish and a law prevents the application of these chemicals. Results with these chemicals have not been outstanding.

Lemna and *Potamogeton* spp. are controlled with such solvents. Grasses, however, receive only a temporary check.

Q.—Would pre-burning before application of chemicals be useful?

A.—There is no difference to the result when the area is burnt before application. Provided enough water is applied to move the chemical down to root level, good results should be obtained.

Q.—What is the possibility of damaging hedges and shelter belts with CMU?

A.—Trees within range of CMU may be completely killed with applications of CMU.