

**An Investigation in to the
Regeneration Capabilities of
Broad-leaved dock (*Rumex
obtusifolius*) and Curled dock
(*Rumex crispus*)**



**Estelle Skinner
2005**

1.0 Introduction

1.1 Biology of the dock

Docks (*Rumex spp.*) are one of the 2 main genera of the *Polygonaceae* family, which includes around 150 species, 23 of them can be found over the British Isles (Chancellor, 1956). Two species in particular are regarded as a major concern in agriculture, namely the broad-leaved dock (*Rumex obtusifolius*) and the curled dock (*Rumex crispus*) (Holm *et al.*, 1977). They are defined as 'injurious weeds' under British law (UK Weeds Act, 1959). Docks can survive in a range of habitats, including at altitudes of up to 2000ft. They are also suited to a variety of soil conditions. They are common on arable and meadowland, permanent pasture, short-term leys and waste ground but do not thrive in acid-rich soils. The highest infestations of docks are in Devon and Sussex (Haggar, 1980), whilst fewer numbers exist in northern Scotland. It is thought that the length of the growing season and low winter temperatures are not responsible for this variation but rather that this distribution pattern is due to a lack of disturbed ground at higher altitudes (Cavers & Harper, 1964). Mature plants can usually survive low temperatures and drought but seedlings may not. Hongo (1989) suggested that docks may have a shorter lifespan in cool-climate regions. It is unusual to find docks growing in fields cut for hay, grazed by sheep or subject to flooding. Hagger *et al.* (1982) found docks to be the most common perennial weed in grassland on dairy farms, particularly in young swards.

1.2 Broad-leaved dock (*Rumex obtusifolius*)

The broad-leaved dock is a highly arable perennial species. These plants often live for five years or more. Docks survive well in Britain's climate. This species is most commonly found in woodlands, arable fields, field margins, short-term leys, permanent pasture, and waste places (Bond, W. & Turner, R. J., 2004). This species grows particularly well on rich soils, where moisture is plentiful. The flowering stem can be up to 120cm tall and is branched. Flowering usually begins in late June or July and can continue until as late as November. It is the most abundant dock in grassland (ADAS, 1977). It is seen as a particular problem in intensively managed permanent grassland (Niggli *et al.*, 1992). They grow well on disturbed soil, for example where gaps appear in grass swards through trampling (Chancellor, 1956).



Plate 1: a broad-leaved dock (*Rumex obtusifolius*)

1.3 Curled dock (*Rumex crispus*)

The curled dock has been described as the most common British dock and is one of the five most widely distributed plants in the world (Cavers & Harper, 1964). This dock often dies after flowering. Established plants can produce up to 40,000 seeds in a year. Curled docks most commonly occur in arable and

meadowland, sand-dunes, shingle and in waste places (Bond, W. & Turner R. J., 2004). The curled dock is common on arable land and is found there more often than the broad-leaved dock and particularly like dryer soils (Chancellor, 1956).



Plate 2: a curled dock (*Rumex crispus*)

1.4 Hybrid dock (*Rumex pratensis*)

A hybrid dock can form between broad-leaved and curled dock, they look very similar as it takes on characteristics of both parent species but they usually have very low fertility rates and so are restricted in their distribution, though they are quite common as the parent docks are often found growing alongside one another.

1.5 Taproots

Docks can form an extensive system of taproots once they are established, which are difficult and time consuming to remove from the soil. The roots may extend to a depth of 1-1.5m on some soils (Bond, W. & Turner, R. J., 2004). It is usually easier to pull the roots up when the soil is moist. Most docks develop secondary taproots and later fragment to form clones. Clonal growth is a common and important part of the docks lifecycle (Pino, J. *et al*, 1995).

1.6 Persistence

Docks are considered to be such troublesome weeds because of their huge reproductive capabilities, the hardiness of the seed, good regenerative capabilities and also the persistence of the plants once they are established. Dock seedlings often cannot establish on an area of dense vegetation but established dock plants cannot be controlled to any effect by even very strong competition from grasses (Niggili *et al*., 1992). The seed production rates of the plants are considered to be the main regenerative system of the species, with large, well-established plants able to produce ripe seeds twice per growing season (Cavers & Harper, 1964). The seeds can remain viable for a long time and are able to stay in dormancy for many years, germinating if the right conditions become available (Foster, 1988).

