ASPARAGUS MANAGEMENT PRACTICES ON A FLOOD IRRIGATED LIGHT SOIL

K.E. Carter[1], D. Saville[2], R. Stoker[1]
[1]Winchmore Irrigation Research Station
MAFTech, Private Bag, Ashburton
[2]Canterbury Agriculture and Science Centre
MAFTech, P.O. Box 24, Lincoln

ABSTRACT

An asparagus experiment was carried out on a Lismore stony silt loam to determine the potential of the light free draining soils of the flood irrigation schemes of Canterbury as an environment for asparagus production.

The cultivar used was Limbras 10. Factors investigated were flat versus ridged soil contour, cultivation versus no cultivation as an extra to herbicide weed control, and dryland versus two irrigation regimes.

For all treatments the experimental plots did not persist well, with high saleable yields in the first three seasons and low saleable yields in the following two seasons; this was associated with an increasing percentage of spears being too thin for sale. The most likely reason for this decline was the poor longevity of the cultivar Limbras 10. The experiment also highlighted the danger of overirrigating asparagus, with the most frequent irrigation treatment having the lowest yield in each season.

Additional Key Words: asparagus, Asparagus officinalis, crop management, flood irrigation, harvest period, spear quality.

INTRODUCTION

The area of asparagus grown in New Zealand declined between 1972 and 1977 (Anon., 1981), but increased from 426 ha to 3156 ha between 1977 and 1985 (Douglas, 1986). There was also a marked shift in industry location from heavier silt soils of Hawkes Bay onto free draining soils. Bussell *et al.* (1985) showed that highest asparagus yields are achieved on moderately well drained soil with lower yields on poorly drained and very free draining soils, although in the latter situation yields are likely to be improved by irrigation.

The purpose of this experiment was to determine the potential of the light free draining soils of the flood irrigation schemes of Canterbury as an environment for asparagus production, under various irrigation management systems.

MATERIALS AND METHODS

The experiment was carried out at Winchmore Irrigation Research Station between 1981 and 1988.

The soil type was Lismore stony silt loam. This soil has 300 mm of topsoil containing stones and overlies deep shingle beds. Available water holding capacity is about 60 mm in the top 300 mm and work has shown the shingle substrata to be capable of holding significant quantities of plant available water (Stoker, 1982).

In the winter of 1981 an area of 1.5 hectares containing 18 irrigation borders was prepared. Two different contours were formed, one a conventional flat border and the other a border containing five raised bedrows. In early September one year old dormant crowns of cultivar Limbras 10 were transplanted in rows 1.5 m apart with approximately 55 cm spacing between plants within the row (population 12,100 plants/ha). There were five rows per border and the crowns were planted 15 cm deep.

The experimental design consisted of three replicates of six treatments arranged in a randomised block design. Each experimental plot consisted of one border. Within this border a harvest area of 18 crowns within 10 metres of a row was marked out. This area was sampled for all harvests. Details of the treatments were:

Treat-ment	Soil contour	Irrigation	Weed control
1	Flat	Non irrigated	Cultivation + herbicides
2	Flat	Irrigated 15% s.m.	Cultivation + herbicides
3	Flat	Irrigated 15% s.m.	Herbicides
4	Flat	Irrigated 20% s.m.	Cultivation + herbicides
5	Raised bed	Irrigated with trt 2	Herbicides
6	Raised bed	Irrigated with trt 4	Herbicides

On Lismore stony silt loam 15% soil moisture (s.m.) corresponds to approximately 25% available s.m. and 20% s.m. to approximately 50% available s.m.

Irrigation was applied by the border strip method according to the soil moisture level in the top 150 mm of soil of treatments 2, 3 and 4. This method of applying water completely covers the ground surface with sufficient water being applied at each irrigation to restore the full soil depth to field capacity.

The raised beds of treatments 5 and 6 kept the crowns out of the waterlogged soil while permitting water uptake by the finer roots. Meaningful gravimetric moisture samples can not be taken in a raised bed so these treatments were irrigated at the same time as treatments 2 and 4 respectively. The number and timing of irrigation in each season are shown in Table 1.

TABLE 1: Irrigation — Total No and Timing.

