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Development of the pickled vegetable industry in the Riverina

HAL

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Know-how for Horticulture™

Mr Kim Jones
NSW Agriculture Griffith

FINAL REPORT

VG416

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1.1 INTRODUCTION AND SUMMARY

This industry development project was established to aid the development of the pickling vegetable industry in the Riverina. It was jointly funded by Parle Foods Pty Ltd, NSW Agriculture and HRDC. This project ran for twelve months from the 1st of November 1994 to the 1st of November 1995 and was an extension of a previous HRDC supported project, the "Development of the food Processing Industry in the Riverina" project number VG115.

The pickled vegetable industry in the Riverina is almost totally based on pickling cucumbers, although other crops with potential for processing and export have been investigated. These other vegetables include Daikon radish (*Raphanus sativus longipinnatus*), Takana (*Brassica juncea*), Perilla (*Perilla frustescens*) and Burdock (*Arctium lappa*). To date no commercial quantities of these other vegetables have been processed. A small industry is developing at Narrandera to supply the domestic market with fresh Burdock (see final report of HRDC project no. VG115 for further details).

The pickling cucumber industry continues to expand rapidly. In 1991/92 a total of 100 hectares of pickling cucumbers were grown at Griffith NSW. This figure had doubled to over 200 hectares by the 1993/94 season and the 1995/96 season sees another doubling of area sown to over 400ha with an expected harvest of about 6,000 tonnes.

During the twelve months of this project the main emphasis has been to fine tune the management strategies for pickling cucumber production.

The research included assessment of new pickling cucumber cultivars as well as further assessment of promising lines that were identified in the previous research project (VG115). Three vine trimming experiments were also conducted with the aim of reducing vine mass and improving yields through a more concentrated fruit set. Irrigation scheduling and monitoring was also carried out using an Enviroscan® soil moisture probe. Guidelines for growing pickling cucumbers have been prepared in a publication (a draft copy appears in this report) entitled "Growing Pickling Cucumbers for Mechanical Harvesting".

2.2 RESULTS AND DISCUSSION

Table 2.1 shows the yield in tonnes per hectare for 15 cultivars that were assessed in the first replicated trial. Seven cultivars had a significantly higher commercial yield than 626. They were Davista, RS 90228, RS 92500 and Mathilde from Royal Sluis, Vlaspik M from New World Seeds, and No.10 and 1356 from Yates. Only Davista and Excel M had significantly higher total yields than 626.

Excel M, SPS 832, Yates No.11 (previously called PCN 5) and 1355 are all earlier than 626 and had significantly more yield in the relish grade (relish grade fruit was not used in the calculations for commercial yield). If these cultivars had been harvested one or two days earlier their commercial yield would have been higher. Of these early cultivars Yates No.11 and Excel M show the most potential because their combined relish and slicing grade yield is significantly higher than the corresponding weights of 626.

Table 2.2 shows the numbers of fruit produced per plot for each grade. Fruit number is often considered a more accurate way of assessing the potential yield of pickling cucumber cultivars where a number of cultivars are harvested on a single day irrespective of maturity. By using fruit number, variations in the maturity time can be accounted for.

The fruit number (Table 2.2) shows a similar result to the yield data (Table 2.1). Davista, RS 90228, RS 92500, Mathilde, Vlaspik M, No.10 and 1356 all had significantly higher fruit numbers in the commercial grades than 626. Excel M and No. 11, which had significantly higher total fruit numbers than 626, can also be added to this list of potentially high yielding cultivars.

Tables 2.3 and 2.4 show the results for the second cultivar trial. These tables include an added column for the percentage of deformed fruit. The size gradings for this trial were changed to relate more closely with the modified commercial sizes. The 30/40 and 20/30 classes were combined and the slicing grade size was increased from a maximum of 52mm to 56mm. The remainder of what was the relish grade has been added to the over size class.

An early frost on April 1 stopped this trial from reaching full maturity so the yields are much lower than for the first cultivar trial. Although this trial was harvested before it reached maturity similar trends to those obtained from the first cultivar trial were apparent. The same cultivars (Davista, RS 90228, RS 92500 and Mathilde from Royal Sluis, Vlaspik M from New World Seeds, and No.10 and 1356 from Yates) that had significantly higher commercial yields in the first trial have shown up as having significantly higher yields (Table 2.3) and fruit numbers (Table 2.4) for the 10/15 grade in the second trial. One can assume that if this trial had reached full maturity much of the fruit from the 10/15 grade would have moved into the slicing grade giving theses cultivars a significant yield advantage over 626. All these cultivars, with the addition of Yates No.11, also had significantly higher commercial and total fruit numbers. Yates 1355 and SPS 832 both had significantly higher yields of deformed fruit (Table 2.3).

There were only three cultivars that had significantly higher commercial yields (Table 2.3) in the second trial. They were Yates No.10 and 11 and RS 92500. No.11 is the cultivar that showed up as being slightly earlier than 626 in the first trial, a trait that has also been evident in past trials. This earliness would be a decided advantage for early and late season crops by bringing the harvests forward.

Among the observation lines only Cornichon appears to have little to offer. It is interesting to note that although the plant populations of the observation lines were between 55 and 70% of the replicated trial the yields were all higher, except Cornichon, than the other cultivars in the replicated trial. This was partly due to the lower plant populations allowing the observation lines to mature quicker than the more densely sown replicated trial. The higher yields were also partly due to more fruit per vine which resulted in a similar fruit number per plot (Table 2.4). The commercial and total fruit numbers of the observation lines were higher than 11 out of the 17 replicated cultivars. This result suggests that we need to reassess our planting density, particularly in respect to any new cultivars that we introduce into the farming program. It may be that we can achieve a similar yield as we are getting now with a much lower seeding rate. Reducing plant density may also be a viable strategy to hasten maturity of late season crops.

Table 2.5 shows the fresh fruit quality attributes from the second trial. Of all the promising high yielding cultivars, only 1356, Excel M and Vlaspik M have a similar L:D ratio for slicing grade fruit as 626. Davista, NO.10, No.11, RS 90228, RS 92500 and Mathilde all have significantly shorter fruit than 626. This is not a major problem provided that the higher yield coming from the field is maintained through the factory. With shorter fruit there will be more losses from fruit ends when the fruit is sliced.

The seed cavities (Table 2.5) of Davista, No.10, SPS 832, RS 90228, RS 92500 and Mathilde were all significantly larger than 626. This means that the dice quality of these cultivars will have to be carefully checked. Davista makes very poor dice, the integrity of the dice cut is poor and the dice continues to drain. A possible reason for this poor dice is the large seed cavity which makes up over 60% of the total fruit flesh in Davista. The flesh in the seed cavity is soft and jelly like so it doesn't hold it's shape and continues to ooze moisture.

There was little difference in the number of seeds (Table 2.5) between the cultivars. Davista had significantly fewer seeds than 626 while SPS 832 and Atlantis were the only cultivars to have significantly more seeds.

Skin penetrometer measurements (Table 2.5) show that there is a number of cultivars with a softer/thinner skin than 626. The skin thickness of 626 is it's major processing fault. The ideal fruit would have thin/soft skin with firm flesh. The penetrometer readings on fresh fruit are only a guide to the processing quality. The flesh of some cultivars will soften more than others during fermentation. The penetrometer reading on the skin is a bit more reliable than the penetrometer readings for the flesh. Of the high yielding cultivars Excel M, RS 90228 and Mathilde all had significantly thinner skin than 626, while the rest of the promising cultivars had similar skin thickness to 626. RS 90228 and AP 1 had the softest flesh, but this doesn't mean that these will be the worst processors. The quality of AP 1 has shown to be acceptable, the dice is a much better product than dice cut from Davista, and the slice, while being a bit seedy is acceptable.

Table 2.6 shows the processing quality of most of the cultivars that were trialed this season. There were six cultivars; 626, Vlasset B, Yates No.11, 1356, PS 10588 and Excel M, that produced excellent dice. AP 1, Napoleon, SPS 832, Atlantis, and Mathilde all produced a fair quality dice. All the other cultivars listed in Table 2.6 that have poor or fair to poor dice quality can automatically be eliminated as potential commercial lines. Any cultivar that is used for commercial sowings has to be a dual purpose cultivar. If either the sliced or diced products are poor the cultivar is unacceptable.

2.3 CONCLUSIONS

If the processed quality (Table 2.6) and the yield data (Tables 2.1 and 2.3) are considered in conjunction the list of potential cultivars can be narrowed to five new lines, all of which are worthy of large commercial trials.

These are:

1) Yates 1356; A high yielding cultivar with good processing qualities.
2) Excel M; Slightly earlier than 626 with similar yields but appears to have better processing qualities.
3) PS 10588; Has returned similar yields to 626 in previous trials and again in this trial. It appears to have better processing qualities than 626, and the fruit doesn't soften after fermenting.
4) Vlaspik B; A high yielding cultivar with good fruit characteristics. This cultivar was not assessed for processing quality, but the fresh fruit penetrometer readings suggest that it will process well.
5) Mathilde; This is a very high yielding cultivar with average but acceptable processing quality. It should be carefully assessed in a tanking trial to ensure the quality does not deteriorate when handled in bulk.

The following cultivars were planted in larger blocks during this season, but due to wet weather they were harvested together with other blocks and no reliable data was collected. They all looked good in the field, especially Yates No. 11 and need to be re-trialed next season before any firm decision can be made on their use.

These are:

1) AP 1; A number of blocks of AP 1 were sown last season, but most of the fruit was mixed with other cultivars when tanking. One tank of AP 1 was put through the factory and had a better processing quality than Davista. There is a question over whether the fruit may be too soft to make a good dice. The small processing trials from this years replicated trial showed that the flesh was soft, but it still made an acceptable dice, although not as good as 626. Table 2.7 shows the results from a hand pick yield assessment of one of the blocks of AP 1. It had a slightly, but not significantly higher yield than a block of 626 that was sown on the same day.
2) Yates No. 11; Has looked promising in trials over the past three seasons and again in the half block trial last season. It is potentially a very high yielding cultivar with good processing qualities. This is perhaps the most promising of all the cultivars so far and is a must for larger area trialing next season.
3) SPS 93/4; Only half a block was sown last season, and it is was grown largely in water logged conditions and never had a chance to reach it's potential. The fruit has good characteristics and it deserves to be re-trialed next season.

