FINAL REPORT

Improved management of pumpkin nutrition in north Queensland (VG215) 1992-1995

Queensland Department of Primary Industries, Mareeba, 1996

HORTICULTURAL RESEARCH & DEVELOPMENT CORPORATION
The Research Arm of the Australian Horticultural Industries

Queensland Fruit & Vegetable Growers

Improved management of pumpkin nutrition in north Queensland (VG215)

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Summary

Field experiments in north Queensland examined the response of Jarrahdale pumpkins to rates of nitrogen and potassium. The research program provides a sound basis for modifying by soil and sap analysis the current nitrogen fertiliser recommendations. Maximum yield of pumpkins was obtained with rates of nitrogen between 0 and 120 kg/ha. Soil nitrogen concentrations at planting influenced the extent of the yield response to fertiliser nitrogen and should now be considered when planning fertiliser programs. Sap nitrate concentrations reflected the nitrogen supply from the soil and applied fertiliser. A guide to the nitrogen status of pumpkin plants based on sap nitrate was developed. The range for optimum sap nitrate concentrations was 2700 to 3700 mg/L between first vine and first flower. The proposed use of soil tests before planting and sap analysis during early crop growth will allow crops to be grown in some cases with reduced nitrogen inputs, a change that will reduce off-site movement of nitrogen and an improved, 'green' image for this industry. An evaluation of post harvest quality was conducted on fruit from one site in 1995. Unfortunately, the variable yield from this non-responsive site restricted the usefulness of this data but it did show that high rates of nitrogen did not affect the quality and consumer acceptance of cooked pumpkin.

Introduction

In Queensland, there has been no detailed research into the nutritonal requirements of pumpkins. As a result, there is a wide range of fertiliser rates and forms used in pumpkin production. In the Mareeba-Dimbulah area, there has been a history of high fertiliser use in the tobacco industry and this fertiliser approach appears to have been adopted by many pumpkin growers. Fertiliser recommendations vary considerably in Queensland. Rates (kg/ha) of nitrogen (N) and potassium (K) respectively, are 0 - 100 and 0 - 75 kg in the Lockyer, 150 and 60 in the Burdekin, and 80 and 75 in the Mareeba area.

Diagnostic criteria for nutrient concentrations in soils and plants for pumpkins are very limited and this restricts the ability of growers to tailor fertiliser applications to crop demand.

Methods

Trial sites were established in the Mareeba and Ayr irrigation areas. Mareeba sites were established on Southedge Research Station in 1992 and 1993 and on commercial farms in 1993 and 1995. Ayr sites were located on Ayr Research Station in all years. Plots were set out as a factorial in a randomised complete block design. Treatments details were:

Site	*Location/ Planting date*	*Design*	*N rates (kg/ha)*	*N timing*	*K rates (kg/ha)*
1	Ayr 1992 11 May	N x K x 2 reps	0, 60, 120, 180, 240	basal	0, 30, 60
2	Mareeba SRS 1992 8 May	N x K x 2 reps	0, 60, 120, 180, 240	basal	0, 30, 60
3	Ayr 1993 20 May	N rates x N timing x K x 2 reps	0, 60, 120, 180, 240	basal or split	0, 60
4	Mareeba 1993 V. Mete 14 May	N rates x N timing x K rates x 2 reps	0, 60, 120, 180, 240	basal or split	60, 120
5	Mareeba SRS 1993 24 May	N rates x N timing x K rates x 2 reps	0, 60, 120, 180, 240	basal or split	60, 120
6	Ayr 1994 29April	N x K x 3 reps	0, 80, 160, 240	basal	0, 60
7	Ayr 1995 6 July	N x K x 3 reps	0, 80, 160, 240	basal	0, 60
8	Mareeba 1995 R. Palmieri 29 July	N rate x N timing x 3 reps	0, 60, 120, 180, 240	basal or split	120 basal

Nitrogen treatments were applied as urea for pre-plant applications and watered in shortly after application by hand and as ammonium nitrate for split applications, applied 1 month after planting. Potassium treatments were applied to the soil before planting.

Non-treatment nutrients were applied by hand before final cultivation and planting. Rates were 60 kg/ha phosphorus as triple superphosphate, 20 kg/ha magnesium as magnesium sulphate, 5 kg/ha copper as copper sulphate and 5 kg/ha of zinc as zinc sulphate. Foliar sprays of boron and molybdenum were applied to plants after emergence.

Plot size varied with site and were from 60 to 110 m^2 according to constraints of the field layout (irrigation system, land available, cultivation equipment) but always consisted of 3 rows. Commercial Jarrahdale seed was used in 1992 and 1993 but an F1 Jarrahdale hybrid was used in 1994 and 1995 in an attempt to reduce variability of fruit size and shape to assist with quality evaluation in 1995. Conventional insect, disease and weed control programs were conducted at each site. At harvest, fruit was collected and assessed for total fruit yield, mature fruit yield, immature fruit yield, number of mature and immature fruit. An assessment of fruit quality was determined in 1992 at the Ayr site and a comprehensive sensory evaluation was conducted by the Centre for Food Technology, QDPI on the 1995 Mareeba site.