Treatment	Total	During Harvest	Post Harvest
1981-82			
Trts 2, 3 and 5	3	N/A	N/A
Trts 4 and 6	11	N/A	N/A
1982-83			
Trts 2, 3 and 5	4	N/A	N/A
Trts 4 and 6	6	N/A	N/A
1983-84			
Trts 2, 3 and 5	2	—	2
Trts 4 and 6	6	—	6
1984-85			
Trts 2, 3 and 5	3	—	3
Trts 4 and 6	18	5	13
1985-86			
Trts 2, 3 and 5	1	—	1
Trts 4 and 6	7	1	6
1986-87			
Trts 2, 3 and 5	4	—	4
Trts 4 and 6	12	3	9
1987-88			
Trts 2, 3 and 5	6	—	6
Trts 4 and 6	11	—	11

N/A = not applicable — harvesting began 1983-84

The cultural procedures used in this project closely followed normal commercial practice on most occasions.

Annual fertiliser applications consisted of a mix consisting of 92 kgs of Nitrogen; 25 kgs of Phosphorus, 50 kgs of Potassium and 2 kgs of Boron per hectare. In the first and second seasons this mix was applied as a 0.6 m wide band in mid October and late September respectively. In subsequent seasons the mix was broadcast at the end of harvest. Applications of agricultural lime were made in August of 1983 and 1985.

Two short term residual herbicides were used in the 1981 season. Subsequently, the longer term herbicides, bromacil and diuron were applied in early September. Knockdown applications of either round-up or spray grow herbicides were used at the end of harvest to control asparagus seedlings.

Cultivation of treatments 1, 2 and 4 consisted of a double pass of conventional discs in early August followed by a double pass of a spintiller approximately one month later. The raised beds were reformed using a potato molder on 10/8/84 and 4/5/87.

In the establishment phase which extended from planting in winter 1981 to first harvest in spring 1983, the irrigation treatments began in the first season and the management treatments of herbicide and/or cultivation began in the second season.

In the first year of the harvest phase (1983) the plots were harvested from 29 September for a period of 40 days. In subsequent years the harvest period was 80 days with the harvest starting on 26 September; 1 October; 10 October and 6 October in 1984, 1985, 1986 and 1987 respectively. Harvesting was carried out daily during periods of peak growth and every second day at other times.

An extra set of plots was harvested in 1987. They were harvested for 60 days, the traditional harvest period in Canterbury, and had previously been harvested for only 60 days in 1986.

All spears were harvested and then graded as saleable or unsaleable. Saleable spears were subdivided into four spear base diameter grades of 20 mm plus, 15-20 mm, 10-15 mm and 8-10 mm. Spears were rejected if less than 8 mm in diameter, or frosted, diseased, deformed or with open bracts. Spears were trimmed to 200 mm length and the butts excluded from the data. Spears shorter than 200 mm were also excluded. The percentage saleable yield was calculated as the weight of saleable spears in the total weight of spears 200 mm long.

RESULTS

In the establishment phase, treatments 4 and 6, irrigated at 20% s.m., produced the most spears and fern/ha. The next best treatments were treatments 2 and 3, irrigated at 15% s.m. on a flat contour. The non irrigated treatment and the raised bed treatment irrigated at the same time as the flat 15% s.m. treatments produced the least spears and fern/ha.

In the harvest phase, total yield from the six treatments increased from 1983 to a peak in 1985 and then declined (Figure 1). Most of this production occurred in the first sixty days of the eighty day harvest period. Saleable and reject yields are also given in Figure 1.

Saleable yield

During the short 1983 harvest treatment 3, irrigated at 15% s.m. on the flat, produced the highest saleable yield while treatments 1, 2, 5, and 6 produced similar, but lower saleable yields. Treatment 4, irrigated at 20% s.m., gave the lowest saleable yield.

In the next two seasons treatment 3 again produced the highest saleable yields, followed by treatments 1 and 5 in 1984, and treatments 2 and 6 in 1985. The yields of treatment 4 were low in both seasons.

The yields of all treatments dropped substantially in the 1986 and 1987 seasons. Again the yields of treatment 4 were low.

The percentage saleable yield for the first three seasons was high ranging from 88 to 76 percent. It then dropped to 54 and 59 percent in the last two seasons.

Reject yield

In the 1983 and 1984 seasons the quantity of spears rejected as unfit for sale was low. From 1985 the quantity increased with the 1986 production having the highest percentage of reject spears.