Although we can't control the weather a greater effort and higher priority needs to be placed on collecting yield data from trial blocks and keeping the fruit separate in the tanks, even if it means only partly filling a tank. New cultivars need to be assessed under commercial conditions before they can be used in large area sowings.

Table 2.1 Pickling cucumber fruit yield for the cultivar trial sown on 17/11/94 and harvested on 13/1/95.

	FRUIT WEIGHT (T/Ha)							
CULTIVAR	30/40	20/30	10/15	SLICE	RELISH	O/S	COMM	TOTAL
626	0.34	0.38	1.21	18.10	15.65	10.14	20.04	45.83
DAVISTA	0.25	0.41	1.82	31.62	16.53	3.06*	34.10	53.69
AP 1	0.36	0.37	1.87	17.82	15.09	5.74*	20.42	41.25
NO.10	0.39	0.42	1.16	28.19	14.81	2.13*	30.17	47.12
NO.11	0.39	0.19	1.04	18.10	22.22	8.38	19.72	50.33
1355	0.24	0.15	2.11	9.91*	22.22	14.40	12.41*	49.03
1356	0.20	0.34	2.53	27.31	15.23	2.64*	30.39	48.26
NAPOLEON	0.36	0.39	1.26	13.29*	12.04	9.72	15.29*	37.05*
SPS 832	0.28	0.32	0.56	11.34*	21.81	12.08	12.50*	46.39
EXCEL M	0.26	0.18	0.95	19.72	25.74	8.29	21.11	55.13
VLASSET B	0.38	0.13	0.97	14.03	17.22	17.08	15.51*	49.82
VLASPIK M	0.38	0.32	1.37	22.96	16.20	3.80*	25.03	45.03
RS 90228	0.27	0.56	3.65	33.24	7.36*	0.93*	37.73	46.01
RS 92500	0.23	0.47	2.17	33.84	8.38*	0.51*	36.71	45.60
MATHILDE	0.40	0.31	1.51	25.37	14.86	5.14*	27.59	47.59
LSD	0.24	0.26	1.54	4.12	4.26	3.39	4.19	5.54

Shaded cells have significantly higher yields than 626 ($P < 0.05$).
* are significantly lower than 626 ($P < 0.05$).
O/S = oversized fruit, COMM = commercial yield.
Commercial yield is calculated from the sum of 30/40, 20/30, 10/15 and slicing grades.

Davista, No. 10, 1356, Vlaspik M, RS 90228, RS 92500 and Mathilde all had significantly higher slicing grade and commercial yields than 626. Only Davista and Excel M had significantly higher total yields than 626. Excel M, No.11, 1355 and SPS 832 are all earlier than 626, shown by higher yields in the relish grade.

Table 2.2 Pickling cucumber fruit number per plot for the cultivar trial sown on 17/11/94 and harvested on 13/1/95.

	FRUIT NUMBER (/PLOT)							
CULTIVAR	30/40	20/30	10/15	SLICE	RELISH	O/S	COMM	TOTAL
626	7.5	4.3	8.0	61.0	31.5	14.0	80.8	126.3
DAVISTA	5.8	5.5	15.3	125.5	40.0	5.0*	152.0	197.0
AP 1	7.5	4.3	13.5	62.5	34.0	9.8	87.8	131.5
NO.10	9.3	6.3	12.0	120.8	39.5	4.3*	148.3	192.0
NO.11	9.0	3.0	8.0	66.3	52.8	14.5	86.3	153.5
1355	5.3	2.0	4.5	35.3*	47.8	24.0	47.0*	118.8
1356	4.3	4.0	17.0	88.0	28.5	3.5*	113.3	145.3
NAPOLEON	6.3	4.0	8.5	43.8*	24.8	13.8	62.5	101.0*
SPS 832	7.3	4.5	4.5	44.5*	46.3	19.0	60.8*	126.0
EXCEL M	6.0	2.5	7.8	68.3	54.5	12.0	84.5	151.0
VLASSET B	6.8	1.8	6.8	46.8	37.3	26.3	62.0	125.5
VLASPIK M	8.0	3.8	10.0	79.3	35.0	6.0*	101.0	142.0
RS 90228	8.3	9.0	38.5	163.0	21.0*	1.8*	218.8	241.5
RS 92500	6.5	7.8	22.5	162.5	24.8	1.0*	199.3	225.0
MATHILDE	10.0	5.8	16.5	113.0	41.8	10.5	145.3	197.5
LSD	**5.41**	**3.51**	**8.26**	**15.43**	**9.79**	**5.13**	**18.85**	**15.74**

Shaded cells have significantly higher fruit numbers than 626 ($P < 0.05$).
* are significantly lower than 626 ($P < 0.05$).
O/S = oversized fruit, COMM = commercial yield.
Commercial fruit number is the sum of 30/40, 20/30, 10/15 and slicing grade fruit.

Davista, No. 10, 1356, Vlaspik M, RS 90228, RS 92500 and Mathilde all had significantly higher fruit numbers for commercial, total and slicing grades than 626. Excel M and No. 11 both have significantly higher total fruit numbers than 626. Excel M, No.11, 1355 and SPS 832 are all earlier than 626, shown by the higher fruit numbers in the relish grade.

Table 2.3 Pickling cucumber fruit yield for the cultivar trial sown on 5/2/95 and harvested on 5/4/95. An early frost on 1/4/95 stopped this trial from reaching full maturity.

	FRUIT WEIGHT (T/Ha)						
CULTIVAR	**20/40**	**10/15**	**SLICE**	**O/S**	**% DEF.**	**COMM.**	**TOTAL**
626	1.07	2.49	8.61	0.14	9.76	12.28	13.63
DAVISTA	1.55	4.57	9.78	0.00	7.60	15.90	17.15
AP 1	0.95	2.49	6.30	0.09	12.66	9.83	11.25
NO.10	1.75	4.29	10.76	0.09	4.83	16.90	17.78
NO.11	0.68*	2.63	11.02	0.14	5.70	17.48	18.50
1355	0.72	1.64	10.33	0.00	23.03	12.68	16.13
1356	1.78	6.31	8.01	0.00	5.45	16.08	16.98
NAPOLEON	0.90	2.11	9.52	0.00	6.74	12.53	13.40
SPS 832	0.95	1.68	10.03	0.09	18.23	12.78	15.50
EXCEL M	0.67*	2.19	9.90	0.28	14.66	13.03	15.23
VLASSET B	0.88	2.25	7.48	0.00	14.43	10.63	12.25
VLASPIK M	1.31	4.09	4.94	0.00	10.27	10.33	11.55
RS 90228	2.39	6.00	5.02*	0.00	3.18	13.40	13.88
RS 92500	1.15	4.10	12.40	0.00	4.28	17.68	18.38
MATHILDE	1.49	4.14	9.87	0.00	4.94	15.50	16.35
ATLANTIS	0.92	2.25	10.26	0.00	13.01	13.45	15.48
PS 10588	1.28	4.51	7.95	0.00	11.94	13.75	15.55
LSD	**0.36**	**1.34**	**3.27**	**0.20**	**6.17**	**4.12**	**4.17**
	OBSERVATION LINES						
RS 92242	1.06	4.24	13.39	0.54	7.67	19.2	20.8
MOHIKAN	0.46	3.69	14.11	0.00	12.15	18.3	20.8
PEREZ	1.24	3.35	14.06	0.00	4.68	18.6	19.6
CORNICHON	1.15	2.87	5.91	0.48	8.82	10.4	11.4

Shaded cells have significantly higher yields than 626 ($P < 0.05$).
* are significantly lower than 626 ($P < 0.05$).
O/S = oversized fruit, COMM = commercial yield, (commercial yield is calculated from the sum of 30/40, 20/30, 10/15 and slicing grades.)
% DEF = percent of deformed fruit.
Only No.10, No.11 and RS 92500 had significantly higher commercial yields than 626.

Table 2.4 Pickling cucumber fruit number per plot for the cultivar trial sown on 5/2/95 and harvested on 5/4/95. An early frost on 1/4/95 stopped this trial from reaching full maturity.

	FRUIT NUMBER (/PLOT)						
CULTIVAR	20/40	10/15	SLICE	O/S	% DEF.	COMM.	TOTAL
626	22.5	18.5	36.0	0.3	14.5	77.3	90.3
DAVISTA	29.5	38.3	45.0	0.0	10.2	112.8	125.3
AP 1	21.3	23.0	29.0	0.3	17.0	73.5	88.5
NO.10	37.5	41.3	56.8	0.3	6.7*	135.8	145.5
NO.11	15.5	23.5	65.3	0.3	9.5	104.5	115.5
1355	16.3	13.0	46.8	0.0	27.3	76.0	103.8
1356	32.9	52.6	34.7	0.0	8.1	120.1	130.3
NAPOLEON	17.8	17.0	40.8	0.0	9.9	75.5	83.8
SPS 832	21.3	14.0	43.3	0.3	23.0	78.8	101.5
EXCEL M	15.3	16.8	43.0	0.5	21.6	75.5	96.3
VLASSET B	20.5	19.5	35.5	0.0	18.4	75.5	92.3
VLASPIK M	27.0	32.5	23.5	0.0	12.1	83.0	94.8
RS 90228	54.0	60.8	29.5	0.0	4.0*	144.3	150.5
RS 92500	26.8	42.0	72.8	0.0	6.4*	141.5	151.0
MATHILDE	36.8	40.3	52.3	0.0	6.8*	129.3	139.0
ATLANTIS	20.3	19.0	43.5	0.0	19.2	82.8	102.8
PS 10588	28.0	34.3	37.5	0.0	15.1	99.8	117.3
LSD	**7.6**	**10.4**	**14.3**	**0.4**	**5.9**	**23.4**	**25.2**
	OBSERVATION LINES						
RS 92242	20.0	34.0	55.0	1.0	11.3	110.0	124.0
MOHIKAN	12.0	36.0	63.0	0.0	21.3	111.0	141.0
PEREZ	25.0	30.0	62.0	0.0	8.6	117.0	128.0
CORNICHON	26.0	25.0	26.5	1.0	13.0	78.5	90.5

Shaded cells have significantly higher fruit numbers than 626 ($P<0.05$).
* are significantly lower than 626 ($P<0.05$).
O/S= oversized fruit, COMM= commercial yield, (commercial yield is calculated from the sum of 30/40, 20/30, 10/15 and slicing grades).
% DEF= percent of deformed fruit.
Davista, No.10, No.11, 1356, RS 90228, RS 92500 and Mathilde all had significantly higher commercial and total fruit numbers than 626.

