The production of Burdock (*Arctium lappa L .*) root in New Zealand - a preliminary study of a new vegetable.

M. H. Douglas[1], J. L. Burgmans[2], L .C. Burton[1] and B. M. Smallfield[3]

[1] New Zealand Institute for Crop & Food Research Ltd., Redbank Research Station, PO Box 42, Clyde.
[2] New Zealand Institute for Crop & Food Research Ltd., East Coast Research Centre, PO Box 85, Hastings.
[3] New Zealand Institute for Crop & Food Research Ltd., Invermay Research Centre, Private Bag, Mosgiel.

Abstract

Burdock (*Arctium lappa L*), a widespread weed in New Zealand, is a popular vegetable in Japan. The aim of the pilot study was to determine the production of burdock cultivars under New Zealand conditions. The test plots, at Hastings, Te Hauke, and Ohakune in the North Island and at Clyde and Palmerston in the South Island, were sown in the spring 1991 and harvested in the autumn 1992. The cultivars, Takinogawa Early, Tokiwa Improved, and Watanabe Early were tested in the North Island while the cultivars Shirohada, Yamada Riso, and Yamada Wase, plus a Dutch (Kieft) seed line were compared in the South Island. The root length, fresh root weight and dry matter % were recorded for all cultivars while additional data on plant density, production per hectare and processing quality were collected at Redbank. At Redbank Research Station Clyde, Yamada Wase produced the highest root weight of 323 g and an estimated fresh root yield of 39 t/ha. This cultivar graded for taste and flavour was judged the best for processing. At the North Island sites Watanabe Early produced the highest root weight of 400 g. At Redbank the roots reached only 29 cm in length while the North Island roots attained 70 cm. A dense soil horizon at Redbank is considered to have reduced root length. It is concluded that on deep free draining textured soils burdock can produce high yields and an acceptable product for processing under New Zealand conditions.

Introduction

Burdock (*Arctium lappa L.)* a tall growing biennial herb, native to Asia and Europe, is a widespread weed in New Zealand (Webb *et al.*, 1988). Burdock a traditional herbal medicine (British Herbal Pharmacopoeia, 1983), was formally listed in the British Pharmaceutical Codex, and is widely recorded in most writings on medicinal herbs (Duke, 1987; Duke and Ayensu, 1985). Although burdock has a medicinal use in the Orient, there is large production for the Japanese vegetable market, and improved and selected seedlines of burdock are used for this purpose. Production is estimated at 180,000 t/annum off 14,000 ha, and of this 140,000 t are purchased for consumption, 10,000 are used for the chilled cut vegetable trade, 500 are processed for dehydration, 200 are frozen, and the remainder is used as stock feed (Shin-ichiro Nada pers. comm.).

The most important ingredient in burdock is the polysaccharide inulin which is present to about 50% (Leung, 1980). There is widespread New Zealand interest to produce processed burdock for niche markets within the Japanese trade or for Japanese tourists in New Zealand. In Japan, burdock is grown as long (80 cm) thin (2.5 cm) roots (350-450 g fresh weight) which are often processed to short thin strands or 'shoestrings' approximately 3 mm x 50 mm. Until recently, it was illegal to import seed and grow burdock in New Zealand and thus study of this root crop was constrained by its past noxious weed status. There is little English language information available on the production and agronomy of burdock.

This preliminary study was to assess the production of burdock root at various sites in New Zealand.

Experimental

In the South Island, at Redbank Research Station, Clyde, the experiment compared the production of three Japanese cultivars Shirohada, Yamada Wase, Yamada Riso (Kyowa seeds), and one Dutch (Kieft) seed line. Shirohada is an extra early variety which matures in 120 days and grows to 75 cm length; Yamada Wase matures in 150 days and grows to 75 cm length; and Yamada Riso matures in 180 days and grows to 80 cm in length. These cultivars are a long slender cylindrical shape which weigh between 350 - 450 g (Kyowa Seeds, 1991). The Redbank experiment was located on a Blackmans loamy silt and the seed direct drilled using a Hege 90 cone seeder at the rate of 3 kg/ha on 3 October 1991.

Each treatment had 6 rows per plot at 25 cm spacing between rows, with a plot size of 6 m x 1.5 m. Four replicates of Shirohada were sown, with only one plot of the other cultivars. Cropmaster 18 (18:8:18:0) fertiliser was applied at a rate of 275 kg/ha after sowing and weed control was carried out by hand. The crop was harvested in May 1992. The fresh roots from the Redbank experiment were assessed by a Japanese processing specialist for their quality.