Soil samples were collected from each site after the final cultivation and before fertiliser application. Four cores per rep as 0-10, 10-20, 20-30, 30-40 and 40-50 cm were collected and bulked. To minimize changes in mineral nitrogen with drying and grinding, field moist samples were immediately frozen after collection and later thawed and analysed in the laboratory. Samples collected for sap and conventional leaf analysis were taken from the youngest fully expanded leaf of 6 plants per plot.

Results

1. Agronomic data

Site 1
Mature fruit yield increased with rate of applied N from 7.5 t/ha with N_0 to a maximum of 20.1 t/ha with N_{180} (Fig.1). Immature fruit yields were low and varied between 0.5 and 2.5 t/ha. The increase in mature fruit yield was due to an increase in number of fruit harvested from 2200/ha at N_0 to 5420 at N_{180} and not in average weight of mature fruit. Rate of applied K had no effect ($P<0.05$) upon mature fruit yield (treatment means, K_0 16.1, K_{30} 16.9, K_{60} 15.8 t/ha). A preliminary assessment of fruit quality detected no treatment differences in uncooked or cooked flesh appearance or in taste.

Site 2
Data from this site were discarded because of poor and uneven growth in the plots that was not related to the treatments applied. Yields were low (a maximum of 11 t/ha) and variable. No satifactory explanation for the poor performance of this site was

found although farm records later showed that a previous maize crop had also been unsatisfactory.

Site 3

Applied N greatly increased mature fruit yields from 4.4 t/ha for N_0. There was a significent interaction between rate of N and time of N application for mature fruit yield (Table 1). At low rates of applied N, mature fruit yield was higher for basal N than for split N, at N_{180} yields were similar while at N_{240}, split application produced a higher yield. Similar results were obtained for number of mature fruit. There were no trends in average weight of mature fruit. Immature fruit yield was low (0.2 to 2.9 t/ha) and not related to fertiliser treatment. Rate of applied K had no significent effect upon mature fruit yield (means K_0 21.6, K_{60} 23.2 t/ha).

Table 1. Mature fruit data for site 3

Rate of N (kg/ha)	*Yield (t/ha)*		*Number of mature fruit/ha*	
	Basal N	Split N	Basal N	Split N
60	22.5	14.0	4558	3133
120	22.5	20.5	4429	4382
180	23.9	23.2	4753	4676
240	24.2	28.1	4814	5663
LSD (P<0.05)	3.94		650	

Site 4

Yield of mature fruit was high in the absence of applied N and was not increased by N fertiliser (Fig. 2). There was a significant interaction between rate of applied N and time of application (P<0.05). For split applications of N, rate had no effect on yield. In contrast, basal N applications of greater than 120 kg/ha produced a significant reduction in mature fruit yield. Differences in fruit yield were due to changes in the number of fruit/ha and not in average weight of mature fruit (Table 2).

Table 2. Number of mature fruit/ha for site 4

N rate (kg/ha)	*Mature fruit (no./ha)*
0	6000
60	6650
120	6708
180	5678
240	4761
LSD P<0.05)	1001

Number of mature fruit were also reduced by time of application of N (means, basal N 5294, split N 6604 fruit/ha). Rate of applied K had no effect upon yield.

Site 5

Yield from all N and K treatments were high and there was no effect due to rate of fertiliser applications or timing (Table 3).

Table 3. Yield vs rate of applied N, site 5.

N rate (kg/ha)	*Yield (t/ha)*
0	34.0
60	33.4
120	36.7
180	38.7
240	35.5

Sites 6 and 7

These two sites were located at Ayr Research Station and were devastated by papaya ringspot virus. Site 6 was ploughed in after sampling for sap analysis on 14 June 1994. Site 7 was harvested on 1 November 1995 but the data were discarded due to low and variable yield and distorted fruit.

Site 8

Yield of mature fruit for individual plots varied from 18.0 to 36.9 t/ha and number of fruit was between 4400 and 7862 per ha. There were no significant differences in yield from rates of applied N or timing of N fertiliser (Table 4).

Table 4. Mean mature fruit yield for site 8

N treatment	*Mature fruit (t/ha)*	*Mature fruit/ha*
0	25.8	5460
60 basal	21.4	4754
120 basal	27.9	5625
180 basal	26.4	5625
240 basal	23.5	5278
60 split	30.7	6324
120 split	30.1	6068
180 split	26.8	5873
240 split	25.2	5873

For this site, there was a significant replicate effect ($P<0.05$). Covariate analysis also revealed a highly significant effect due to the `side' of the irrigation line on which plots were located. This effect was attributed to uneven distribution of irrigation along the trial associated with prevailing winds during the trial period. As a consequence of the replicate and covariate result, it is very difficult for treatment differences to be detected. However, it does appear that the site was not responsive to applied N.