Table 2.5 Fresh fruit quality attributes for pickling cucumber cultivars sown on 5/2/95 and harvested on 5/4/95.

	CUCUMBER FRUIT QUALITY ATTRIBUTES							
CULTIVAR	SMALL L:D	SLICE L:D	% SEED CAVITY	SEED No.	SEED SIZE	SEED MATURITY	SKIN PENET	FLESH PENET
626	3.6	2.7	53.9	2.17	30.5	1.50	22.3	12.9
DAVISTA	3.5	2.5*	61.3	0.67*	25.5	1.17	19.8	10.2*
AP 1	3.1*	2.4*	55.0	3.50	32.8	1.83	18.6*	9.5*
NO.10	3.0*	2.3*	60.3	3.33	32.2	1.67	20.2	11.8
NO.11	2.8*	2.2*	57.0	1.67	35.9	2.00	21.9	12.6
1355	3.1*	2.5*	56.3	1.17	38.2	2.00	21.7	11.1*
1356	3.5	2.7	54.7	2.00	27.0	1.67	22.6	12.6
NAPOLEON	3.3	2.5*	52.3	2.33	37.3	2.00	18.6*	10.3*
SPS 832	3.6	2.6	62.3	3.67	34.2	1.50	19.7	10.8*
EXCEL M	3.9	2.6	54.8	1.17	32.0	1.67	18.3*	11.3*
VLASSET B	3.1*	2.4*	49.9	3.33	28.3	1.33	23.4	12.8
VLASPIK M	3.9	2.6	52.6	2.83	33.0	1.50	19.8	11.3*
RS 90228	3.4	2.4*	63.0	3.00	28.7	1.83	14.0*	8.1*
RS 92500	2.8*	2.0*	59.6	1.17	38.7	2.00	20.6	10.9*
MATHILDE	3.0*	2.1*	61.0	2.67	30.5	1.50	18.8*	10.5*
ATLANTIS	3.8	2.8	58.7	3.83	36.0	2.00	18.7*	10.7*
PS 10588	3.6	2.6	51.7	2.00	28.0	1.67	19.8	11.1*
LSD	**0.39**	**0.18**	**5.36**	**1.46**	**11.4**	**0.61**	**3.0**	**1.5**
	OBSERVATION LINES							
RS 92242	3.0	2.4	61.2	0.33	12.0	0.67	18.7	11.3
MOHIKAN	3.0	2.3	66.2	2.00	40.0	2.00	14.3	8.3
PEREZ	3.9	2.6	65.1	2.67	34.7	2.00	17.3	12.2
CORNICHON	2.8	2.4	51.4	2.67	28.0	1.33	23.3	13.8

Shaded cells have significantly higher values than 626 (P<0.05).
* have significantly lower values than 626 (P<0.05).

Davista, AP 1 No.10, No.11, 1355, Napoleon, Vlasset B, RS 90228, RS 92500 and Mathilde all have shorter slicing grade fruit than 626 which means that it takes more fruit to make up a tonne. Davista, No.10, SPS 832, RS 90228, RS 92500 and Mathilde all have significantly larger seed cavities than 626. AP 1, Napoleon, Excel M, RS 90228, Mathilde and Atlantis all have significantly softer skin than 626. All cultivars had significantly softer flesh than 626 except for No.10, No.11, 1356, and Vlasset B.

Table 2.6

PROCESSING QUALITY OF FERMENTED FRUIT								
CULTIVAR	PENETROMETER		AVE FRUIT WT (G)	SMALLS (G)	DEFECTS (G)	SLICE COUNT/KG	% RETURN	DICE QUALITY
	SKIN	FLESH						
626	15.2	11.3	153.2	17.8	1.6	234	95.46	1
VLASSET B	21.7	15	124.8	19.8	0	218	95.68	1
YATES No.11	17.8	12	149.4	18.7	13.8	235	92.36	1
AP 1	17.3	8.5	125.0	23.5	0	247	94.20	2
1356	17	13.3	119.6	30.1	0	283	91.48	1
PS 10588	16.8	11.7	119.6	58	0	258	85.04	1
NAPOLEON	16.5	8.7	133.3	47.7	0	230	89.03	2
SPS 832	15.5	12	126.1	32.4	0	233	92.45	2
EXCEL M	15.2	11.3	150.2	33	22.7	237	86.80	1
ATLANTIS	15	10.5	151.9	42.1	10.4	258	86.46	2
MATHILDE	12.8	9.5	123.8	49.1	0	235	88.46	2
DAVISTA	12.7	9.5	145.8	33	2.1	245	91.40	2-3
YATES No.10	12.7	9.3	122.4	55.1	0	244	86.56	2-3
RS 92242	12.2	8.8	117.5	51.6	0	270	86.07	2-3
RS 90228	11.3	7.8	91.1	78.1	3.9	289	76.30	3
PEREZ	10.2	7	119.8	101.9	0	274	72.08	3
RS 92500	10	8.8	146.5	27.8	0	245	93.19	3
MOHIKAN	9.5	6.8	129.0	27.9	0	259	92.77	3

Dice was subjectively assessed for texture, colour and seediness and given a rating for overall quality. 1 = good 2 = fair and 3 = poor.
% return is a measure of the weight of fruit recovered as sliced product minus weight of defects and small slices.

Table 2.7 Comparison between AP 1, sown in block A10 on 16/11/94, and 626, sown in block A6 on 16/11/94.

FRUIT NUMBER (/2m PLOT)								
GRADE	**30/40**	**20/30**	**10/15**	**SLICE**	**RELISH**	**O/S**	**COMM**	**TOTAL**
AP 1	6.25	3.50	7.25	44.3	25.3	7.00	86.5	93.5
626	4.75	2.00	9.25	27.0	24.5	9.75	67.5	77.3
LSD	**4.00**	**4.00**	**11.76**	**16.14**	**13.46**	**7.62**	**27.47**	**28.08**

FRUIT WEIGHT (/2m PLOT)								
GRADE	**30/40**	**20/30**	**10/15**	**SLICE**	**RELISH**	**O/S**	**COMM**	**TOTA L**
	(g/plot)			**(kg/plot)**				
AP 1	151.0	182.5	567.5	6.33	5.95	2.18	13.18	15.4
626	120.5	102.0	745.3	4.00	6.38	3.68	11.36	15.0
LSD	**113.5**	**222.5**	**1048**	**2.46**	**3.97**	**2.97**	**3.81**	**5.74**

There was no significant difference between the yield of AP 1 or 626 in this hand picked comparison. Wet weather meant that separate yield data from the mechanical harvesters was not obtained for each block. AP 1 had significantly more fruit numbers in the slicing grade, but because the AP 1 fruit is shorter this was not translated into significantly higher yields.

2.4 PICKLING CUCUMBER CULTIVAR DESCRIPTIONS

CULTIVAR: 626

SOURCE: Standard

TYPE: US

L:D RATIO: 3.6:1 (small fruit) 2.7:1 (slicing grade)

SKIN FIRMNESS: 22.3 lbs **FLESH FIRMNESS:** 12.9 lbs

COMMENTS: 626 has a small seed cavity with relatively large seeds. The skin is quite tough and flesh is firm. Fruit tends to taper towards the end. 626 is a consistent performer that yields well in a range of environmental conditions.

CULTIVAR: Davista

SOURCE: Royal Sluis

TYPE: Dutch

L:D RATIO: 3.5:1 (small fruit) 2.5:1 (slicing grade)

SKIN FIRMNESS: 19.8 lbs **FLESH FIRMNESS:** 10.2 lbs

COMMENTS: Davista consistently returns high yields, however its poor resistance to downy and powdery mildew and it's poor processing qualities are major problems. Davista suffered from severe carpel separation in the second trial, but this was not so evident in the first. The processing quality of Davista is often very poor. The dice has poor texture and continues to bleed while draining. The slice is often soft.

CULTIVAR: AP 1

SOURCE: Henderson Seeds

TYPE: US

L:D RATIO: 3.1:1 (small fruit) 2.4:1 (slicing grade)

SKIN FIRMNESS: 18.6 lbs **FLESH FIRMNESS:** 9.5 lbs

COMMENTS: AP 1 returned similar yields to 626 in both cultivar trials from this season. AP 1 appears to have better resistance to downy and powdery mildew than 626 and both the skin and flesh are softer than 626. It is slightly later maturing than 626. This cultivar has firm fruit after fermentation and produces a good slice and average dice. Larger fruit tend to be seedy. This cultivar should be reassessed in tank trials next year.

CULTIVAR: No 10

SOURCE: Yates

TYPE: Dutch

L:D RATIO: 3.0:1 (small fruit) 2.3:1 (slicing grade)

SKIN FIRMNESS: 20.2 lbs **FLESH FIRMNESS:** 11.8 lbs

COMMENTS: Yates No 10. has a short blocky dark green fruit. It has a large seed cavity with relatively large seeds. This cultivar significantly out yielded 626 in both trials this year. The fermented fruit is only medium firm with larger fruit tending to be soft. It makes only a poor to medium dice of borderline acceptability and an average slice. Even though this is a very high yielder, at best the processing quality is average so it doesn't warrant any further assessment.

CULTIVAR: No.11

SOURCE: Yates

TYPE: US x Dutch

L:D RATIO: 2.8:1 (small fruit) 2.2:1 (slicing grade)

SKIN FIRMNESS: 21.9 lbs **FLESH FIRMNESS:** 12.6 lbs

COMMENTS: This cultivar appears to be a hybrid between the US and Dutch types. It has a slightly warted spined skin. It is slightly earlier than 626. Yields were similar to 626 in the first trial, but significantly higher in the second. It has a large seed cavity which may adversely affect processing quality. The seeds tend to be larger than 626, but there is fewer of them. The fermented fruit is firm and produces good quality diced and sliced products. This cultivar has looked promising in trials over the past two seasons and warrants further assessment in large area trials next season.

CULTIVAR: 1355

SOURCE: Yates

TYPE: US

L:D RATIO: 3.1:1 (small fruit) 2.5:1 (slicing grade)

SKIN FIRMNESS: 21.7 lbs **FLESH FIRMNESS:** 11.1 lbs

COMMENTS: Cultivar 1355 has a short blocky fruit with a medium sized seed cavity. The seeds are larger than 622 but there is usually very few seeds in a fruit. It is earlier than 626, with a similar yield. It had significantly more deformed fruit than 626 in the second trial. This cultivar does not offer any significant advantages over 626.