1.7 Management techniques

Docks can be controlled in numerous ways. A good rotation is very important for weed control. In grassland, sheep are useful as they will graze docks, as will goats and cattle to a lesser extent. Topping, cutting or mowing can reduce the impact of docks if cut 5-7 times a year. It is important to carry out topping at the correct time, when flowers are forming but before seed is set. Topping can be started as early as possible and continued over a number of months. A flail topper is a good machine to use. Fields should not be left for conservation for too many years, to prevent docks from becoming very established.

In cultivated land, sowing a competitive crop can help control docks. Where there are heavy infestations the docks should be cut before going to seed. If possible, crops should be harvested before docks go to seed, if not they may be pulled by hand. Grazing fields after harvest is a good way to prevent their re-generation. To manage docks mechanically usually means leaving land bare to dry out the weeds (fallowing). This is done using spring tines, a plough or a rotovator. A spring tine should be reaching depths of at least 15cm and pulling the root out to the surface. The process should be repeated weekly during dry weather. Ploughing should be done to 15-20cm and repeated 3 or 4 times in dry weather. A rotovator should only be used in leys at least 2 years old. The ley should be rotovated to 10cm in early July. A spring tine should also be used weekly and the ley finally ploughed. Rotovating can also be done repeatedly, at greater depths each time, to exhaust the root reserves. (www.organicweeds.org.uk)

2.0 Aim

This aim of this project was to assess the re-generation capabilities of docks after being exposed on the soil surface for increasing amounts of time. The project also looked at the effect of burial depth and size of root on regeneration capacity. The goal of the project was to provide information useful to farmers in the practical management of dock when fallowing and/ or ploughing, the two times when docks can be exposed on the surface of the soil. This project will aid the research being done by the organic weed management project at the Henry Doubleday Research Association, which aims to help farmers in decision making for the management of docks on their land.

3.0 Methods

Four replicates were set up each consisting of four treatments, with 23 docks in each treatment. The docks were all cut from the HDRA research field (see plate 3). This is also where the experiment was conducted. The land is used for vegetable production on a twelve-course rotation system.

The area where the experiment was set-up was the border of the research field, which was predominantly covered by grass. Clover, thistles and a number of other weeds were also present. These were all removed to give more realistic conditions for the experiment. This was done using a strimer and by hand weeding when needed. A random mixture of broad-leaved, curled and hybrid docks were used in the experiment.



Plate 3: HDRA field, site where experiment was conducted

Root size: The dock roots were all cut at 3 inches below the soil. They were divided into 'thin' and 'thick' categories. If the roots were 1cm or less in width they were classed as thin docks and any roots >1cm were classed as thick roots. These were kept separate throughout the experiment in order to analyze any differences.

Depth of burial: All docks in replicates one and two were buried at a depth of 4 inches, docks in replicate three were buried at 8 inches and docks in replicate 4 buried at 12 inches. Docks were buried using a trowel, except Replicate 4, which were buried using an auger.

Exposure on soil surface: after cutting the docks were immediately buried (treatment 4) or left exposed on the soil surface for increasing periods of time. Some roots were left on the soil surface for 4 weeks (treatment 1) and some for 8 weeks (treatment 2 and 3). Treatment 3 was also covered with black plastic for the full 8 weeks.

Regeneration: The plants were examined weekly and the number of plants that had resurfaced in each treatment, after being buried, was recorded. Photos were taken of each treatment and any other relevant points noted. The area used for the experiment was cordoned off, using netting, to protect it from tractors that are regularly used on the land, and to prevent the roots that were on the soil surface from being blown away.