2. Soil analytical data

The soils selected were representative of the production areas at Mareeba and Ayr. Concentrations of exchangeable potassium were generally low.

Table 5. Summary of some soil chemical data for all sites (0-10 cm)

Site	*pH*	*Electrical conductivity (dS/m)*	*Na (m.e./100g)*	*K (m.e./100g)*	*Ca (m.e./100g)*	*Mg (m.e./100g)*
1	6.3	0.07	0.05	0.18	6.88	3.34
2	5.5	0.03	0.04	0.14	0.97	0.35
3	6.4	0.08	0.03	0.21	5.95	2.67
4	7.2	0.09	0.86	0.44	2.40	0.35
5	6.6	0.06	1.10	0.34	2.00	0.75
8	5.5	0.03	0.01	0.28	0.85	0.39

Soil inorganic N data

Inorganic N concentrations, a measure of the available N in the soil, at planting were low at site 1 and high at sites 4 and 8. High inorganic N concentrations over the 0 to 30 cm depth at sites 4 and 8 (52 and 47 mg/kg respectively) supplied sufficient N for the crop. Low concentrations at site 3 (6 mg/kg, 0 - 30 cm) were associated with a large response to fertiliser N. However, inorganic N concentrations of approximately 20 mg/kg for 0 - 30 cm were associated with a good response to applied N at site 3 and no response at site 5.

Table 6. Mean soil ammonium-N (NH_4) and nitrate-N (NO_3) concentrations at planting (mg/kg)

	Site 1		*Site 3*		*Site 4*		*Site 5*		*Site 8*	
Depth (cm)	NH_4	NO_3	NH_4	NO_3	NH_4	NO_3	NH_4	NO_3	NH_4	NO_3
0-10	3.9	7.8	2.3	0.7	0.6	14.6	3.0	4.6	1.8	7.2
10-20	3.0	2.5	1.5	0.8	1.9	25.1	0.8	9.2	1.2	33.5
20-30	2.3	<0.5	0.8	0.5	0.8	9.7	0.5	1.6	0.9	2.1
30-40	1.0	<0.5	0.5	0.5	<0.5	2.3	<0.5	0.5	0.7	2.1
40-50	<0.5	<0.5	0.4	<0.5	<0.5	0.5	<0.5	<0.5	<0.5	0.5
sum 0-30	9.2	10.3	4.6	1.7	3.3	49.3	3.9	15.4	3.9	42.8

3 Plant chemical data

Total N in leaves

Concentrations of N in youngest fully expanded leaf (YFEL, lamina and petiole) for N_0 treatments at first flowering for the responsive sites (sites 1 and 3) were 4.37 and 5.07%, respectively (Table 7). For the non-responsive sites, N concentrations were 5.30 to 5.31% and only slightly higher than site 3. Leaf N concentrations generally increased with rate of applied N and differences between basal and split N treatments were small. Nitrogen concentrations at site 3 were higher than at the other sites for basal 120, 180 and 240 treatments and the split N treatments.

Potassium concentrations were always increased by K application, although no yield responses were obtained.

Table 7. N and K concentrations (%) in YFEL at first flowering

N rate kg/ha)	*Timing*	*Site 1*	*Site 3*	*Site 4*	*Site 5*
0		4.37	5.31	5.07	5.30
60	basal	5.61	5.79	5.72	5.57
120	basal	5.75	6.42	5.48	5.73
180	basal	5.70	6.53	5.56	5.52
240	basal	5.92	6.43	6.13	5.96
60	split		6.42	5.47	5.31
120	split		6.45	5.53	5.36
180	split		6.45	5.50	5.49
240	split		6.57	5.48	5.64
K rate (kg/ha)					
0		3.99	3.95		
30		4.54			
60		4.64	4.05	4.97	5.30
120				5.20	5.22

Sap nitrate in petioles of YFEL
Sap nitrate concentrations in YFEL reflected available soil N and the N rate and timing of treatments (Table 8). Concentrations varied from 93 to more than 6000 mg/L of nitrate. In basal N treatments (apart from N_0 treatment), sap nitrate concentrations decreased rapidly over time. The responsive of sites to applied N was confirmed by concentrations in N_0 treatments. Concentrations were low (<761 mg/L of nitrate) at the responsive sites, 1 and 3. In contrast, concentrations were greater than 3760 mg/L early in the season at sites 4 and 5 where there was no response to applied N. Sap concentrations from the optimum N treatments were related to crop stage to derive a guide for sap nitrate concentrations (Fig. 3). Optimum sap concentrations were between 2700 and 3700 mg/L between first vine and first flower.