CULTIVAR:	1356	
SOURCE:	Yates	
TYPE:	US	
L:D RATIO:	3.5:1 (small fruit)	2.7:1 (slicing grade)
SKIN FIRMNESS:	12.6 lbs	**FLESH FIRMNESS:** 12.6 lbs
COMMENTS:	1356 has a dark green tapered fruit that is slightly shorter than 626. It has a medium sized seed cavity. The number of seeds varies greatly from fruit to fruit. It significantly out yielded 626 in the first trial and had significantly higher fruit numbers than 626 in both trials. It also has a very low percentage of deformed fruit. The fermented fruit is very good and it produces excellent dice. The skin may be too tough, but this needs to be further assessed with a large commercial trial. This is a promising cultivar and warrants further assessment.	

CULTIVAR:	SPS 832	
SOURCE:	SPS	
TYPE:	US	
L:D RATIO:	3.6:1 (small fruit)	2.6:1 (slicing grade)
SKIN FIRMNESS:	19.7 lbs	**FLESH FIRMNESS:** 10.8 lbs
COMMENTS:	SPS 832 has a very large seed cavity and the larger fruit tends to have numerous large seeds. It had significantly lower yields than 626 in the first trial and similar yields in the second. It also had significantly more deformed fruit than 626. The fermented fruit is firm and it produces a good firm slice and good to medium textured dice. This cultivar has no advantage over 626.	

CULTIVAR: Excel M

SOURCE: New World Seeds

TYPE: US

L:D RATIO: 3.9:1 (small fruit) 2.6:1 (slicing grade)

SKIN FIRMNESS: 18.3 lbs **FLESH FIRMNESS:** 11.3 lbs

COMMENTS: Excel M has a blocky shaped fruit with a medium sized seed cavity and very few seeds. The skin is significantly softer than 626 while the flesh is firm. It is slightly earlier than 626 and returned similar yields in both trials. Although the yields were similar to 626 it makes a better processed product. The fermented fruit is very firm and the dice has good texture. This cultivar warrants further evaluation in a larger trial next season.

CULTIVAR: Vlasset B

SOURCE: New World Seeds

TYPE: US

L:D RATIO: 3.1:1 (small fruit) 2.4:1 (slicing grade)

SKIN FIRMNESS: 23.4 lbs **FLESH FIRMNESS:** 12.8 lbs

COMMENTS: Vlasset B has a short blocky fruit with very small seed cavity. It has a large number of seeds, but these tend to be small and immature. The skin is quite tough when fresh which may detract from it's processing quality. Vlasset B returned a significantly lower commercial yield than 626 in the first trial, but was over mature. In the second trial it had similar yields and fruit numbers as 626. This cultivar doesn't have any significant yield advantages over 626, but produces very high quality slice and dice. The fruit set isn't as concentrated as some other cultivars and is probably more suited to hand pick operations.

CULTIVAR: Vlaspik M

SOURCE: New World Seeds

TYPE: US

L:D RATIO: 3.9:1 (small fruit) 2.6:1 (slicing grade)

SKIN FIRMNESS: 19.8 lbs **FLESH FIRMNESS:** 11.3 lbs

COMMENTS: Vlaspik M has a short tapered fruit with a medium sized seed cavity that contains large numbers of immature seeds. This cultivar significantly out yielded 626 in the first trial and had similar yields in the second. Vlaspik M shows promise and should be carefully assessed in a tanking trial for commercial processing quality. It warrants further assessment in a larger area trial next season.

CULTIVAR: RS 90228

SOURCE: Royal Sluis

TYPE: Dutch

L:D RATIO: 3.4:1 (small fruit) 2.4:1 (slicing grade)

SKIN FIRMNESS: 14.0 lbs **FLESH FIRMNESS:** 8.1 lbs

COMMENTS: RS 90228 has a short tapered fruit with very large seed cavity. Both the skin and flesh are significantly softer than 626. It is later maturing than 626, but has the potential to significantly out yield 626. The large seed cavity and soft flesh produce a poor processed product. The high yield of this cultivar is attractive, but the fermented fruit produces a soft sloppy slice and seedy dice with poor texture. The processing faults preclude taking this cultivar any further.

CULTIVAR: RS 92500

SOURCE: Royal Sluis

TYPE: Dutch

L:D RATIO: 2.8:1 (small fruit) 2.0:1 (slicing grade)

SKIN FIRMNESS: 20.6 lbs **FLESH FIRMNESS:** 10.9 lbs

COMMENTS: This cultivar has very short tapered fruit with a large seed cavity and very few seeds. RS 92500 has a very concentrated fruit set and significantly out yielded 626 in both cultivar trials. The processing quality of this cultivar is poor. It produces a soft dice with poor texture and pale colour. The sliced product is acceptable but we require a dual purpose fruit. This cultivar doesn't warrant any further assessment.

CULTIVAR: Mathilde

SOURCE: Royal Sluis

TYPE: Spined - Parthenocarpic

L:D RATIO: 3.0:1 (small fruit) 2.1:1 (slicing grade)

SKIN FIRMNESS: 18.8 lbs **FLESH FIRMNESS:** 10.5 lbs

COMMENTS: Mathilde has short blocky fruit and appears to be a hybrid between the US and Dutch cucumber types. Mathilde is slightly slower maturing than 626, but has the potential to significantly out yield 626. It has a very low percentage of deformed fruit. The fermented fruit produces an average quality slice and dice. This cultivar warrants further assessments.

CULTIVAR: Atlantis

SOURCE: Harris Moran (via Krugers)

TYPE: US

L:D RATIO: 3.8:1 (small fruit) 2.8:1 (slicing grade)

SKIN FIRMNESS: 18.7 lbs **FLESH FIRMNESS:** 10.7 lbs

COMMENTS: Atlantis has a dark green tapered fruit with numerous large mature seeds. It is slightly later than 626 with similar yields. The fermented fruit is reasonably firm, and the dice and slice products are average. This cultivar offers no significant advantage over 626.

CULTIVAR: PS 10588

SOURCE: Peto Seeds (via Krugers)

TYPE: US

L:D RATIO: 3.6:1 (small fruit) 2.6:1 (slicing grade)

SKIN FIRMNESS: 19.8 lbs **FLESH FIRMNESS:** 11.1 lbs

COMMENTS: PS 10588 has a dark green blocky fruit with a small seed cavity. It has few seeds which are smaller than 626. The skin is softer than 626 and the flesh is firmer than Davista, but not as firm as 626. The yield was not significantly better than 626. The fermented fruit remains firm and the processed quality of both the slice and dice products is excellent. The texture of the dice is firm, the colour is good and there is very few seeds. The improved processing quality of this cultivar makes it worthy of further assessment.

CULTIVAR: RS 92242

SOURCE: Royal Sluis

TYPE: US x Dutch (Spined)

L:D RATIO: 3.0:1 (small fruit) 2.4:1 (slicing grade)

SKIN FIRMNESS: 18.7 lbs **FLESH FIRMNESS:** 11.3 lbs

COMMENTS: RS 92242 has a blocky fruit with a large seed cavity that contains very few seeds. It has a soft skin with medium firm flesh. There was only enough seed to include this cultivar in an observation trial, but yield potential looks very promising. The fermented fruit was soft with soft centres. The sliced product was soft and the dice had poor texture that tended to bleed. The poor processing quality of this cultivar makes it unacceptable.

CULTIVAR: Mohikan

SOURCE: Hungary (via Sandor Gurban)

TYPE: Smooth no spines

L:D RATIO: 3.0:1 (small fruit) 2.3:1 (slicing grade)

SKIN FIRMNESS: 14.3 lbs **FLESH FIRMNESS:** 8.3 lbs

COMMENTS: There was only enough seed to include this cultivar in an observation trial. It has short pale green fruit with soft skin and soft flesh. It has a very large seed cavity with large mature seeds. The soft flesh and large seed cavity are severe defects for a diced product. It has a very concentrated fruit set and high yields. The fermented fruit was very soft and unsuitable for slicing. The dice had poor texture and the colour was too pale. The slice was soft

This cultivar is not suitable for sliced and diced products but has potential as a small whole gherkin bottled product.

CULTIVAR: Perez

SOURCE: Hungary (via Sandor Gurban)

TYPE: Smooth skin

L:D RATIO: 3.9:1 (small fruit) 2.6:1 (slicing grade)

SKIN FIRMNESS: 17.3 lbs **FLESH FIRMNESS:** 12.2 lbs

COMMENTS: Perez has tapered fruit with a thin skin and large seed cavity. It has a very concentrated fruit set and often sets four or more slicing grade fruit per plant making it a prolific yielder. It has a very large seed cavity which will adversely affect it's dicing quality. The fermented fruit is soft and makes poor quality dice and slice. This cultivar is not suitable for our production but the prolific number of fruit set on each vine may make it suitable for little pickles.

CULTIVAR: Cornichon

SOURCE: Bulsem, Italy

TYPE: US

L:D RATIO: 2.8:1 (small fruit) 2.4:1 (slicing grade)

SKIN FIRMNESS: 23.3 lbs **FLESH FIRMNESS:** 13.8 lbs

COMMENTS: Cornichon has a blocky shaped fruit with a small seed cavity and small immature seeds. The fruit set is not very concentrated resulting in low yields in a once over harvest. This cultivar is more suited to a hand pick operation.

CULTIVAR: Napoleon

SOURCE: Henderson Seeds

TYPE: US

L:D RATIO: 3.3:1 (small fruit) 2.5:1 (slicing grade)

SKIN FIRMNESS: 18.6 lbs **FLESH FIRMNESS:** 10.3 lbs

COMMENTS: Napoleon has blocky shaped fruit, a small to medium sized seed cavity with few but large seeds. It had significantly lower yields in the first cultivar trial, mainly due to poor plant establishment, than 626. Yields in the second cultivar trial were similar to 626. It produces an average quality diced product. Napoleon has been trialed in previous seasons and doesn't appear to have any advantage over 626.

