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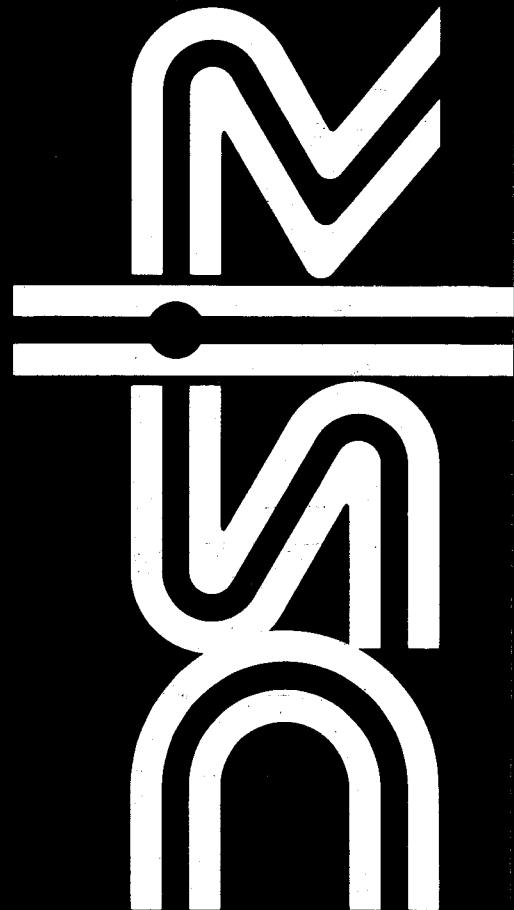
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by Asparagus: Effect
of Environmental
Factors on
Sensory Quality

A report prepared for the
New Zealand Asparagus Council

by Winna Harvey
& June 1992

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Making Science Work For New Zealand

Internal Report No. 76

Asparagus: Effect of Environmental Factors on Sensory Quality

A report prepared for the New Zealand
Asparagus Council

Winna Harvey

June 1992

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1 EXECUTIVE SUMMARY

Environmental conditions prior to harvest affect the quality of fresh asparagus spears. (see DSIR Internal Report No. 22, "Effect of cooling asparagus on off-flavour and tip-rot. A report on research conducted for the N.Z. Asparagus Research Council" W.J. Harvey *et al.*) In order to gain more information on these effects, asparagus was harvested over a six week period and environmental conditions, (air and soil temperature, rainfall, solar radiation, and soil moisture) were recorded.

The asparagus was assessed fresh (3 days from harvest), by a trained taste panel, and after storage (four weeks at 4-6°C) was visually assessed. Defects which showed up in the fresh and stored spears were compared with environmental factors prior to harvest.

A cool season did not produce the hot conditions desired for testing the effect of temperature extremes. However, cool, wet weather produced off-flavours and poor storage in spears picked on those days.

Further extensive statistical tests covering several years and cultivars showed the following correlations:

1. Cold temperatures and rain increased sweetness and off-flavour and decreased crispness.
2. Rain after hot weather increased crispness.
3. An increase in maximum temperatures and solar radiation increased off-flavours in some cultivars.

2 INTRODUCTION

Sensory studies carried out at DSIR Crop Research from 1989-90 on several cultivars of asparagus, indicated that the largest contributor to the variation in sensory and storage quality was the "day of picking" (DSIR Crop Research Food Report No. 7 "Fresh Asparagus Sensory Evaluation: Effect of cultivar and cooling on flavour and tip-rot development." W.J.Harvey et al). In earlier studies conducted at the Levin Horticultural Research Centre a general decline in asparagus quality has been observed as the season progresses.

In the above studies at DSIR during the 1989 season,(see "Report on Sensory Evaluation of Asparagus Cultivars" Oct-Nov. 1989, Winna J. Harvey et al) off-flavours were observed in several cultivars after periods of hot weather. In trials in 1990 where asparagus was shaded during the harvest season, some cultivars had less off-flavour.