Crop profile

As this project progressed the spear diameter declined (Table 2). The production of large spears (>15 mm)

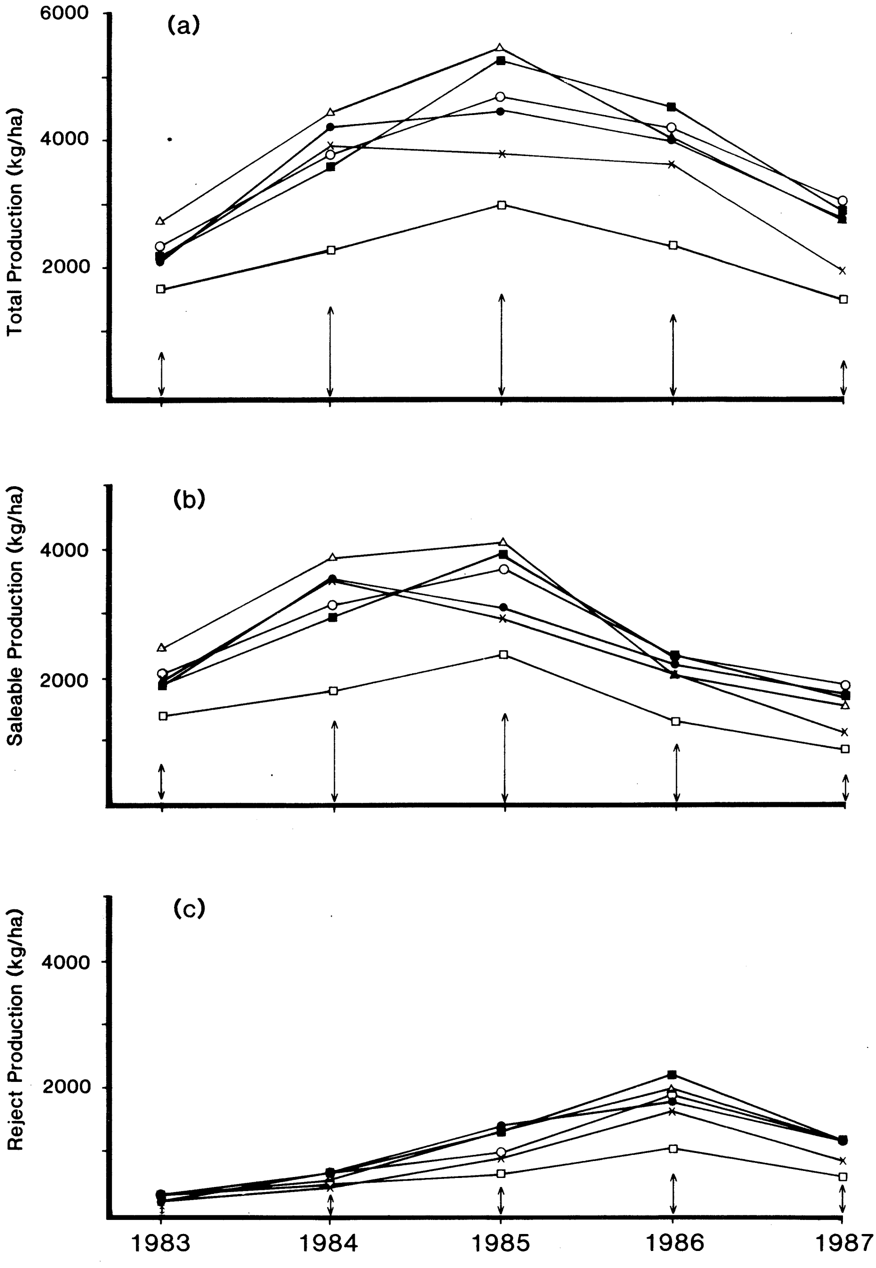

Figure 1: Production (kg/ha) for each treatment and season as (a) total, (b) saleable and (c) reject. Flat contour treatments are coded as (1) × ; (2) ○ ; (3) △ ; (4) □ , while corresponding raised bed treatments are coded with the corresponding filled symbols: (5) ● ; (6) ■ . Vertical bars are LSD(5%)'s.

averaged 38.9% in the first two years, but averaged only 7.1% in the last two years.

The quantities of spears with open bracts were consistent except for 1986. This season started late and extended to the end of December. Most spears with open bracts were produced in the last 20 days of this harvest or during cold periods. The quantities of frosted, deformed and diseased spears were consistent throughout. The foliar fungal disease stemphylium was first noticed in the project in early 1985. Subsequently most spears produced in wet weather were infected and rejected.

DISCUSSION

Although it is considered that asparagus should remain productive for 10-12 harvest seasons, Limbras 10 gave satisfactory yields of saleable spears on this site for only up to the third harvest.