The replicates were all set-up at slightly different times of year, to find if this had any obvious effects on the docks. The dates on which each replicate was set-up are shown below;

Replicate 1 – 16th March 2005

Replicate 2 – 30th March 2005

Replicate 3 – 29th April 2005

Replicate 4 – 1st June 2005

Fifteen docks root, which remained in the ground after having the top 3 inches of their roots cut, were labeled, soil was put back on top to cover them and they were observed to find if they would regenerate. These dock roots were from a mixture of thin and thick, also broad-leaved, curled and hybrid docks.

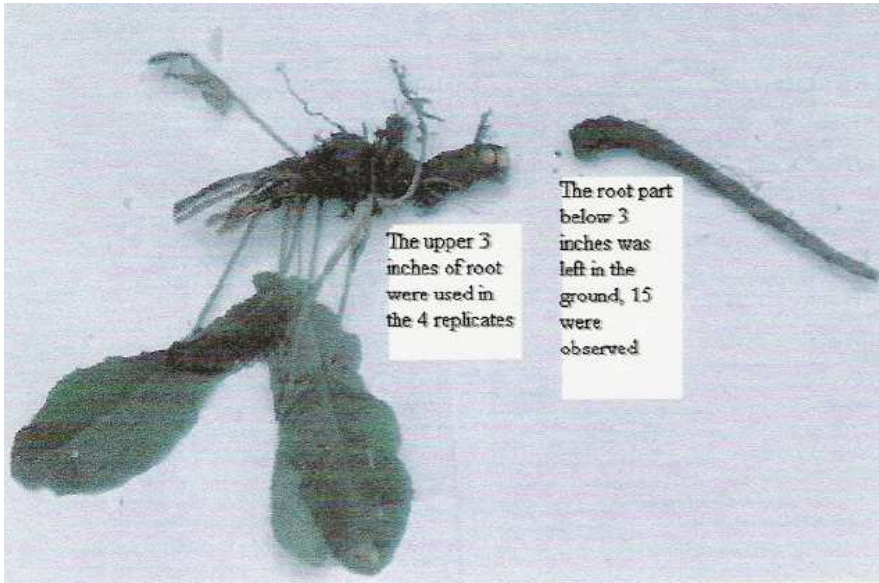


Plate 4: different parts of the dock plants that were used for different parts of the experiment

In summary the basic 4 different treatments were carried out were:

1. Docks cut and left on the soil surface for 4 weeks and then buried
2. Docks cut and left on the soil surface for 8 weeks and then buried
3. Docks cut and left on the soil surface, covered with black plastic, for 8 weeks then buried
4. Docks cut and then buried immediately

In addition to this the depth of burial was increased to 8 and then 12 inches in the final two replicates.

4.0 Results

The records of the weekly observations can be seen in the appendix. These show the state of the plants before burial, the number of plants that had resurfaced each week, the number of plants that had resurfaced each week, the number of plants that were either in their vegetative phase or produced inflorescences and flowered, when/ if root hairs were present, any pest or diseases noticed, and any other points of information noted at the time.

Table 1: date treatments were buried and date they began to resurface, number that resurfaced and number of days taken before they began to resurface (from highest to lowest number that resurfaced, then earliest to latest date buried).

Replicate/ Treatment	Date buried (all 2005)	Date began to resurface	Number that resurfaced	No. days before began resurfacing
Rep 1, T4	16 th March	15 th April	23	30
Rep 3, T4	29 th April	11 th May	21	12
Rep 2, T4	30 th March	15 th April	16	16
Rep 1, T1	15 th April	29 th June	13	14
Rep 1, T2	12 th May	19 th June	3	38
Rep 2, T2	3 rd June	20 th July	2	47

Rep 2, T1	28 th April	11 th May	1	13
Rep 3, T1	27 th May	3 rd July	1	37
Rep 2, T3	3 rd June	2 nd July	1	29
Rep 1, T3	12 th May	-	-	-
Rep 4, T4	1 st June	-	-	-
Rep 4, T1	27 th June	-	-	-
Rep 3, T2	28 th June	-	-	-
Rep 3, T3	28 th June	-	-	-
Rep 4, T2	20 th July	-	-	-
Rep 4, T3	20 th July	-	-	-

Will be adding stat. analysis**

Time of exposure: Treatment three was the most effective of the four dock treatments used in this experiment. Only one dock resurfaced in total over all four replicates, it resurfaced on treatment three, replicate 2.