Although it has been shown that environmental factors have an effect on the quality of fresh asparagus, the exact nature of this effect has been difficult to establish, particularly the contribution made by the natural progression of the season and that made by temperature and rainfall fluctuations.

This experiment was aimed at advancing our understanding of these effects. This would aid the industry to ensure that spears in which adverse physiological changes had occurred did not enter the export chain where only the best spears survive.

3 METHOD

Asparagus (cv Jersey Giant) was sampled once a week for six weeks, from trial plots at DSIR Crop Research, Lincoln, from 14 October until the 18 November, 1991. Recordings of air and soil temperatures and soil moisture were taken on the plot, and solar radiation and rainfall readings were recorded nearby.

At each harvest date 15 spears were washed, cooled in tap water and stored for three days in unsealed polythene bags at 4-6°C, and then tasted as fresh spears by a trained panel of 10 panellists. From the same harvest, five replications of 10 spears each were washed, cooled in tap water, cut to 18 cm and stored in micro-perforated bags at 4-6°C for four weeks. Spears were removed from storage, a gas sample taken from the bag for analysis, the bag opened and the spears examined for defects. Presence of tiprot and other defects were assessed in the spears 0,1,2,3, and 4 days at 15-20°C, after removal from cool storage.

4 RESULTS

4.1 Effect of environment on fresh asparagus sensory quality

Table 1 shows the rainfall, maximum temperature and solar radiation as well as the soil temperatures and moistures over the harvest period. This was another cool season (mean T_{max} was 17.3° C in 1991 compared with 17.6 °C in 1990 and 19.7°C in 1989)

Table 2 shows the mean scores for each flavour and texture attribute for each of the six weeks of harvest.

The most noticeable differences occurred in week five. Bitterness, flavour and crispness were very low, but sweetness and off-flavour were up. This off-flavour was described as compost-like, fermented or off, and was noticed by 8 out of nine tasters, but was not present in any other cultivars. (Other cultivars were being assessed as part of cultivar screening tests.) There was a heavy rainfall the day before which could have had an effect. There was also a heavy rainfall before week four's picking where off-flavours were also high. Crispness was also significantly lower at these two pick dates.

An extensive analysis to find correlations between off-flavour and environmental factors was performed. In this analysis off-flavour scores for Jersey Giant from three years' taste panel assessments were compared with,

maximum temperature, rainfall, minimum temperature, solar radiation and mean temperature

for the 24 hours prior to picking.

Off-flavour scores were also compared with the mean rainfall, max and min temperatures and solar radiation for the three days prior to picking but there were no significant correlations.

Correlations were also performed against mean off-flavour, sweetness and crispness scores for all cultivars tested in 1991 and against sweetness and crispness scores for J.Giant from the three years (1989-91).

There were few significant correlations but the following interrelations were found:

1. An increase in rain caused increased sweetness and higher maximum temps caused less sweet spears.

2. Crispness increased in 1991 as the minimum temp increased. This was also connected with rain as the spears were less crisp after rain. Rain and cold temperatures occurred together in 1991 whereas in other years (1989-90) rain came after hot dry weather where crispness was increased.
3. Off-flavour in J Giant was high with high rainfall in 1991. Some cultivars showed increased off-flavour with increased maximum temperature and solar radiation.

Asparagus tends to be sweeter after rain and cooler, shadier, weather. Cooler weather has occurred later in the season during the last two years and the asparagus has become sweeter. Crispness was strongly correlated with minimum temperature in 1991, increasing as minimum temperature increased. Low minimum temperatures occurred during periods of high rainfall, and resulted in the asparagus being less crisp. However in 1989 when there was very little rain, the asparagus was crisper after rain. This rain came with a min temp of 10°C whereas in 1991 the minimum temp during the rain was 3°C.

During 1991 off-flavour in some cultivars was positively correlated with maximum temperature and solar radiation for the day before picking.

4.2 Effect of environment on stored quality

Table 3 shows the mean percentage of spears without rots for each day out of cold storage.

Days 4 and 5 had the worst storage performance and were both picked after cold, wet spells of weather. Off-flavour was significantly worse (see table 2) for the fresh spears from these two harvests.