The mean saleable yields of the 1984 and 1985 harvests were 3.2 and 3.4 t/ha. These yields were similar to mean saleable yields obtained in the 1983 and 1984 harvests from six research stations throughout New Zealand (Brash and Bussell, 1986). Also the mean percentage of saleable spears was 80% compared with 63% from the other research stations. However, in subsequent harvests, the saleable yield dropped drastically. This reduction was not site specific as a similar pattern of yield reduction for Limbras 10 occurred in other research in Canterbury (P. Falloon pers. comm., 1988).

In an attempt to find possible causes of the yield reduction the following aspects of production were looked at:-

length of harvest
disease
irrigation during harvest
soil nutrient levels and
cultivar longevity

The harvesting period for this project was eighty days based on a North Island recommendation. In retrospect, a sixty day period, following local commercial practice would have been more appropriate. For example in the 1986 season most of the spears produced in the last 20 days were either thin or opened their bracts before reaching a harvestable height. From this it appeared that the root reserves were almost exhausted. Fortuitously guard areas in each plot had been allowed to go to fern after 60 days in the 1986 season, so an additional harvest area was set up in each plot and harvested for just 60 days in 1987. In all treatments the areas harvested for 60 days gave similar or better yields than the areas harvested for 80 days. However the saleable yields were still low ranging from 1.9 down to 0.9 t/ha.

Disease did not appear to be a significant problem in this project. No root, spear rots or fern diseases were observed.

Irrigations were applied to treatment 4 and 6 during the harvest period (Table 1) and the cooling effect probably had an effect on yields. However, the drastic yield reductions occurred in all treatments, including dryland.

The annual application of fertiliser after harvest maintained soil test values for the major elements at adequate levels.

The longevity of the cultivar Limbras 10 is the likely reason for the dramatic yield decline. In regional cultivar evaluation trials over five seasons its yields rose from 3.5 t/ha in 1983 to 5.5 t/ha in 1985, but by 1987 they had dropped to 2.2 t/ha. Local growers of this cultivar have also experienced this yield decline. Limbras 10 appears to be a shortlived cultivar.

Within New Zealand's traditional growing areas the yield and longevity of asparagus has declined. This has been associated with an increase in disease but there is no evidence that disease is the prime cause of asparagus decline. Changes in management practices such as flat beds, herbicides and increases in plant density have occurred but the effects of these practices have rarely been studied (Robb, 1984).

The performance of Limbras 10 has overridden all irrigation and management treatments of this project. However, several interesting trends did occur. The asparagus grown in the flat beds and receiving the most frequent irrigation (treatment 4), established well with the highest fern production in the first two seasons. This fern was sampled in late May 1982 and June 1983 respectively. However, from the first harvest of 1983, this asparagus performed poorly and there were no apparent reasons for this performance. This asparagus was irrigated at 20% s.m. or 50% available soil moisture and several studies have shown that irrigating asparagus to maintain soil moisture

TABLE 2: Crop Profile (% by weight). An * indicates the most common grade size. The last row gives the data for a second set of harvest areas which were harvested for only 60 days in 1987.

	Saleable				Reject			
	Grade A (20 mm+)	Grade B (15-20 mm)	Grade C (10-15 mm)	Grade D (8-10 mm)	Too thin	Open bract	Frost /diseased	Deformed
1983	1.9	32.4	45.5*	7.9	0.8	2.4	4.0	5.2
1984	6.7	26.7	43.7*	7.7	1.1	11.2	0.6	2.0
1985	3.0	17.4	40.9*	14.1	2.5	13.8	3.0	5.1
1986	1.2	6.2	22.6	23.9*	14.5	22.3	4.4	4.9
1987	0.9	5.9	22.3	29.9*	23.5	10.3	4.4	2.8
1987 (60)	1.6	6.6	25.7	30.0*	19.8	7.2	5.0	5.0

levels at 50% or 60% field capacity have resulted in significant yield increases (Hanna and Doneen, 1958; Cannell and Takatori, 1970; Kaufmann, 1965; Pinkau and Grutz, 1985). This poor performance may be associated with irrigation during harvest (Table 1). Irrigation during harvest can decrease yield by decreasing the number of spears produced (Takatori *et al.*, 1970). Kaufmann (1965) also experienced yield suppression when irrigation water was applied during harvest.

The asparagus grown in raised beds and irrigated at the same time as the above asparagus (treatment 6) gave higher yields than the asparagus grown on the flat beds.