Table 8. Sap nitrate concentrations for N treatments over time

N rate	*0*	*60*	*120*	*180*	*240*
Site 1					
10/06	108	2213	3730	3785	3404
19/06	394	2522	3527	3132	3640
03/07	761	948	1668	2402	2093
17/07	111	385	981	1153	1758
31/07	93	220	388	877	1058

N rate/time	*0*	*60 basal*	*60 split*	*120 basal*	*120 split*	*180 basal*	*180 split*	*240 basal*	*240 split*
Site 3									
23/06	197	1207	187	2053	236	2043	409	2395	2639
04/07	449	1897	1861	2808	2287	2763	2394	3047	2534
15/07	351	467	747	1361	2207	1228	2505	2005	2162
04/08	131	620	285	428	501	703	533	603	988
Site 4									
01/07	3760	5430	4710	5770	4870	6010	5000	5553	5265
08/07	2870	4025	3800	3905	3630	4080	4015	4850	3750
15/07	1950	2765	2860	3190	3785	3020	4260	2980	3925
22/07	1710	2310	2875	4335	3773	4620	4440	3935	4973
29/07	886	1476	1351	4562	3610	4363	5115	4717	3565
Site 5									
21/07	4125	4290	4710	4305	4850	5420	4720	5507	4845
28/07	2224	3085	3632	3500	2887	3352	3492	4439	4586
04/08	2126	3167	3565	3986	4075	3565	3676	3632	4230
12/08	1092	1417	1838	2347	2835	3233	3366	3056	2082
18/08	1270	1860	2680	2281	3189	2059	2059	2104	2835

4. Post harvest quality assessment

A detailed report by Anne Ford is attached. There were no significant differences in acceptability of pumpkins although N_{240} split treatment had softer, more moist flesh. It is unfortunate that this work was conducted on a variable and non-responsive site but it does indicate that high rates of N applied to a soil with high levels of available N has not reduced consumer acceptability.

Discussion

N requirements of Jarrahdale pumpkins can be determined by the available N in the soil at time of planting. Large responses to applied N were measured where inorganic soil ammonium plus nitrate concentrations in the 0 - 30 cm depth were less than 20 mg/kg. Yield responses to applied N were found at only 2 sites. Fertiliser N required was between 60 and 120 kg/ha at planting, with no yield benefit measured for split applications. At high rates of applied N to a site with high soil N (site 4), splitting N application prevented the yield reduction associated with basal N application. Current recommendations are 80 kg N/ha for Mareeba-Dimbulah irrigation area, 80 kg N/ha for the Lockyer Valley, and 150 kg N/ha in the Burdekin. These rates do not consider the contribution of soil N to the nitrogen requirement of pumpkins. Because of the range of response of pumpkins to applied N at the experimental sites, these fertiliser recommendations and the limited use of soil analyses prior to planting should be reviewed.

There was no response to applied K at any site despite low concentrations in the soil at some sites at time of planting. Current K recommendations of between 60 and 75 kg/ha are conservative compared to estimates of K removal in the harvested fruit of 750 kg/ha (K concentration in fruit 3%, yield of 25 t/ha).

Sap nitrate concentrations in the youngest fully expanded leaf successfully integrated available soil N at planting and N fertiliser applications. It is a rapid and inexpensive method of monitoring the N status of the plant. The guidelines developed by this project will allow growers to modify standard side-dressing application of N at the time of final cultivation. Fertigation of N may also be used as a method of adjusting the plant N status. The rapid decrease in sap nitrate with the growth of the crop regardless of rates of applied N is typical of the response recorded in other crops such as tobacco, tomatoes, capsicum and barley.

Concentrations of N in dried YFEL by conventional plant analysis were not as sensitive as sap nitrate to N supply. A response to applied N was obtained where leaf N was 4.4% but a concentration of 5.3% was measured at both a responsive and non-responsive site. As K concentrations were always greater than 4%, this concentration can be considered to be in the adequate range.

Extension

The results of the research program have been extended to growers by talks at grower's meetings, field days in Mareeba and Townsville and an article in Horticultural Expo News. Another article summarising all the experimental work is planned as is a review of current pumpkin fertiliser recommendations.

Acknowledgments

We acknowledge the excellent co-operation provided by growers and Mr J M Hardy, Manager, Southedge Research Station, Mr D E Crowther, Manager, Ayr Research Station; Mr D C Wiffen and Ms D E Rowan for technical assistance; Ms A Ford for post harvest quality evaluation. QFVG and HRDC provided funding support.