This indicates a relationship between off-flavour and storage performance as has been suggested in previous research.

None of the spears were really marketable after this long storage period (4 weeks). This period was chosen to tie in with previous research here and at Levin Horticultural Research Centre. However, 4 weeks is too severe and a shorter period may have shown the relationship between off-flavour and development of tiprot in storage more clearly.

Analysis of gases from the bag atmospheres surrounding the stored asparagus showed that there was modification of CO₂ and O₂ levels. The CO₂ level ranged from 2.1% to 4.9%, and the O₂ levels from 17.8% to 19.4%. However, this modification was only slight and at the low storage temperatures used would not have affected quality adversely. It was interesting to note that the highest modification occurred in the bags from weeks 4 and 5 which had the most rots.

5 CONCLUSIONS

From this research it appears that cold, wet conditions as well as hot, dry ones can adversely affect the quality of asparagus. UC157 did not have off-flavours under any conditions, whereas J Giant was adversely affected by the cold weather as was Mary Washington (see shade trials reported to Asparagus Council in 1990). Other cultivars have shown in other years that they are susceptible to hot conditions (Rutgers Beacon and certain crosses - see the same report 1990). It is possible that conditions which slow the normal growth of a spear, whether too hot or too cold, cause physiological damage. Conditions usually warm up as the season progresses so decrease in sugars and increase in off-flavours has been assumed to be related to the time of the season. However, this may not be the case as indicated by this research where off-flavours occurred in response to cold and rain in mid-season.

The J.Giant spears used in this trial stored worst when picked after heavy rain-fall. The spears tasted from these pick-days had the highest off-flavours compared with spears picked on other days. There appears to be a connection between off-flavour in fresh spears and the ability of spears to store well. Other cultivars however, did not show high off-flavour on these days. (see Table 4)

The relationship between environmental conditions and sensory quality of fresh asparagus is a complex one. The results reported above are specific to the cultivars tested and the particular conditions which occurred. More work is needed to establish a mathematical relationship.

Cultivars appear to respond differently which implies that one cultivar may perform well in one site but not in another.

6 ACKNOWLEDGEMENTS

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TABLE 1: Meteorological Details

DATE	RAINFALL	MIN TEMP	MAX TEMP	MEAN TEMP	SOLAR RAD	SOIL TEMP	SOIL MOIS
11.10	0.0	-0.6	13.60	7.1	21	10.7	20.5
12.10	0.4	4.5	19.6	12.1	23.4	13.2	
13.10	2.4	7.5	19.5	10.2	11.9	12.0	
14.10*	0.0	-0.2	15.9	8.8	21.0	11.4	19.1
15.10	0.0	4.6	24.4	14.4	13.5	12.1	
16.10	0.0	15.9	26.2	20	19.0	15.5	
17.10	1.4	17	24.2	19.7	8.9	15.8	
18.10	0.2	9.4	17.4	12.6	20.8	16.2	
19.10	0.0	5.5	19.1	12	16.6	14.4	
20.10	0.6	3.5	14.1	9.8	13.3	13.3	
21.10*	0.0	4.8	16.3	11.4	22.6	13.4	19.2
22.10	0.0	5.0	23.4	14.2	21.5	14.6	
23.10	1.2	7.6	24.8	15.3	22.8	16.1	
24.10	0.0	8.0	17.3	10.9	18.1	15.4	
25.10	0.0	5.8	17.1	11	25.8	14.9	
26.10	0.0	6.2	15.2	11.4	12.9	14.3	
27.10	0.0	10.2	19.6	14.9	16.3	15.2	
28.10*	0.0	12.3	22	13.8	11.2	14.9	
29.10	0.0	6.9	14.1	9.9	16.9	14.4	
30.10	0.0	-0.6	17	8.8	26.9	14.8	19.0
31.10	0.0	4.0	16.4	11.6	25.6	15.1	
1.11	5.4	9.4	25.8	16	22.9	16.6	
2.11	26.2	10.6	10.8	10.1	4.5	14.0	
3.11	5.2	7.0	9.4	8.1	11.2	11.2	
4.11*	1.0	5.9	13.0	8.5	21.4	11.5	27.4
5.11	0.0	0.7	12.7	7.6	16.8	10.6	
6.11	0.0	5.7	16.3	10.9	25.5	13.2	
7.11	0.0	9.6	16.4	11.9	16.8	14.2	
8.11	0.0	5.5	19.1	12.3	21.7	15.0	
9.11	0.0	6.3	20.0	13.3	24.1	15.7	
10.11	11.4	3.3	17.3	10.6	21.1	14.0	
11.11*	3.9	6.8	16.7	11	22.4	14.4	23.2
12.11	1.2	4.5	16.1	10.9	27.4	13.9	