The asparagus grown on the flat beds and irrigated at 15% s.m. with weed control by herbicide alone (treatment 3) produced the highest saleable yields in the first three seasons. In the following two seasons the yields dropped relative to other treatments. This suggests that the crowns gradually rose closer to the surface and a higher number of thinner spears were produced. Asparagus spear production is affected by soil covering depth (Douglas, 1986; Takatori *et al.*, 1974; Williams and Kendall, 1976). The other asparagus grown in the flat beds, irrigated at the same time as the above and with cultivation included (treatment 2), was a consistent performer over all seasons. The cultivation appears to limit crowns from growing closer to the surface.

Over the five seasons the non irrigated asparagus tended to have lower yields than the irrigated asparagus, excluding the asparagus irrigated at 20% s.m. on the flat, which had the lowest yields.

CONCLUSION

The performance of Limbras 10 ended this project prematurely, so the potential of the light soils of the Canterbury flood irrigation schemes for asparagus production has not been fully tested.

From the experience gained during the experiment the writers suggest that asparagus can be grown successfully in this environment if the following management practices are followed:

1. Plant the crowns in the conventional flat bed of the border and give 3 or 4 irrigations in each of the two seasons of establishment.
2. Ensure weed control is adequate in these seasons.
3. In the following seasons herbicides alone or in conjunction with shallow cultivation can be used for weed control.
4. Check to ensure the asparagus crowns do not grow close (< 15 cm) to the soil surface. If this occurs, spear diameter decreases and it is necessary to ridge more soil over the crowns.
5. Harvest for 40 days in the third season and for 60 days in subsequent seasons.
6. Follow harvest with an application of fertiliser.
7. Apply 3 or 4 irrigations during the post harvest period of fern growth.

ACKNOWLEDGEMENTS

We gratefully acknowledge the technical assistance by I.M. Kermode and T.P. McCarthy.

REFERENCES

Anon 1981. New Zealand Horticulture statistics 1981. Ministry of Agriculture and Fisheries, New Zealand.

Brash, D.W., Bussell, W.T. 1986. Performance of Asparagus cultivars in Central Otago. *Proceedings of the Agronomy Society of N.Z. 16:* 13-15.

Bussell, W.T., Nichols, M.A., McCormick, S.T., Alspach, P., Nikoloff, A.S., Brash, D.W. 1985. Asparagus cultivar evaluation in New Zealand. *Proceedings of the 6th International Asparagus Symposium, Guelph, Canada, 1985:* 52-62.

Cannell, G.H., Takatori, F.H. 1970. Irrigation — Nitrogen in Asparagus and measurement of soil moisture changes by the Neutron Method. *Proceedings of Soil Sci. Soc. of Amer., Vol 34:* 501-506.

Douglas, J.A. 1986. A review of the current research on asparagus in New Zealand in relation to the future development of the industry and the export trade in asparagus. N.Z. Ministry of Agriculture and Fisheries, Ruakura Agricultural Research Station, Northern North Island Region, pp 76.

Hanna, G.C., Doneen, L.D. 1958. Asparagus Irrigation Studies. *California Agriculture 12 (9):* 8, 14-15.

Kaufmann, F. 1965. Zur Beregnungswurdigkeit von Grunspargel auf leichten Boden. (The Value of Sprinkler Irrigation for Green Asparagus on Light Soils). *Deutsche Gartenb. 12:* 97-99.

Pinkau, H., Grutz, E.M. 1985. Einfluss von Stickstoff, Beregnung und Erntezeitraumlange auf Ertrag und Qualitat des Grunspargels. (Effect of Nitrogen, Sprinkler Irrigation and Length of Cutting Period on Yield and Quality of Green Asparagus). Arch. Gartenb., Berlin 33 (1985) 4, 177-189.

Robb, A.R. 1984. Physiology of asparagus (Asparagus officinalis) as related to the production of the crop. *New Zealand Journal of Experimental Agriculture 12:* 251-260.

Stoker, R. 1982. Soil wetting and moisture extraction on a Lismore stony silt loam. Technical Report 16, Winchmore Irrigation Research Station.

Takatori, F.H., Cannell, G.W., Asbell, C.W. 1970. Effects of soil moisture conditions on asparagus at two nitrogen levels. *California Agriculture 24 (2):* 10-12.

Takatori, F.H., Stillman, J.I., Souther, F.D. 1974. Influence of planting depth on production of green asparagus. *Californian Agriculture 28 (1):* 4-5.

Williams, J.B., Kendall, M. 1976. Cultural studies of asparagus with reference to flat beds, ridging and spacing. *Experimental Horticulture 28:* 1-14.