Treatment two was also relatively effective, only 5 docks resurfaced in total. No docks resurfaced in treatment two replicates three or four, 2 resurfaced in replicate 2 and three in replicate 1.

Depth of burial: Treatment one was quite effective in three of the replicates. No docks resurfaced in replicate 4, 1 in replicate 3, 3 in replicate 2 but 13 docks resurfaced in replicate 1. In total 17 docks resurfaced.

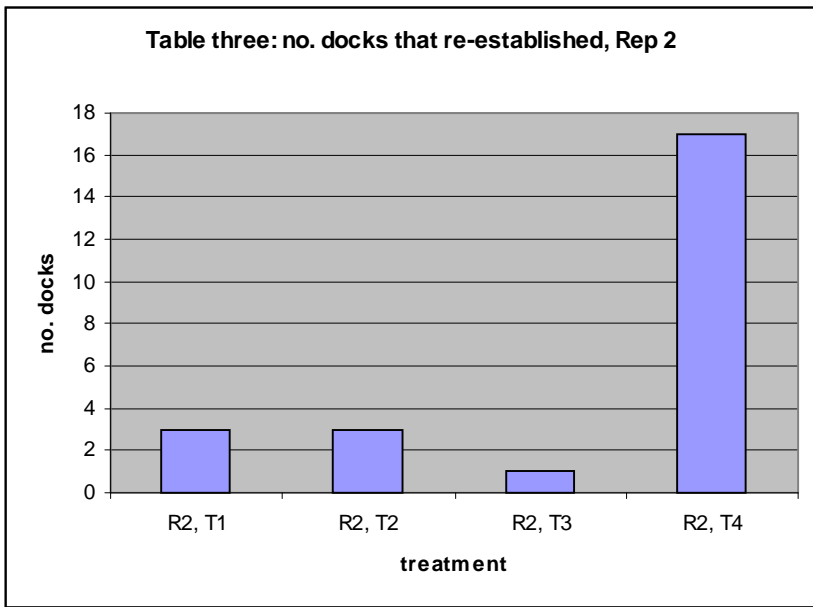
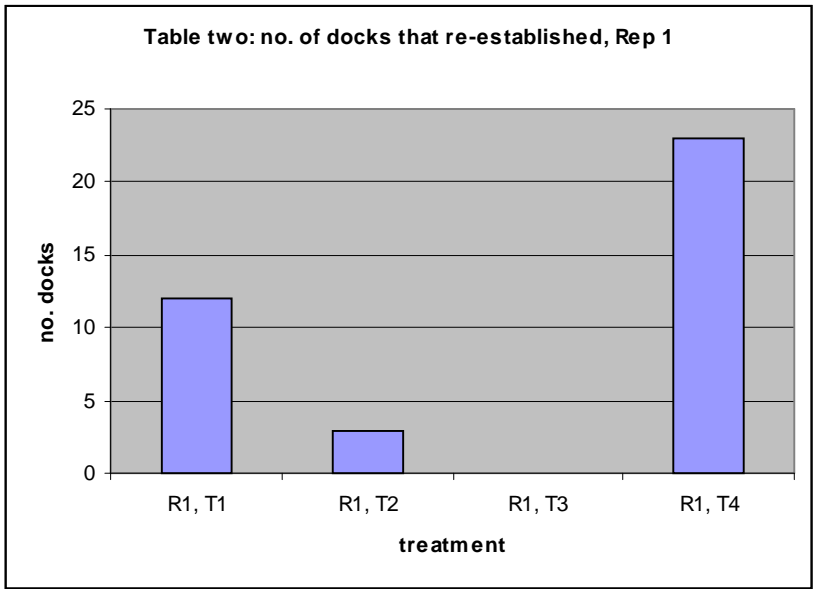
Treatment four was the least effective of the four dock treatments in this experiment. In total 50 docks resurfaced. None resurfaced in replicate 4, 16 in replicate 2, 21 in replicate 3 and all the docks resurfaced in replicate 1, this was the only plot on which all the docks resurfaced. Fourteen of the docks that resurfaced in replicate 1, treatment 4, flowered after re-establishing.