At Palmerston, on a Pomahaka loamy silt (McIntosh, 1992), the experiment compared the effect of the pre-sowing herbicide trifluralin on the root production of the cultivar Yamada Wase. The trifuralin as treflan was incorporated immediately before planting at 3 litres/ha. Seed was sown on 19 November 1991 at 3 kg/ha using an Oyjord cone seeder with 8 rows 15 cm apart. Plots were 20 m x 4 drill runs for the non-sprayed and 20 m by 3 drill runs were trifuralin treated. The crop in the non-sprayed treatment was sampled on 24 April 1992 after the tops had senesced in early April. Both treatments were sampled on 7 August 1992 to determine effects of plant density on root weight and root length but no processing assessment of the roots was made. The crop received no further follow up management.

In the North Island the production of three Japanese cultivars Takinogawa, Tokiwa, and Watanabe Early (Takii Seeds) were compared on various soil types. Sites were located at Hastings on a Hastings clay loam, at Te Hauke on a Poukawa peaty loam, and at Ohakune on a Ohakune silt loam. These were direct seeded and compared to a seedling transplant establishment of Watanabe Early. At Hastings and Te Hauke the cultivars were compared with 1 row of 1.5 m length, while at Ohakune there were 2 rows/plot of 0.4 m length. The in-row plant density was nominally 20 cm. Hastings was established on 19 November 1991 and harvested on 24 March 1992; Te Hauke on 14 December 1991 and harvested 12 May 1992; and Ohakune 21 November 1991 and harvested on 13 February 1992.

Results

At Redbank the mean root length varied between 25 - 29 cm, at Palmerston 40-50 cm, while in the North Island the root length varied between 50-70 cm (Table 1). The fresh root weight ranged between 15 g to 400 g for seeded cultivars and 80 g to 250 g for the transplanted seedlings. Although there were large differences in the age of root harvested, the fresh root weight at Redbank had similar weights to the North Island cultivars irrespective of the length difference. The best cultivar at Redbank was Yamada Wase with a root length of 29 cm, a fresh root weight of 323 g, and of a density of 12.1 plants/m^2 had a fresh root yield of 39 t/ha. At Redbank,

Table 1. The Location, Sowing Date, Harvest Date, Age, Root Length, Fresh Root Weight and Fresh Root Yield of *Arctium lappa* Cultivars at Five Sites.

Location	Sown 1991	Harvest 1992	Age days	Cultivar	Root Length (cm)	Fresh Root Weight (g)	Fresh Root Yield (t/ha)
Redbank	3/10	10/5	218	Shirohada	25	256	23
				Yamada Riso	26	292	23
				Yamada Wase	29	323	39
				Kieft	26	118	17
Palmerston	19/11	7/8	262 *	Yamada Wase	40	15	8
				Yamada Wase + Treflan	50	61	17
Hastings	19/11	24/3	124	Takinogawa Early	60	230	
				Tokiwa Improved	65	220	
				Watanabe Early	55	400	
				Watanabe Early †	30	300	
Te Hauke	14/12	12/5	148	Watanabe Early †	35	250	
Ohakune	21/11	13/2	83	Tokiwa Improved	50	200	
				Watanabe Early	70	120	
				Watanabe Early †	20	80	

* Plant tops senescence April 1992

† Transplanted seedlings

there was a problem with seedling establishment, and the densities ranged between 8 plants/m^2 to 14.6 plants/m^2, whereas a planned plant density of 20 cm in-row and 25 cm between rows would have been 20 plants/m^2. The mean dry matter of all cultivars was close to 25% (Range 23.5% - 28.6%). The burdock cultivars grown at Redbank were assessed for their processing quality. Yamada Wase provided the best quality with a sweet taste and a good flavour, while the worst, the Kieft seedline showed poor taste and only a weak flavour (Table 2). All cultivars grown at Redbank irrespective of planting time had a pith cavity or a spongy core, and the root diameter varied between 34-49 mm.

At Palmerston spraying trifuralin prior to sowing gave a lower plant density (28.8 plants/m^2) compared to the non-sprayed (62.6 plants/m^2), but the lower density produced roots with a greater root weight and increased root yield (Table 1). This suggests that the seeding rate was too high and this is confirmed in the results of root diameter and fresh weight (Table 3) where less than 5 % of roots in the non-sprayed treatment had a root diameter greater than 20 mm. Interplant competition and weed competition plus the late sowing date may account for the lower root production relative to Redbank and the North Island sites (Table 1). The majority of roots were however long, pencil shaped and sound in contrast to the same cultivar grown at Redbank. Roots with a diameter greater than 20 mm had a length greater than 50 cm.