3 PICKLING CUCUMBER VINE TRIMMING TRIAL

3.1 INTRODUCTION

The yield of machine harvested pickling cucumbers is heavily dependant on the concentration and evenness of fruit set. Excessive vine growth can also create problems at harvest. Pruning or clipping crop foliage is a practice that is used for a range of crops to improve uniformity and size or to modify crop maturity (Humphries and Vermillion, 1994). Sims and Gledhill (1968) conducted vine pruning trials on pickling cucumbers in an attempt to retard fruit production on more advanced vines and promote crop uniformity. They found that severe pruning reduced yield, but if the vines at 30cm were pruned back to 20cm there was no adverse effect on yield. Humphries and Vermillion (1994) also found that vine trimming at various stages of growth had little effect on the final yield. Only when 50% of the leaves were removed at the two leaf stage was a significant yield decrease observed (Humphries and Vermillion 1994). Both these earlier experiments on pickling cucumber vine trimming were performed on furrow irrigated crops that were sown at much lower plant densities then is used for mechanically harvested crops in the MIA.

The experiments reported here were conducted to determine if vine trimming could be used to improve fruit uniformity and reduce vine bulk in a densely planted (250,000 plant/ha) trickle irrigated pickling cucumber crop.

3.2 MATERIALS AND METHODS

Three separate experiments were conducted in three commercial crops. Each experiment had the trimming treatment imposed at a different growth stage (Table 3.1). The crops were sown on 1.8m beds with four rows of plants on each bed and 8cm within row spacing. The crops were watered with a single drip line buried at 20cm in the centre of each bed. Three replicates of each vine trimming treatment were imposed on 5 metre plots in a complete random block design. A 2m harvest area was pegged out after the treatments had been imposed. A buffer row was left between each plot. This buffer row had the same treatment imposed as the adjoining plot to prevent competition from vines that may have run into the treated area. The treatments were imposed using a brushcutter to trim the tops and sides of the plots.

Yields were assessed from a once over hand pick to simulate mechanical harvesting. The fruit from each plot was graded and fruit number and weight recorded for each grade.

Table 3.1

Vine Trimming Treatment

Experiment	Crop Stage	Treatment
1	Approximately 5 nodes - no flowers 3-4 immature flower buds	Trimmed to approximately 4 nodes
2	Approximately 10 nodes - cucumber flowering No fruit set	Trimmed to approximately 6-8 nodes
3	Approximately 12 nodes - Fruit set, largest fruit was 10/15 grade, most fruit was 20/30 grade	Trimmed to approximately 8-11 nodes

3.3 RESULTS AND DISCUSSION

Lightly trimming the vines before the first flowers had opened significantly reduced the number (Table 3.2) and weight (Table 3.3) of slicing grade fruit. It also significantly reduced the yield of marketable fruit and the total fruit weight (Table 3.3). Due to other commitments this trial was harvested about three days premature which accounts for the slightly lower fruit numbers (compared to experiments 2 & 3) and the much lower fruit weight.

Table 3.4 and 3.5 show the results from experiment 2. The treated plots had significantly more fruit in the 30/40 grade than the control, while the control had significantly more total and relish grade fruit (Table 3.4). The control plots were slightly more advanced than the treated plots which is indicated by the significantly higher weight of slicing and relish grade fruit. The average weight of the slicing grade fruit in the trimmed plots was only 135g compared to 155g from the control plots. The lower average fruit weight in the slicing grade for the trimmed plots was due to the fruit being at the bottom end (small slicing) of the slicing grade. The vine trimming treatment also increased the number of deformed fruit (data not shown) especially in the larger sizes. Many of the slicing grade fruit were pinched at the blossom end which would also contribute to the lower average fruit weight.

In the late vine pruning trial (experiment 3) the total and commercial number of fruit (Table 3.6) and yields (Table 3.7) were significantly reduced. The main decrease occurred in the slicing grade where the control plots had both higher fruit numbers (Table 3.6) and high fruit weight (Table 3.7). The 10/15 grade in the control also had significantly higher fruit weight (Table 3.7) then the trimmed plots.

Table 3.2

EXPERIMENT 1

FRUIT NUMBER (/2m PLOT)								
GRADE	30/40	20/30	10/15	SLICE	RELISH	O/S	COMM	TOTAL
TRIMMED	18.5	9.50	18.8	29.5	2.00	0.00	78.3	78.3
CONTROL	21.0	13.3	18.5	38.5	2.25	0.25	93.5	93.8
LSD $_{.05}$	**9.23**	**4.57**	**5.09**	**5.81**	**5.72**	**0.80**	**16.25**	**16.56**

The control had significantly more slicing grade fruit than the trimmed treatment.

Table 3.3

EXPERIMENT 1

FRUIT WEIGHT (/2m PLOT)								
GRADE	30/40	20/30	10/15	SLICE	RELISH	O/S	COMM	TOTAL
	(g/plot)			(kg/plot)				
TRIMMED	469.3	417.8	1115	3.46	0.48	0.00	5.95	5.95
CONTROL	586.3	627.3	1328	5.10	0.54	0.09	8.18	8.27
LSD $_{.05}$	**362.1**	**268.6**	**617.7**	**0.69**	**1.42**	**0.28**	**1.47**	**1.59**

The control had significantly higher yields of slicing grade, commercial and total fruit.

Table 3.4

EXPERIMENT 2

FRUIT NUMBER (/2m PLOT)								
GRADE	30/40	20/30	10/15	SLICE	RELISH	O/S	COMM	TOTAL
TRIMMED	14.0	7.00	7.50	41.0	11.3	3.00	80.8	83.8
CONTROL	8.75	4.50	10.3	62.0	19.0	6.50	104.5	111.0
LSD $_{.05}$	**4.38**	**5.28**	**6.41**	**27.77**	**4.93**	**8.27**	**27.66**	**21.83**

The trimmed treatment had significantly higher fruit numbers in the 30/40 grade, while the control had significantly more total and relish grade fruit.

Table 3.5

EXPERIMENT 2

FRUIT WEIGHT (/2m PLOT)								
GRADE	30/40	20/30	10/15	SLICE	RELISH	O/S	COMM	TOTAL
	(g/plot)			(kg/plot)				
TRIMMED	330.8	333.8	503.5	5.53	2.81	1.21	9.50	10.7
CONTROL	260.8	214.3	811.0	9.70	4.84	2.59	13.5	16.1
LSD $_{.05}$	135.5	219.0	508.1	3.87	1.94	2.86	7.41	6.04

The control had significantly higher fruit weights in the slicing and relish grades.

Table 3.6

EXPERIMENT 3

FRUIT NUMBER (/2m PLOT)								
GRADE	30/40	20/30	10/15	SLICE	RELISH	O/S	COMM	TOTAL
TRIMMED	6.75	8.75	10.3	41.8	13.5	2.00	81.0	83.0
CONTROL	16.5	8.75	15.3	49.5	18.5	1.25	108.5	109.8
LSD $_{.05}$	13.95	3.90	6.50	7.04	10.15	2.00	24.94	24.18

The control had significantly higher numbers of total, commercial and slicing grade fruit.

Table 3.7

EXPERIMENT 3

FRUIT WEIGHT (/2m PLOT)								
GRADE	30/40	20/30	10/15	SLICE	RELISH	O/S	COMM	TOTAL
	(g/plot)			(kg/plot)				
TRIMMED	167.0	382.5	683.0	5.28	3.04	0.64	9.55	10.2
CONTROL	491.5	440.0	1149	7.20	4.55	0.41	13.8	14.2
LSD $_{.05}$	532.0	144.2	227.7	1.46	2.32	0.52	2.73	2.42

The control had significantly higher fruit weights in the 10/15 and slicing grades as well as commercial and total fruit weights.

These three experiments have shown that vine trimming in a densely sown trickle irrigated pickling cucumber crop will at best delay the harvest and most probably reduce the commercial yield. In all three experiments the yield of slicing grade fruit was significantly reduced (Tables 3.3,3.5 & 3.7).

While it is an advantage to reduce the amount of vine growth for mechanical harvesting these experiments have shown that pruning during the early stages (before flowering) tends to remove some of the buds that would have otherwise set fruit. This results in fewer fruit in the slicing grade at harvest (experiment 1). Trimming vines after most of the fruit has been set (experiment 3) tends to increase the number of deformed fruit and delays maturity, significantly reducing the slicing grade and total and commercial yields.

Vine trimming is not a management option for a densely sown mechanically harvested pickling cucumber crop. It doesn't give a more concentrated fruit set or enhance the final yield.

REFERENCES

Humphries E.G. and Vermillion D.L., (1994). Pickling cucumber vine pruning treatments and their implications for mechanical harvesting. Trans. of ASAE. 37(1) pp71-75.

Sims W.L. and Gledhill B.L., (1968). Effect of plant size on mechanical clipping of pickling cucumbers. California Agriculture. 22(9) pp4-5.

4 RAINSAVER® WATER CRYSTAL EVALUATION TRIAL

4.1 INTRODUCTION

It has been claimed that Rainsaver® water crystals will improve yield and quality of a number of vegetable crops by reducing water stress. Even in well watered crops where no visible signs of moisture stress have been seen yield and quality have been enhanced. A trickle irrigated tomato crop grown at Gatton showed significant improvement in early yield and quality (R. Reynolds, pers.com.).

A Rainsaver® water crystal evaluation trial was established on a pickling cucumber crop at Griffith, NSW. The cucumber crop was grown on raised beds that were 1.8 metres wide and watered with a single buried drip irrigation line. The soil was a clay loam, and the cucumber crop was direct seeded with a precision seeder to give a final plant density of about 200,000 plants per hectare.

4.2 METHODS

The Rainsaver® crystals were spread by hand at a rate of $10g/m^2$ and rotary hoed in immediately after application. The crystals were spread and incorporated on the 1/11/95. The crop was sown on the 3/11/95 and harvested on 8/1/96. The trial design was a split plot design (nine replicates of each treatment) with half the plot receiving the crystals and the other half kept as a control. After emergence a harvest area of 5 metres was pegged out for yield assessments. Yields were assessed from a once over hand pick to simulate mechanical harvesting. The fruit from each plot was graded and fruit number and weight recorded for each grade.

4.3 RESULTS

Table 4.1 shows the mean number of marketable fruit harvested from each treatment. There were no significant differences for any grade, however, the Rainsaver® treated plots had slightly higher numbers of larger fruit (slicing and O/S grades) than the control plots. The fruit weight (Table 4.2) followed exactly the same trend with no statistically significant difference between the treated and the control plots.

The number (Table 4.3) and weight (Table 4.4) of deformed fruit from the Rainsaver® treatment was slightly lower than the control plots, but once again the differences were not significant.

Table 4.1

MARKETABLE FRUIT NUMBER (per 5m Plot)					
GRADE	20/40	10/15	SLICING	O/S	TOTAL
CONTROL	23	33.5	125.5	7	189
RAINSAVER	23	33	131	13	200
LSD $_{0.05}$	9.5	12.5	20.5	11.5	20.5

There was no significant differences in fruit number for any grade.