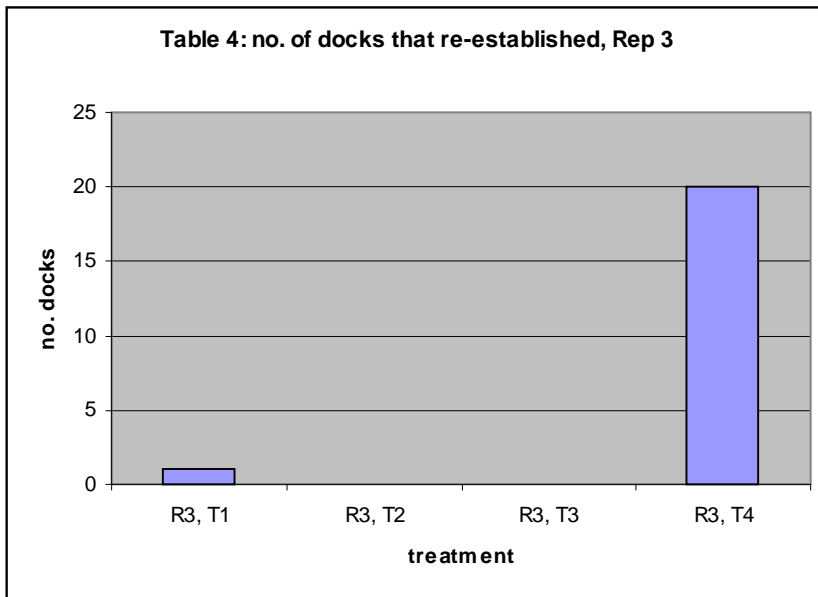


Plate 5: Replicate 1, treatment 4, just 8 weeks after being buried

and all 23 docks have re-established well (23rd May 2005)

The tables below show the significant difference that the treatments made on the rate of survival of the docks. The docks in treatment 4 re-established much more freely than the docks in any of the other treatments. The docks in treatments 2 and 3 survived the least well, particularly treatment 3.





None of the docks buried in replicate four resurfaced, all were buried at 12 inches. Replicate 1, treatment 1 was the only plot on which all the docks resurfaced. In replicate three, 21 docks resurfaced, in replicate 2, 22 resurfaced and 29 in replicate 1.

Thickness of stem: In each treatment in replicate 1, 7 thin docks and 16 thick docks were used. In all treatments in replicate 2, 12 thin docks and 11 thick ones were used. Replicate 3's treatments consisted of 17 thin docks and 6 thick ones and in replicate four, 10 thin and 13 thick docks were used in each treatment. In total, 184 thin and 184 thick docks were buried in this experiment. Of these 37 thin docks resurfaced and 51 thick docks resurfaced. This is not statistically a significant difference but indicates that the thick docks may be more persistent than the thin docks. **will be adding analysis, anova

White root hairs were observed on most of the plants left on the surface. They began to grow 1-2 weeks after having been cut and left on the soil surface and then began to disappear after about 4-6 weeks. A couple of the plants became attached to the soil with these root hairs but only one became attached very firmly and did not re-establish in this way. Some of the plants were moved during observations and this may have had some affect on this. The white root hairs were often thicker on the roots of the plants in treatment three.



Plate 6: thick white root hairs on Replicate 2, treatment 3, 10 days after the docks had been cut (taken 8th April, 2005)

Most of the leaves, of treatment 1, 2 and 3 in replicates 3 and 4, became brown and crisp 1-2 weeks after being cut. In treatment 3 this occurred slightly more slowly, as they were under plastic. Some of the leaves in replicate 1 and 2 were also effected in this way, but much more gradually and to a lesser extent. Many of the leaves were eaten by insects, more so in replicates 1 and 2. When the plants in replicate 1, treatment 1 emerged, some of the leaves of the plants were twisted but these plants did re-establish.