At the North Island sites Watanabe Early reached the greatest length of 70 cm at Ohakune. The heaviest root weight of 400 g was at Hastings, and this site produced the best quality root. The transplanting of Watanabe Early seedlings appears to effect the root development, with root length of the transplants being considerably less than the direct seeded plants (Table 1).

At Te Hauke the season was very wet and late, and immediately after sowing heavy flooding caused many plants to die and the direct seeded plots did not emerge. At Ohakune the season was very cold and the roots had a high number of rootlets. The harvesting on the lighter soils at Te Hauke and Ohakune was easier than on the Hastings clay loam. The dry matter percentage of the roots ranged from 24.5% to 25.5%.

Table 2. Processing assessment of burdock root grown at Redbank Research Station, 1991 - 1992. Processing recovery is estimated to be 48%.

Sample	Taste	Flavour	Texture
Shirohada	OK	Good	Outer OK, Core spongy *
Yamada Riso	Weak	Weak	Outer OK, Core spongy
Yamada Wase	Good, sweet	Good	Outer OK, Core spongy
Kieft	Poor	Weak	Outer OK, Core spongy

* A consistent flesh is necessary to slice/shoestring

Table 3. Distribution of Root diameter, proportion of forked or distorted roots and root fresh weight of Yamada Wase at Palmerston. Harvested 24 April 1992.

Root Diameter (mm)	% of Roots in each Diameter Range	Roots Forked or Distorted (%)	Root Fresh Weight (g)
>20	4.7	21.6	59.46
15-20	16.1	25.2	33.46
<10	79.1	40.7	13.66
Total	65.8 plant/m^2	37.3	18.98

Discussion

The preliminary experiments for burdock show production up to 39 t/ha, which appears to be considerably higher than the estimated mean production of 13 t/ha in Japan.

The short, thick roots harvested at Redbank were very different from the typical long, thin roots grown at the North Island sites and at Palmerston. The reasons for the thick root appear to be soil related. The Blackmans loamy silt has an eluvial zone at 27-53 cm depth which resists penetration (McIntosh, 1990) and a dense pan exists beneath this at a depth of 53-63 cm. As the growing point contacted these dense layers, impeded growing appears to have created a thickened root and root branching. Japanese penetrometer studies into the relationship between soil hardness and root shape of burdock showed that the long root shape was a function of reducing hardness (Moriizumi and Osaki, 1984). These authors note that it is desirable that a cone index of the soil is less than 6 kg/cm^2 in order to get a long root in burdock. The value of 6 kg/cm^2 is equivalent to 590 kPa which would be a typical value in a cultivated silt loam up to one month after cultivation. Peat rich soils would also provide soil of low cone index (P.B. Greenwood pers. comm.). The harvesting of a root crop

to 0.8 metres is difficult, and a shorter root would aid harvesting. Although a 'carrot' root shape is not a disadvantage to processing, a pith cavity is. The processing assessment noted that all root grown at Redbank had a pith cavity. The presence or development of pithy tissue is a characteristic identified in Kyowa cultivars (Kyowa Seeds, 1991). It is not clear what causes this condition although Japanese study concluded it is caused by "unbalanced growth" between the leaves and the tap root (Iziro, 1989). It is also recognised pithy tissue develops with age and thus a short growing season is desirable. Pith cavity was not recorded at Palmerston or at the North Island sites and these crops had short growing seasons. As the extent of the pith cavity reduces the root suitable for processing, further study of pith development under New Zealand growing conditions is warranted, with specific reference to sowing date and the length of growing season. The question of plant density is unresolved, but when plant density at Redbank and Palmerston is considered, a plant density close to 20 plants/m^2 would appear desirable for root shape and production.

Conclusion

Spring-sown–autumn-harvested burdock produced high yields and an acceptable product for the processing trade but the sowing and harvest dates are as yet, not well defined for the varied New Zealand environments. The selection of cultivar is also unresolved but Yamada Wase performed well at the South Island sites and Watanabe Early at North Island sites. The choice of a free draining soil is an important issue when a long slender tap root and ease of harvest is desired.

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