Table 4.2

MARKETABLE FRUIT WEIGHT (kg / 5m Plot)					
GRADE	20/40	10/15	SLICING	O/S	TOTAL
CONTROL	.581	2.22	20.95	2.28	26.03
RAINSAVER	.625	2.21	21.95	3.78	28.57
LSD $_{0.05}$	.475	0.96	2.98	3.52	3.45

There was no significant differences in fruit weight for any grade.

Table 4.3

DEFORMED FRUIT NUMBER (per 5m plot)			
GRADE	10/15	SLICING	TOTAL
CONTROL	12.2	11.1	23.4
RAINSAVER	7.8	9.5	17.2
LSD $_{0.05}$	8.1	10.2	14.0

Rainsaver® water crystals had no significant effect on the number of deformed fruit in any grade.

Table 4.4

DEFORMED FRUIT WEIGHT (kg / 5m plot)			
GRADE	10/15	SLICING	TOTAL
CONTROL	.610	.984	1.594
RAINSAVER	.362	.944	1.307
LSD $_{0.05}$	.359	.911	.921

There was no significant effect of Rainsaver® water crystals on the weight of deformed fruit.

4.4 CONCLUSIONS

In this trial applying Rainsaver® crystals at a rate of 10 grams per square metre had no significant effect on either yield or quality of the pickling cucumber crop. This crop was very well grown and at no time did the plants suffer from water stress. The climate was unusually mild for this time of the year which favoured vine growth and fruit production, resulting in a very high yielding crop. The commercially usable yield from the control plots was 28 tonnes per hectare, about 8 tonnes per hectare above an average crop. The buried drip irrigation system permitted frequent watering and fertigation is a standard management practise. The soil type, a clay loam with good water holding capacity, may also have diminished the expected effect of the Rainsaver® water crystals.

It would appear that Rainsaver® has no significant role to play in this short season crop that is grown using the latest technology for irrigation and fertigation.

5 GROWING PICKLING CUCUMBERS FOR MECHANICAL HARVESTING.

5.1 INTRODUCTION

Pickling cucumbers are commonly, although incorrectly, called gherkins. The term gherkin strictly belongs to the prickly or West Indian cucumber (*Cucumis anguria* L.), however most western cultures have adopted gherkin to mean the small immature fruit from cucumbers (*C. sativus* L.).

The consumption of pickling cucumbers in Australia is rapidly increasing, but is still far behind that of other countries. In the U.S. the consumption of processed cucumbers per capita ranks second behind processed tomatoes (Nonnecke 1989). In Australia the industry is increasing in line with the rapidly expanding hamburger chains that use pickled cucumber products in their hamburgers and sauces. There also exists potential export markets in New Zealand and South East Asia. The industry in Australia is largely situated in the Murrumbidgee Irrigation Area with some off season production in the Burdekin (central eastern Queensland). There is also some small areas of production in Victoria and South Australia.

Pickling cucumbers are an intensive crop that require accurate timing of farming operations to achieve maximum yield. Good pre-season planning is essential to ensure that the farming operations run as smoothly as possible during the season.

The high cost and unreliability of harvest labour means that mechanical harvesting is the only real option for large scale production in Australia. Mechanical harvesting is a once over operation so the size distribution of the fruit and the total yield are critical to the producers profit. In order to maximise yields and profit the crop needs to be grown with high densities and good husbandry to ensure a concentrated fruit set at harvest. A well grown crop will have over 60% of the fruit in the slicing grade (32-50mm diameter).

5.2 SITE SELECTION

Pickling cucumbers require a well structured, fertile soil that is high in organic matter. To produce optimum yields well drained clay loam or loam textured soils with a pH of 6.0 to 7.0 are best suited. Acid soils below 5.5 should be avoided.

Soil samples should be taken when selecting the site to establish the status of the major elements and soil pH. This pre-season sampling will aid in determining fertiliser strategies. Maintaining records of soil test results for individual paddocks will enable the grower to make more informed decisions based on past crop performances. Table 5.1 shows the level of the major nutrients required for optimum cucumber growth. The requirement of nitrogen and some micro-nutrients are difficult to forecast from soil tests and are best assessed from local knowledge and by tissue or petiole sap analyses taken from the young crop.

Table 5.1

SOIL NUTRIENT TESTS FOR OPTIMUM CUCUMBER GROWTH

Nutrient	Mean	Max.	Min.	
P mg/kg	229	294	180	(Measured by Mehlich, 1 test)
K mg/kg	103	148	64	
Ca mg/kg	824	1168	554	
Mg mg/kg	57	102	29	
pH	6.2	7.0	5.4	(20ml soil : 25ml H_2O)

Adapted from Evanylo G.K (1990).

Site selection should take place early enough to allow ample time for bed preparation and irrigation instillation. Where buried drip irrigation is to be used, installation needs to be completed well before the start of the season. This will allow time to test the system and let the soil settle along the drip installation line before final seed bed preparation. If furrow irrigation is to be used, beds and furrows should be formed in the preceding Autumn. Some settling of the beds and furrows will take place over winter and bumps and hollows need to be smoothed out prior to sowing.

Cucumbers are very sensitive to herbicides so site selection must be done with care to avoid any residuals, such as atrazine, from previous crops. Sites that are known to be infested with troublesome summer broadleaf weeds should also be avoided or, where this is not possible, should be fumigated before sowing.

5.3 CULTIVARS

Cultivars will vary from year to year as new cultivars are released by seed companies. The ideal cultivar will have a broad spectrum of disease resistance, be high yielding with a concentrated fruit set and have relatively compact vines. The fruit should be cylindrical with blocky ends and a dark green skin colour. The skin should be thick enough to prevent damage during harvest, but thin enough to permit the penetration of brine during processing. The flesh should be firm and not bleed (seep moisture) when sliced or diced. Uniform skin colour is highly desirable. Internal fruit structure is very important especially for sliced or diced products. Superior cultivars have relatively strong carpel sutures which prevents carpel separation when the fruit is sliced. They also have a small seed cavity and slow developing seeds.

The Length:Diameter (L:D) ratio is not so important with a sliced or diced end product, however, shorter fruit will have more waste when the ends are removed. L:D ratios will vary from location to location and with growing conditions. Good growing conditions tend to increase ratios and poor growing conditions tend to decrease ratios. The preferred ratio will depend on the end product. If the cucumbers are to be bottled for sale as gherkins an L:D ratio of 3:1 is preferred. If the cucumbers are to be used for slicing a larger ratio (longer fruit) will give less wastage in the factory.

Most cucumbers currently being used for commercial production are hybrids. Hybrids have the advantage over open pollinated lines in that they have a more concentrated fruit set and generally have resistance to a wider range of diseases. Pickling cucumbers can be divided into different types by their flowering habit.
Predominantly female (P.F.) varieties, which are sometimes incorrectly called gynoecious hybrids, are the most common type used for mechanical harvesting. A true gynoecious line will produce only female flowers, whereas most commercial cultivars grown in the field will usually produce some male flowers. A pollinator (a variety that produces mostly male flowers) is often included with most P.F. commercial lines to ensure that there is enough pollen for fertilisation.

Parthenocarpic cultivars do not need to be pollinated to produce fruit. The use of parthenocarpic cultivars by commercial growers is still very restricted because of the major fruit quality problems that still need to be addressed. The fruit tends to be soft, especially the pericarp (seed cavity) which gives a poor diced or sliced product after fermentation. The fruit skin tends to turn yellow in the larger sized fruit and the plants usually have poor disease resistance. Many of these problems also existed in P.F. cultivars when they were first released, but breeding and selections have overcome them. The same trend is evident with parthenocarpic cultivars, but they still have some way to go before they reach an acceptable commercial standard.

5.4 SEX EXPRESSION

All very young flower buds on a cucumber plant have the ability to develop into either a male or female flower. When the buds are very small (1-2mm) they contain both stamen (male) and pistil (female) primordia. Environmental conditions and the genetic makeup of the plant will determine whether these buds develop into male or female flowers. In general any environmental conditions that stress the plant or slow down its' growth will cause a shift towards male flowers (Cantliffe 1974). Conditions that favour male flower production include water stress (both too little and too much), high temperatures, high light intensities and long days.

The sex of the flowers produced on the first six to seven nodes is determined in the very young seedling at about the two true leaf stage

(Asgrow 1990). Environmental conditions just before flowering do not influence the sex of flowers whose buds have already formed.

Although certain environmental conditions will encourage a shift to male flowering, not all cucumber cultivars will respond in the same way or to the same extent. Some cultivars have a more stable female sex expression and will be effected to a lesser degree by adverse conditions.

While it is obviously preferable for the plants to produce female flowers some male flowers are still essential for pollination. It is only when the male flowering becomes excessive that growers need be concerned. If this occurs the grower needs to check that the crop wasn't stressed early in its' development (two leaf stage). If no stress occurred, either through management or climatic conditions, the grower may need to change cultivars to a more sex stable variety.

Pickling cucumbers sown at high densities for once over harvest on average will only produce about 1.25 fruit per plant. A very few plants may produce three or even four fruit, but most will produce only one. Even parthenocarpic cultivars will average less than two fruit per plant at high densities.

5.5 SEED BED PREPARATION

Seed bed preparation needs to begin at least two weeks before the scheduled planting date. There is two main methods used for seed bed preparation, and both use the assumption that beds and furrows have been pre-formed and allowed to settle over winter, or that permanent beds are used for a number of consecutive seasons.

5.5.1 Conventional

Conventional seed bed preparation requires that weeds, or a green manure crop (see section on green manure crops) are incorporated into the soil about two weeks before sowing. This incorporation is usually done with a rotary hoe or offset discs. The rotary hoe creates a fine tilth which is ideal for sowing into, but must only be used when the soil moisture is relatively low. Using a rotary hoe in damp soil will cause soil compaction and create a smear layer at the bottom of the cultivation zone. This will result in restricted root growth and poor water penetration. A fine smooth seed bed is essential to achieve an even germination. The tops of the beds need to be smooth and flat so the seeds are sown at an even depth and to aid mechanical harvesting. The field is then pre-irrigated to germinate weeds, which are sprayed off with a contact herbicide just before or immediately following sowing. Alternatively a blade plough used instead of herbicides. Blade ploughs are designed to cut the weeds off just below the soil with very little disturbance to the surface.