Fig. 1. Mature fruit yield vs N rate at site 1

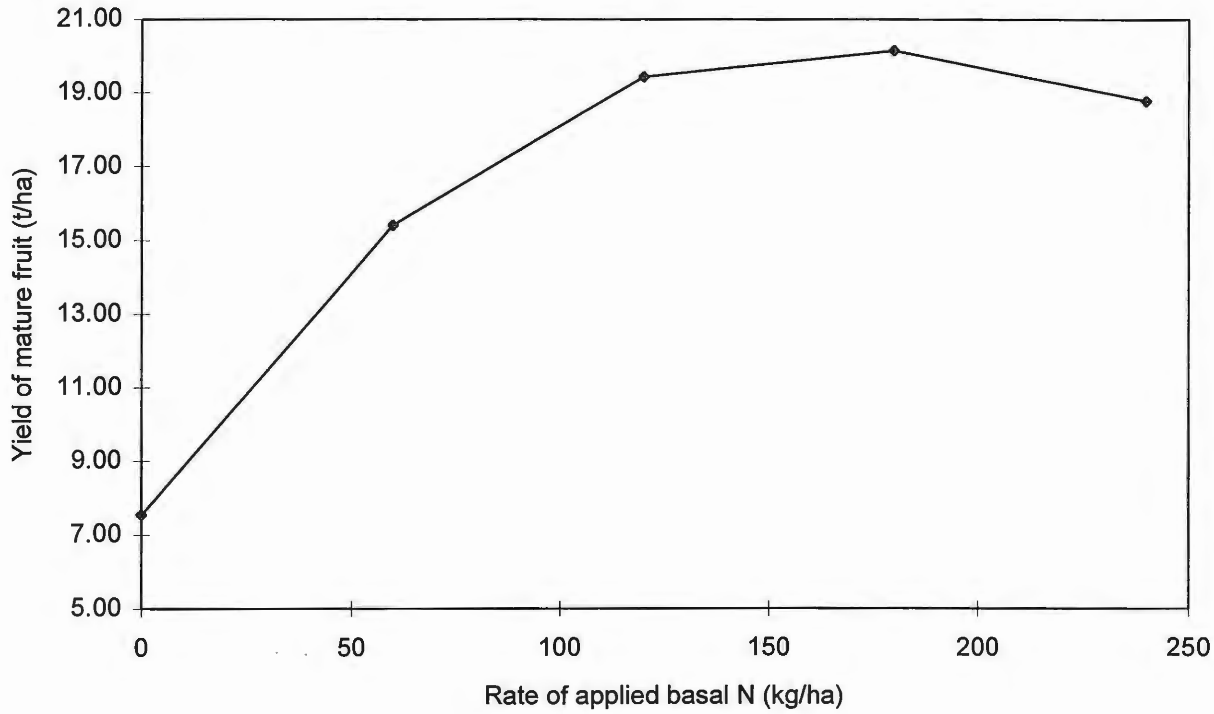


Fig. 2. Mature fruit yield vs N rate at site 4

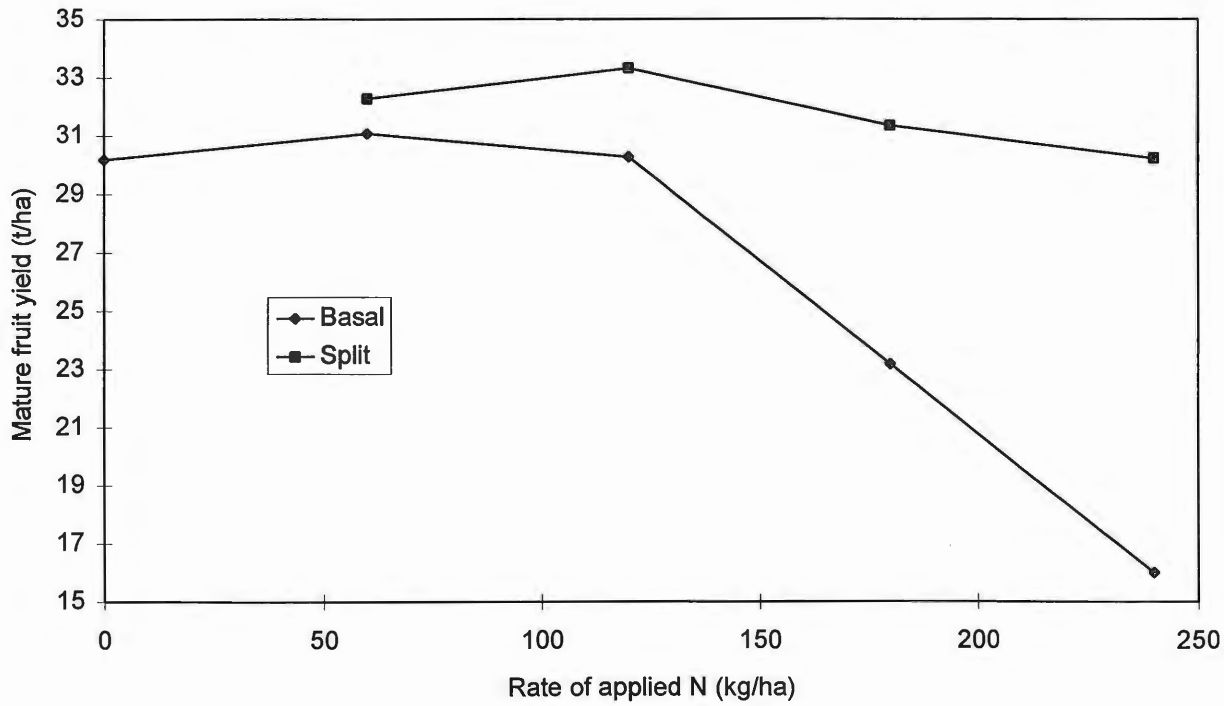
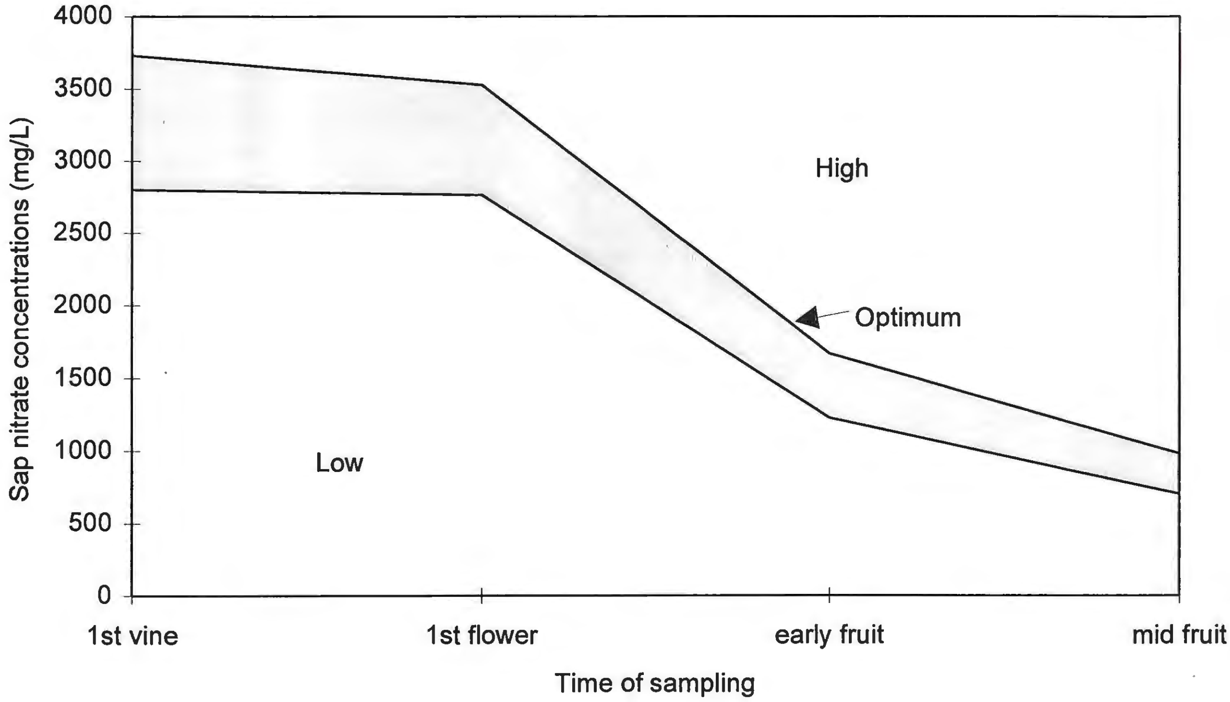


Fig. 3. Optimum sap nitrate concentrations vs crop stage



REPORT ON THE SENSORY EVALUATION OF PUMPKIN FROM A NUTRITION TRIAL

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CONTENTS

AIM OF TESTS

To evaluate the effects of fertiliser application regime on the eating quality of Jarrahdale pumpkins grown in North Queensland.

SAMPLES

Jarrahdale pumpkins grown in Mareeba, North Queensland and fertilised using:

1	Nil	Nitrogen Application
2	120	Basal Nitrogen Application
3	120	Split Nitrogen Application
4	240	Basal Nitrogen Application
5	240	Split Nitrogen Application

METHODOLOGY

Pumpkins were held at room temperature until tasted. They were washed to remove excess dirt weighed and cut in half vertically through the stem. Half of each pumpkin was prepared for tasting and the second half was used to obtain colour and firmness measurements on the raw fruit/flesh. Hunter Lab values were obtained on duplicate central slices. An instron universal testing machine was used to measure firmness by a compression test applied in 3 positions along a 3 cm thick slice cut vertically through the pumpkin.

COOKING

Seeds were removed and half pumpkins were cooked (skin on) in a commercial steamer, cut side down on wire racks. Cooking time was 20 minutes in free flowing steam at 100°C. All the membranes and any remaining seeds were removed. The half pumpkin was cut into two wedge shaped pieces. The stem and flower of each wedge was removed and the remaining piece was peeled and cut into chunks which were approximately 25 cm cubes (10 g). This varied slightly depending on the size and shape of the original pumpkin. Cubes were held warm at 70°C in a Bain Marie until tasted.