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DATE	RAINFALL	MIN TEMP	MAX TEMP	MEAN TEMP	SOLAR RAD	SOIL TEMP	SOIL MOIS
13.11	1.0	7.5	17.5	12	28.9	13.5	22.4
14.11	1.0	3.1	15.5	10.3	26.0	13.0	
15.11	0.0	6.5	14.9	11	26.1	14.6	22.4
16.11	0.0	5.3	18.2	11.9	29.0	16.4	
17.11	0.0	9.8	21.7	14.4	26.7	17.2	
18.11*	0.0	11.3	17.5	13.6	24.2	17.6	
19.11	0.0	9.4	20.9	12.6	17.5	16.6	21.2
20.11	0.0	5.9	20.0	12.6	18.3	14.9	

For the above table:

* = Days asparagus was picked for this experiment

Temperatures are in °C

Rainfall is in mm

Solar Radiation is in MJ/m²

TABLE 2: Mean Scores for sensory attributes for each pick day.

Pick day	sweet	bitter	flavour	off-fl	soft/ crisp	stringy
1. 14/10	524	481	670	224	945	481
2. 21/10	588	489	677	86	937	477
3. 28/10	738	439	669	186	703	597
4. 4/11	706	419	719	319	636	525
5. 11/11	742	269	562	383	463	534
6. 18/11	529	429	691	185	807	556
Overall	638	421	664	230	749	528
LSD(5%)	72	71	66	73	71	73
LSD(1%)	95	93	87	96	94	96

All attributes were scored by panellists using a rating line (150 mm long). Panellists make a mark on the line to rate each characteristic and the distance from the zero point at the left end of the scale to the mark is measured. Scores for each attribute range from 0 for absence of the characteristic to 1500 for extreme strength in that characteristic. Asparagus is expected to be around 750 for sweetness, flavour, crispness and fibrousness, 400 for bitterness, and 0 for off-flavour.

TABLE 3: Mean Percentage of spears without rots for each day out of cold storage.

Pick day	0 hours	24 hours	48 hours	72 hours
1. 14/10/91	86%	66%	14%	5%
2. 21/10/91	52%	32%	26%	14%
3. 28/10/91	70%	56%	34%	10%
4. 4/11/91	34%	0%	0%	0%
5. 11/11/91	30%	0%	0%	0%
6. 18/11/91	64%	24%	2%	0%
7. 25/11/91	56%	26%	0%	0%

TABLE 4: Off-Flavour scores for each cultivar and controls for each pick day.

CULTIVARS	PICK DAYS						mean
	1. 14/10	2. 21/10	3. 28/10	4. 4/11	5. 11/11	6. 18/11	
CV 1	35	496	202	13	102	127	162
CV 2	140	46	153	38	79	199	109
CV 3	122	125	169	267	79	386	191
CV 4	35	158	81	233	90	117	119
CV 5	40	77	29	172	134	157	102
CV 6	112	90	34	132	95	193	110
CV 7	155	196	42	147	103	63	118
J.Giant*	117	102	361	207	221	230	206
UC157	48	43	70	83	37	122	67
J.Giant (Environ)	224	86	186	319	383	185	230
LSD(5%)	179.5						73.3

J.Giant* and UC157 were controls grown with new cultivars 1-7.
 J.Giant(Environ) are the spears used specifically for this experiment.