5.5.2 Minimum Till

Alternatively minimum till seed bed preparation can be used. The pre-formed beds are left untouched until about two weeks before sowing. The site is sprayed with a contact herbicide to kill weeds and seeding is done directly into the stubble with minimum disruption to the soil. Minimum till seed bed preparation is only suited to permanent beds and is especially applicable for the second crop in a season. After the first crop is harvested the beds can be resown with little or no cultivation. This increases the turn around time and can bring the harvest of the second crop forward which reduces the risk of frost damage at the end of the season. Minimum till practices require specialised sowing equipment that can handle working in crop trash without blocking up. If minimum tillage is to be used for the second cucumber crop in a field, the remnants of the previous crop need to be mulched to prevent the long cucumber runners from blocking up the seeder.

At all times when preparing seed beds avoid over cultivation and cultivating when the soil is wet. This causes compaction and subsequent problems with water penetration and seedling emergence. Only use rotary hoes when absolutely necessary. Rotary hoes tend to destroy soil structure.

Both these seed bed preparation methods aim to reduce the weed seed population. Chemical weed control in cucumbers is poor, except for grasses, so good husbandry is essential to reduce competition and subsequent yield losses due to weeds. On sites where there is known to be a heavy infestation of troublesome broadleaf weeds, soil fumigation with methan sodium may be required to reduce weed numbers to a manageable level. Soil fumigation is expensive, can give variable results, and requires a lag time of about two weeks, to allow the fumigant to dissipate, before the crop can be safely sown. This lag time can vary depending on soil type and climatic conditions so it is a good safety precaution to do a trial germination test in the treated soil before sowing. Wherever possible these weedy sites should be avoided or included in a crop rotation so that selective herbicides can be used to reduce the weed seed population.

5.6 SOWING

Once the starter fertiliser has been banded and a good fine seed bed prepared, the site is ready for sowing. Cucumbers require a soil temperature of at least 15°C for germination. When planning earliest sowing dates, historical weather records, that include soil temperatures, and past experience will give a good indication of when sowing can commence. Monitoring soil temperatures on the proposed site will allow the grower to fine tune his first sowing date and take account of seasonal fluctuations.

When planning a sowing schedule it is important to consider the maximum area that can be harvested in one day. Because cucumbers expand so rapidly, the yield of commercially saleable fruit is heavily reliant on timely harvest. If harvest is delayed, for any reason, yield will be lost to over sized fruit. Where the sowing schedule is disrupted during the season, either from wet weather or some other influence, the grower must not loose sight of his harvest capacity when trying to catch up and get back on schedule. It is better to catch up over a longer period and perhaps even reduce the planned planting area than to sow an area that is too large to handle at harvest. One strategy that may help to overcome a disruption in planting schedule is to reduce the sowing density. A less dense crop will mature faster than a dense crop. This means that two fields sown on the same day at different densities will be ready for harvest on different days.

A firm seed bed on flat uniform beds is essential to obtain good seedling emergence. Precision seeding is critical with cucumbers if high yields are to be obtained. Precision placement of seeds within the row reduces seed costs and eliminates the need for later thinning. Depth of sowing, must also be uniform to achieve an even emergence and subsequent uniformity of maturity at harvest-time. This is particularly important for mechanically harvested crops. Cucumbers are usually sown between 1.5cm and 2.5cm deep depending on soil type and conditions.

Seed spacing depends on cultivar, cultural and environmental conditions and harvest method. Hand picked crops are usually sown at 18,000 to 71,000 plants/ha with in-row spacings of 15-30cm and about 100cm between rows. Once over mechanical harvest crops are sown much more densely. Plant populations between 150,000 and 450,000 plants per hectare, will give good yields. To achieve these populations plant spacings with 7cm to 15cm within rows and 25cm to 60cm between rows need to be achieved. Cucumber seed counts average about 35,200 per kilo, so sowing rates for a mechanically harvested crop will be between 4.3 and 12.8kg/ha.

5.7 WEED CONTROL

Chemical weed control in cucumber crops is virtually limited to grasses. Chemicals that are registered for cucumber crops generally give very poor control of broad leaf weeds and run the risk of damaging the crop and some broad spectrum herbicides will cause excessive numbers of male flowers. This means that mechanical methods are the only reliable way to control most broad leaf weeds.

Weed control should begin long before the crop is sown. Where continuous cropping of the same land is practised weed control should begin at the end of the previous season. Once the last crop is harvested the land should be irrigated to germinate as many weed seeds as possible. These weeds should then be killed off with a contact herbicide before they can produce seeds. A green manure crop can then be sown which will help suppress weed growth during the winter and add valuable organic matter to the soil.

The process of irrigating to germinate weeds and spraying off is repeated in the spring just prior to sowing. Once the irrigation and knockdown is carried out prior to sowing avoid disturbing the soil surface again as this will only encourage another flush of weeds to germinate. Shallow cultivation between rows may be needed just prior to the crop producing runners. Once the crop has covered the soil shading will prevent most weeds from becoming a problem. Good farm hygiene where headlands and crop surrounds are kept free of weeds will also help prevent troublesome weeds making in-roads into the crop. A sound rotation program that includes alternative crops, where selective herbicides can be used, will help stop the build up of troublesome weeds.

In a farming system where there is a high capital investment in an irrigation system, such a buried drip, that can't easily be moved the grower must maintain a high regular return from the system to justify the capital out lay. In these systems it is uneconomic to leave the ground fallow and unless a high value alternative crop is available the grower will be forced to continuously mono-crop that land for the life of the irrigation system. Although not ideal this system will succeed for a number of years provided sound management practices are followed, and soil born diseases can be kept at bay.

5.8 PESTS AND DISEASES

Cucumbers are susceptible to a number of diseases, however, resistant cultivars are now available for many of the more common fungal diseases and breeders are continuously attempting to add further resistance to new lines.

Downy mildew, a fungal disease that grows rapidly under warm moist conditions, will quickly spread through a susceptible crop. In inland areas downy mildew is usually only a problem in wet years. Infected plants show small yellow spots on the leaves which are angular and limited by the small veins. A faint purple spore growth develops on the lower surface. Infected leaves die and in severe cases the plants will be defoliated. Low humidity, high temperatures and a lack of water on the leaves will prevent its' growth. Chemical control requires frequent applications when moist conditions from rain or heavy dews prevail. Resistant cultivars are available.

Powdery mildew is usually only a problem late in the season when the temperatures are milder and dews start to form. The infection begins as small pale yellow spots on the stems, petioles and leaves. These spots spread and become covered with white spores which gives it a powdery appearance. Resistant cucumber varieties are available, however, some so called resistant cultivars are only tolerant and under severe disease pressure will suffer some defoliation. This leaves the fruit exposed to the sun and makes it difficult to harvest with machines.

Angular leaf spot is another fungal disease that can become a problem in susceptible cultivars. The first symptoms appear as small water soaked lesions on the under side of leaves. These small angular spots turn brown and eventually the centre falls out giving the leaf a shot gun appearance. The disease can be spread on seed and can survive in the soil for up to two years. Resistant cultivars are available.

For further information on diseases and their control see "Australian vegetable Growing Handbook" published by IREC, CSIRO Griffith (1991).

Pumpkin beetles (*Aulacophora spp.*) feed on leaves, flowers and young fruit and can quickly defoliate young seedlings. They are yellow to orange, about 6mm long and either have four black spots on their back (*A. hilaris*) or are a solid orange colour (*A. abdominalis*). Pumpkin beetles prefer warm dry climates and can be most prevalent after wet or windy weather. Control is most important on young crops. Once the cucumbers begin to run they can usually out grow the damage. Spray young crops with recommended chemicals.

Twenty eight spotted ladybirds (*Epilachna cucurbitae*) have a round to oval shaped body, about 6mm long and are a dull yellow-orange colour with 24-28 black spots on the wings. The larvae are also about 6mm long, yellow with many branched black spines giving them a hairy appearance. The larvae feed on the undersides of the leaves, while the beetles feed on the uppersides. Both the larvae and the beetles feed only on the inter veinal tissue leaving the leaf with a skeletonised appearance. Control is similar to pumpkin beetles.

Aphids are small soft bodied sap sucking insects about 1.5 to 3.0mm long. They can be winged or wingless and green or powdery blue to black. The two species most common on cucumbers are the melon aphid (*Aphis gossypii*) and the green peach aphid (*Myzus persicae*). They usually feed on the undersides of leaves and young petioles. Their numbers can increase very rapidly. In inland areas they are more often a problem during autumn, but can also be prevalent in spring. Spray with recommended chemicals for control.

Cutworm caterpillars (*Agrotis spp.*) are plump soft-skinned caterpillars that cut through the stem of young seedlings at ground level. They usually feed at night and hide in the soil close to the damaged plants during the day. The mature caterpillars are brown, grey or black, 25-45mm long and curl into a tight spiral when disturbed. In severe infestations they can significantly reduce plant stands. To control cutworms apply a band of insecticide over the young seedlings late in the afternoon.

Wireworms chew into germinating seeds and stems and roots of young seedlings. The larvae are 1-4cms long with a hard smooth body. They have pale brown bodies with dark brown heads. Severe infestations can significantly reduce seedling establishment. Unlike cutworms, wireworms feed under ground making chemical control difficult. Larvae populations can be reduced by clean cultivation and simmer fallow to remove their food source.

Thrips are tiny (1.5mm) slender winged insects. They are usually greyish brown and can quickly invade crops from surrounding vegetation. The nymphs congregate after hatching and feed on sap from the flowers or leaves. Feeding on the flowers can disrupt pollination, fruit set and fruit formation. Control is by recommended chemicals.

For further information on insect pests and their control see Agfact number H8.AE.9, "Pests of cucurbit vegetables" (1987), published by NSW Agriculture, and the "Australian Vegetable Growing Handbook" (1991), published by IREC,C/- CSIRO, Private Mail Bag, Griffith NSW.

5.9 NUTRITION

It is difficult to recommend a fertiliser practice for cucumber production that has universal application. Specific nutrients and amounts will vary with soil type and natural fertility level. However, there are some principles that apply to most cropping situations. Research over the past 50 years has consistently shown that cucumbers benefit from generous amounts of organic matter in the soil. This can be achieved by applying 20-35 t/ha of manure or by incorporating similar amounts of a green manure crop.