Plate 7: replicate 3, treatment 1, 25 days after having been cut (taken 23rd May 2005)

Regeneration of cut docks: Of the fifteen roots observed, after having the top 3 inches of the root cut, 13 did not regenerate after 6 months. These were all cut on the 16th March. One thin root regenerated with a

few leaves of 3-6 inches and a flowering stem of 1.5 feet. Another thin root had also regenerated. It stood at about 3-4 inches and had a few small leaves.

5.0 Discussion

Treatment 3 was the most successful dock treatment in the experiment. The docks in this treatment were left on the surface for 8 weeks and were covered by black plastic. After 8 weeks they were buried at 4, 8 or 12 inches. Only 1 of the docks resurfaced, this was in replicate two and had been buried at 4 inches. The docks in replicate two, treatment 3 were buried on the 3rd June. Weather readings (from HDRA records) show that there were very favourable conditions following this, which may have been why this dock resurfaced.

The docks in treatment 3 were cut off from sunlight and had little moisture because of their treatment. These plants were prevented from photosynthesizing and therefore could not produce their own food. The black plastic covering also prevented most rainwater from getting to the plants and this along with the effects of the sun on the plastic caused them to dry out more than usual. Depriving these plants of two of their basic needs caused them to become weak and less able to re-establish. Plate 8 below shows the plants 2 weeks in to the experiment. The leaves are pale and look weak from lack of sunlight. They are standing vertically in an attempt to reach sunlight. Plate 9 shows the plants after 8 weeks under plastic, the leaves have all died or been eaten and the roots are dry, crumbly and no longer healthy enough to re-establish.



Plate 8: replicate 1, treatment 3, 2 weeks after having been cut and kept under black plastic (30th March)



Plate 9: replicate 1, treatment 3, 8 weeks after having been Cut and kept under black plastic (13th May)

It seems the longer the docks were left on the surface the weaker they became. Only 1 dock resurfaced in treatment three, and 5 in treatment two. These docks were left on the soil surface for 8 weeks. Seventeen docks resurfaced in treatment one, which were left on the surface for 4 weeks. Fifty docks resurface in treatment four, which were buried immediately after being cut.

Many of the leaves on the plants, in the treatments that were left on the surface, became brown and crisp. This eventually caused them to shrivel up and fall off the plants. Replicates 3 and 4 were the worst effected because the weather was much milder when the first 2 replicates were set-up. Replicate 1 was set up on 16th March and replicate 2 on 30th March. The highest temperatures averaged 14.9 and 15.3°C during the time in which treatments of replicates 1 and 2 were on the soil surface. Replicate 3 was set-up on 29th April, the highest temperatures for the next 8 weeks averaged 19.6°C. Replicate 4 was set-up on 1st June and the highest temperatures over the following 8 weeks averaged 22.5°C.

Many of the leaves on the plants in the treatments were eaten by insects. This occurred more so in some of the treatments of replicates 1 and 2, as many of the leaves remained greener for longer than in replicates 3 and 4. Treatment 4 was buried straight away and was therefore not exposed as the other treatments were. The plants in treatment 1 usually had a few leaves remaining when they were buried. The plants in treatments 2 and 3 had often lost all their leaves by the time they were buried.

The plants in treatment 4 had a higher chance of survival by being buried straight away. They did not have as much stress from a large amount of leaf loss and from drying out on the soil surface. This suggests that if farmers cut and plough their docks straight back in to the land that they may be encouraging them to re-establish by providing suitable conditions (depending on the burial depth). A more effective way to manage them may be to cut the docks and leave them on the surface for a number of weeks before cultivating the soil again (and burying them as deep as possible), or to cut the docks and perhaps compost them after clearing them off the land (making sure they are fully decomposed before returning them to the soil).

Whether the docks were young or older roots did not have a significant effect on their rate of survival. Hongo (1988) transplanted plants of *Rumex obtusifolius* and *Rumex crispus* in to grassland and found that

the survival of the plants was not size dependant for either species, phytometers died at random regardless of individual sizes.