Before the cucumber crop is sown a starter fertiliser needs to be banded below and/or just to the side of the seed row. The composition of this starter fertiliser can best be determined by soil analysis. All starter fertilisers will have nitrogen and phosphorus and most will also contain some potassium. Even in highly fertile soils a starter fertiliser is recommended to give the young seedlings an early boost. Some soils may return an analysis that is high in phosphorus but most of the phosphorus will be fixed and not readily available for uptake by the crop. In areas where soil tests show there is ample phosphorus in the soil a maintenance application of 20-40kg P/ha is still required. This helps maintain the fertility of the soil and prevents nutrient mining by successive crops. Banding phosphorus below the seed line retards it's fixation and increases it's availability to the young seedlings. This is particularly important under cool soil conditions, such as early season crops, when cucumbers show little uptake of phosphorus. Uptake is also increased in the presence of nitrogen.

Nitrogen is an essential part of a starter fertiliser and is required by plants to produce chlorophyll and to convert amino acids into protein. Nitrogen is highly mobile in the soil and is easily leached. If chicken manure has been incorporated, a reduced rate (about 50%) of starter can be used, but some starter is still necessary to give maximum yields.

Apart from the initial application of nitrogen in the starter, most crops will require further nitrogen applications during the season. Drip irrigated crops can be fertigated (fertiliser applied with the irrigation water) in frequent small doses through the irrigation system. Furrow irrigated crops will require a side dressing just before the vines start to run . Two applications of Nitrogen is enough for this short season crop on most soil types.

Nitrogen levels should be allowed to decline as the crop approaches maturity. No nitrogen should be applied in the two weeks before harvest. Excessive amounts of nitrogen can reduce yields, delay harvest, produce long rangy soft plants and can affect fruit quality. Nitrogen levels in the crop can be monitored throughout the season by petiole sap tests. As a general rule, for a machine harvested pickling cucumber crop, apply between 60 and 100kg N/ha.

Table 5.2 RECOMMENDED LEAF TISSUE NUTRIENT LEVELS FOR PICKLING CUCUMBERS AT EARLY BLOOM

N %	2.7 - 4.4
P %	0.3 - 0.7
K %	2.5 - 5.0
S %	0.3 - 0.7
Ca %	2.5 - 5.0
Mg %	0.4 - 1.0
Na %	0.0 - 0.2
Cl %	0.0 - 0.8
Zn mg/kg	30 - 80
Cu mg/kg	7 - 15
Mn mg/kg	60 - 240
Fe mg/kg	50 - 200
B mg/kg	45 - 115
Mo mg/kg	0.6 - 1.7

Potassium if required is can be applied as a side dressing just before the vines produce runners or as a foliar spray or through the drip system. Cucumbers have an increased demand for potassium during the fruit expansion stage, so potassium fertiliser should be applied as close to this growth phase as possible. Soils that are naturally high in potassium rarely show any response to additional potassium.

Trace elements are rarely a problem with cucumbers, but where they are detected can usually be remedied through foliar fertilisers. Leaf tissue or petiole (leaf stalk) sap analyses will quickly pin point any deficiency that was not evident from soil analysis. Zinc deficiencies may occur on some naturally alkaline soils in inland areas, while on many acid coastal soils Molybdenum (Mo) may be deficient. On soils where Zinc is known to be deficient (soil analysis can determine Zn status) the problem can be corrected by applying 3-10kg Zn/ha with the starter fertiliser. This single application should remedy the problem for a few seasons. Similarly Mo can also be incorporated with the starter fertiliser at a rate of about 350g Mo/ha.

Table 5.3 RECOMMENDED PETIOLE SAP NUTRIENT LEVELS FOR PICKLING CUCUMBERS

GROWTH STAGE	YOUNG PLANT	FRUIT SET	HARVEST
NITRATE ppm	4000-5000	35000-4500	1500-2500
PHOSPHATE ppm	50-150	60-150	50-150
POTASSIUM ppm	4000-5000	45000-5500	3800-4500
CALCIUM ppm	300-400	300-400	300-500
MAGNESIUM ppm	250-450	300-450	300-500
ZINC ppm	2.0-5.0	2.5-5.0	2.5-5.0
COPPER ppm	1.5-7.0	1.5-7.0	1.5-7.0
MANGANESE PPM	1.0-5.0	1.0-5.0	1.0-5.0
IRON PPM	2.0-10.0	2.0-10.0	2.0-10.0
BORON ppm	3.0-15.0	3.0-15.0	3.0-15.0

Adapted from: Hall J. (1993).

It is important to closely monitor cucumber crops for early signs of nutrient deficiencies. The earlier a problem is detected and corrected the less will be its effect on the final yield. It is a good idea to have petiole sap tests or leaf tissue analyses done at first flowering or earlier if symptoms appear. When collecting leaf or petiole samples for nutrient analyses use the youngest fully expanded leaf, usually the fifth or sixth leaf back from the growing tip. Collect 50 petioles randomly throughout the crop, remove the leaf blade, and send over night in a plastic bag for analysis. Table 5.2 and 5.3 show the optimum range of nutrients for leaf tissue and petiole sap analyses respectively.

Salinity levels over 3ms cm^{-1} will markedly reduce dry matter accumulation and yield. High salinity also reduces Calcium uptake in cucumbers. Soil analyses will indicate wether salinity will be a problem.

5.9 GREEN MANURE CROPS

A green manure crop is a crop grown for no other reason than for turning into the soil while still green to improve soil conditions.

Green manure crops will improve soil structure, and water penetration by preventing surface sealing and assisting to break up plough pans. They add organic material to the soil and can help prevent wind and water erosion. They also capture residual fertiliser from the previous crop and recycle them. As the green manure crop breaks down, major and minor nutrients become available to the next crop. They assist in the control of weeds, and help destroy disease organisms in crop debris.

An undesirable effect from green manure crops is that they can lower soil temperatures in early spring. Reduced soil temperatures will delay the early sowings and may delay maturity. To over come this problem do not plant earliest fields to green manure crops, or, alternatively incorporate the manure crop well before the planned sowing date. Green manure crops should be incorporated at least 2 weeks before bed preparation. This interval will allow initiation of the breakdown of the manure crop roots and reduce the tendency for clod formation.

Because pickling cucumbers are a broadleaf crop the most suitable manure crops will be grasses or cereals such as oats, barley, ryegrass or ryecorn. If broadleaf species are preferred they should be incorporated well before sowing, pre-irrigated and sprayed off to kill any re-growth.

Grass manure crops tie up soil Nitrogen in the spring, and their residues have a slow decomposition rate during the summer. This means that Nitrogen rates may need to be increased. The nitrogen levels can be simply and quickly checked with petiole sap nitrate tests and adjusted accordingly. If a legume cover crop is used, Nitrogen rates can be reduced in the following crop.

5.10 IRRIGATION

Pickling cucumbers have a high water requirement so frequent supplemental irrigation is essential to prevent serious water stress. The requirement for cucumbers in dry climates has been estimated at between 1.5 to 2 megalitres per hectare (Asgrow). They have a relatively shallow root system and use most of their water from the top 20cm of the soil profile. From the onset of flowering until dry down for harvest the soil should be maintained as close to field capacity as possible

The soil profile can be allowed to dry down after the plants have reached the three to four leaf stage until just before flowering. Keeping the soil drier during this period forces the young seedlings to put down more extensive root systems as they chase the receding moisture. The larger root system that results from forcing the crop to seek out moisture allows the plant to capture more nutrients and sustains the crop during the dry down phase before harvest. Once the crop has become established irrigation scheduling becomes a balancing act between maintaining enough moisture to prevent water stress while avoiding over irrigating which will leach nutrients and, if water logged conditions exist for any length of time, result in root death. Tan *et al* (1983) found that letting the soil dry down to 25% available soil moisture between irrigations gave as good or better yields than if they were watered more frequently at 60% available soil moisture. Cucumbers are particularly sensitive to water stress from the onset of flowering through to dry down for harvest. If the crop is stressed during flowering bud drop will occur resulting in a split fruit set. If water stress occurs during fruiting deformed fruit will result which will reduce the economic yield.

Drip irrigation systems permit greater control over irrigation scheduling and if the system is buried it should be possible to maintain the root zone at field capacity without wetting the soil surface. Prolonged periods of wet soil promotes the development of fruit rotting diseases and raises the humidity under the leaf canopy which increases the risk of leaf diseases such as powdery and downy mildew. Keeping the soil surface dry will help prevent a second flush of weed seeds from germinating.

The last irrigation needs to be timed so that the plants do not wilt and the field will be dry enough to get heavy machinery on for harvest. This dry down phase will be easier to judge and have a much greater safety margin if the cucumbers have been forced to produce a larger root system through good irrigation practices.

Both drip and furrow irrigation systems are suitable for pickling cucumber production. Drip is preferred and in most cases will return a higher yield, but requires substantial capital outlay to set up. Furrow irrigation is only suitable on well structured soils with good water holding capacity. Overhead sprinklers are not recommended because they create favourable conditions for disease.

5.11 HARVEST

The timing of harvest for pickling cucumbers is critical. A delay of just a couple of days in harvest will result in yield being lost. A cucumber fruit takes about 4.5 days to expand from a diameter of 4cm to 5.5cm at 20° C (Marcelis and Hofman-Eijer 1993). This rate of expansion will be faster at higher temperatures. Harvest timing is even more critical with a densely planted crop. A crop with very high plant numbers reaches a yield peak and then quickly drops off as the fruit becomes oversized. A less dense crop reaches harvest stage faster, but the yield peak has a more gradual decline. Where sequential crops are being grown, the harvest capacity must be the overriding factor when planning sowing dates. **Never** sow more on a single day than can be realistically harvested on a single day.

Mechanical harvesting will return lower yields than multiple hand pick. The decision to mechanical harvest needs to be judged on economic factors which includes the cost, availability and reliability of harvest labour. Machines may also damage fruit leading to a high incidence of bloaters in the brine tanks. Bloaters are formed by the liberation and expansion of dissolved super-saturated gas that is contained in the cucumber tissue. Larger sized fruit is particularly susceptible to bloater damage and softening and at times can cause serious economic loss. Where machines are used for harvesting the respiration rate can be 20 per cent higher than hand picked fruit. Impacts and pressure during harvesting can cause serious damage to the cucumbers. A drop of less than one metre onto a hard surface can cause visible internal cracks and bruising, both of which increases bloating during fermentation. Every effort needs to be made to reduce the height and number of fruit drops. The sooner a machine harvested crop is graded and brined the better the processed quality will be.

5.12 BIBLIOGRAPHY

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