The different burial depths had a significant impact on the docks. Fifty-one docks that were buried at 4 inches resurfaced (29 in replicate one and 22 in replicate two), 22 docks that were buried at 8 inches resurfaced and no docks that were buried at 12 inches resurfaced. The same overall amounts resurfaced in replicates 2 and 3 though.

No docks resurfaced after being buried at 12 inches. This was the last replicate to be set-up and so had the least amount of time in which to resurface. The longest time taken between burial and resurfacing was in replicate two, treatment two, which took 47 days to begin resurfacing after being buried at 4 inches. Replicate four, treatment four had been buried for 100 days, treatment one for 74 days, treatments two and three for 54 days before observations ended (9th September). The observations ended due to time restraints. It is likely that none of the docks would have resurfaced after this time anyway as treatments 1 and 4 had been observed for a substantial amount of weeks after burial and though these plants were the most likely, of replicate four, to resurface, none did.

Robert & Hughes (1939) found that small pieces of regenerative dock tissue should be buried deeper than 15cm and an entire dock plant at a considerable depth, to prevent re-establishment. The docks in this experiment did not re-establish when buried at 12 inches (30cm) but some were able to re-establish from depths of 8 inches (20cm) and many were able to re-establish from a depth of 4 inches (10cm), though this depended on the treatment of the docks before burial. This suggests that deep ploughing can be much more effective than shallow ploughing, but the treatment of the docks prior to ploughing should also be considered.

All docks used in the experiment were cut at 3 inches. The effect of the depth at which dock roots are cut was researched by Dierauer (1993). He found that roots cut at 5cm gave a reduction of 53% and cutting at 10cm gave a reduction of 80%, in the short-term, of *Rumex obtusifolius* in organic pasture. Dierauer concluded that tearing out the entire root and cutting the root at 1-cm were the only two successful methods, long-term, for managing *Rumex obtusifolius* in organic pasture. The results of this experiment show that dock roots cut at 3 inches can have a significant short-term impact. Only 2 docks (13%) regenerated of the 15 that were cut at 3 inches. This number may have become higher if the docks had been observed for longer than 6 months. Vegetative regeneration of *Rumex obtusifolius* is possible only from intact root and shoot meristems, their position depends on the plants age. Therefore, plants at different stages of growth will respond differently to cutting (Hughes, Froud-Williams, 1993).

It is impossible to give a general 'best method' for managing docks as there are so many variables to consider and each site is unique. Some farmers do not consider the docks on their farmland to be a problem whereas some feel it is their biggest problem. Farmers can use quadrats to estimate the amount of docks present on their land to help decide what, if any, action needs to be taken. Docks are not always seen as a problem. For example, Courtney (1972) found that docks could make a positive contribution to herbage yields under a system of cutting for conservation.

6.0 Conclusions

There are numerous techniques for managing docks, such as using leys (i.e. clover), rotations, farm machinery or rouging. This report has explored just a small part of this process, a part which was found to be important to farmers in contact with HDRA, through the weed management project.

There are many factors to consider when deciding on the best strategy for weed management. The type of farmland the weeds are on, the extent of the weed problem, the seed bank and management history, time of year, weather and resources available, all play a part in this decision.

The results of these experiments show burial depth to be an important factor, and the deeper docks are buried the less likely they are to re-establish. Twelve inches was deep enough to stop the roots cut at 3 inches from resurfacing. Of the rest of the roots, from which the top 3 inches were cut, only a small amount re-generated. More tests could be done in the future, involving a larger amount of roots and perhaps cutting at different root depths, to get a more definite idea of root regeneration rates.

The amount of time the docks were left on the soil surface to dry out had a huge effect on the survival of the plants. In treatments 2 and 3, in which the plants were left on the soil surface for the longest amount of weeks, a very significantly less amount of plants survived than in the other treatments.

Composting docks is a promising option that should be researched in more detail in the future. The results of treatment 3 indicate that this is a viable, effective and useful method. In personal past experience it has been found that docks well composted should contain no viable seed or root fragments.