SENSORY EVALUATION

Treatments were tasted according to a partially balanced incomplete block design involving a sixth sample made from combining excess cubes of other treatments. 3 replications of all treatments were completed. Three treatments were compared at each session with four pumpkins from each treatment included.

Sixteen tasters assessed four cubes of each treatment, with subgroups of four tasters assessing one pumpkin. Order of presentation of samples was randomised over the panel of sixteen tasters. These were staff from the Hamilton site who were experienced tasters but had not tasted pumpkin before.

They were asked to score the appearance, overall acceptability, colour of flesh (yellow and orange), brightness of colour, flavour and texture of the pumpkins on graphic line scales using a standard rating procedure (AS 2542.2.3). Reference cards of yellow and orange were provided to anchor the endpoints of the colour scale. Extra questions on appearance and flavour providing objectives for selection of additional descriptors were provided.

Hedonic rating scales for texture and flavour were used in addition to objective scales of softness, moistness, typical pumpkin flavour intensity, sweetness and bitterness.

Finally tasters were asked to give an overall rating of acceptability for each sample and to make specific comments on the samples where relevant.

Data was collected using an integrated sensory software system (Compusense 5.1, Compusense Inc, Canada). Tasters sat in individual booths which were illuminated with white light (daylight equivalent) and samples were served hot to tasters when they were required.

RESULTS AND DISCUSSION

Range and mean of weights of pumpkins tasted are summarised in Table 1 below. There were no large differences between treatments, although results were significant at the 10% level.

Table 1	Fertilisers Application				
	Nil	120 Basal	120 Split	240 Basal	240 Split
Minimum	3352	3259	3333	2943	2466
Mean	4879[a]	4508[ab]	4856[a]	4157[b]	4029[b]
Maximum	6360	6621	6050	5904	6236

[a,b] Means with the same superscript are not significantly (P>0.10) different.

SENSORY EVALUATION

Numerical scores of 0 and 100 were assigned to all scales on the questionnaire, with 0 representing the left hand end and 100 the right hand.

All the data was subjected to analysis of variance, and pairwise comparison of means for those variables which showed a significant difference (P<0.05) between the treatments.

APPEARANCE

Appearance acceptability was also significant at the 10% level, and the 120 split nitrogen application produced the best accepted flesh. From attribute scores (Table 3) this seems to be due to a more orange, brighter flesh in these pumpkins.

TEXTURE

Fertiliser treatment did not produce a significant effect on overall acceptability of the pumpkins, although texture acceptability was significantly affected at the 10% level with the 240 split nitrogen application producing the most acceptable pumpkin (Table 2). This was due to the significantly (P<0.05) higher level of softness and moistness in pumpkins from this treatment (Table 3).

FLAVOUR

There were no significant ($P<0.05$) effects on pumpkin flavour from the treatments. Although AOV showed a significant overall difference in typical pumpkin flavour intensity at the 10% level, there were no obvious trends with rate or method of fertiliser application.

GENERAL

Charts 1 to 3 show a graphical representation of additional descriptor selections for appearance, texture and flavour respectively. This data has not been statistically analysed, but helps to provide an indication of treatment effects not collected on the line scale section of the questionnaire.

Chart 4 presents the statistical means of the characteristics profiled.

All comments made by panellists have been summarised under treatments and are presented at the end of the appendix.

CONCLUSIONS

The main effect of the fertiliser treatments tested was in texture of the pumpkins. The 240 split nitrogen treatment produced significantly ($P<0.01$) softer, more moist flesh. Overall there was no significant ($P>0.05$) difference in acceptability of pumpkins between the treatments.

APPENDIX

MEAN PANEL SCORES - PUMPKIN SENSORY EVALUATION

Table 2 **Acceptability**

Fertilizer Treatment	Appearance	Texture	Flavour	Overall
Nil N_2	60.42	56.33	57.33	54.42
120 Basal N_2	64.87	57.90	59.36	58.49
120 Split N_2	67.24	55.37	56.02	53.74
240 Basal N_2	59.31	56.21	53.27	50.84
240 Split N_2	63.46	64.20	54.74	56.98
Probability from F ratio	0.0815	0.0938	0.2357	0.2352

Scales:

0 = Dislike extremely, 50 = Neither like nor dislike, 100 = Like extremely

MEAN PANEL SCORES - PUMPKIN SENSORY EVALUATION

Table 3 **Appearance, Texture & Flavour Characteristics**

Fertilizer Treatment	Colour of flesh	Brightness	Softness	Moistness	Typical pumpkin	Sweetness	Bitterness
Nil N_2	58.22	61.42	43.37^{ab}	46.32^{a}	48.27	25.58	9.14
120 Basal N_2	64.76	67.46	43.62^{ab}	46.82^{a}	51.17	25.16	10.36
120 Split N_2	70.20	67.06	40.79^{a}	43.25^{a}	47.11	21.24	9.06
240 Basal N_2	63.42	62.98	49.69^{bc}	48.22^{a}	50.11	22.87	12.14
240 Split N_2	65.83	65.28	53.83^{c}	54.14^{b}	47.09	23.46	13.69
Probability from F ratio	0.0837	0.0615	0.0001	0.0014	0.0794	0.2584	0.3774
Tukey's HSD (5%)	NSD	NSD	7.69	6.76	NSD	NSD	NSD

Scales:

0 = None, 100 = Very .... NSD - No significant difference ($p>0.05$)

Means in the same column followed by a common superscript are not significantly different ($p>0.05$)

Frequency of Selection of Specific Descriptors for Pumpkin Appearance

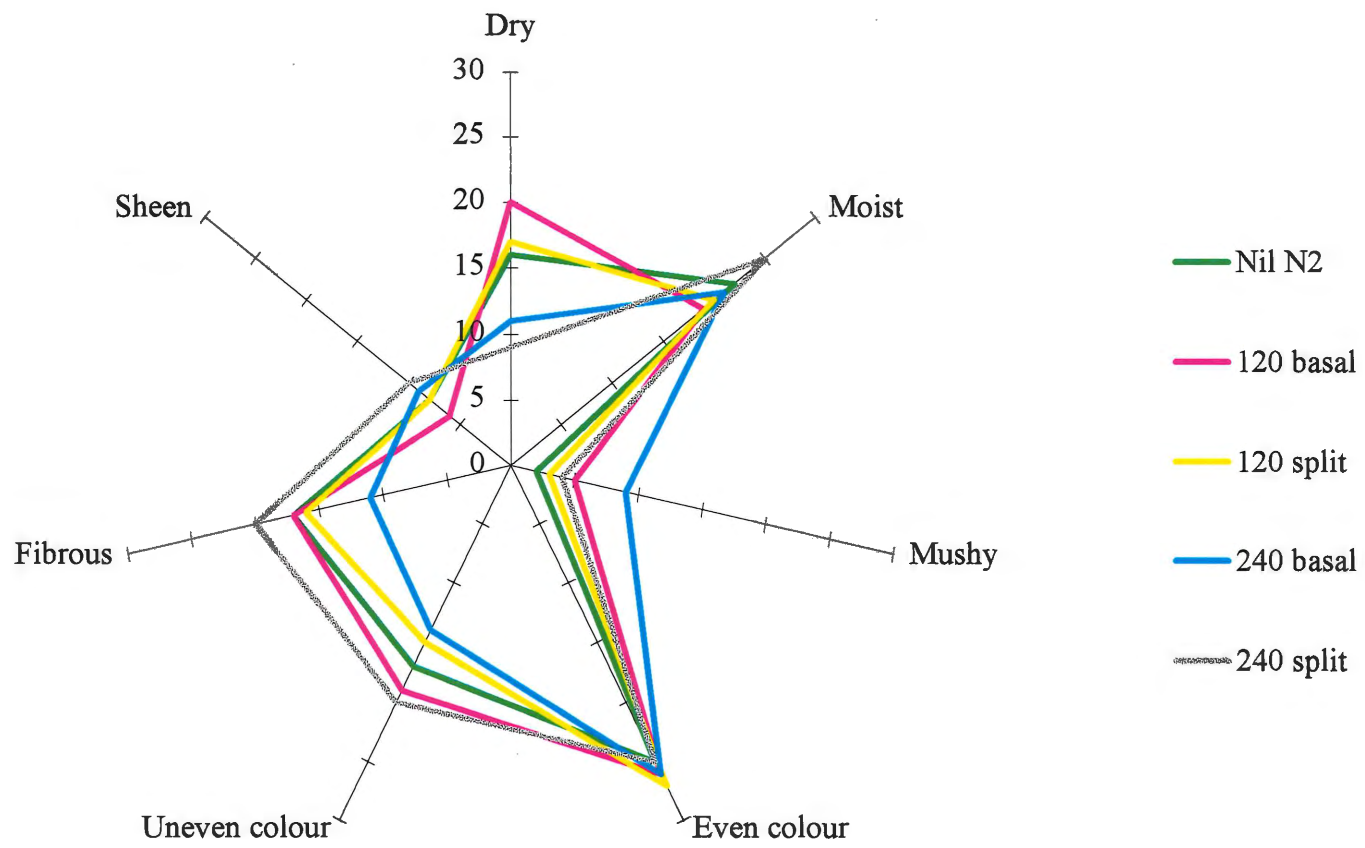

Chart 1

Frequency of Selection of Specific Descriptors for Pumpkin Texture

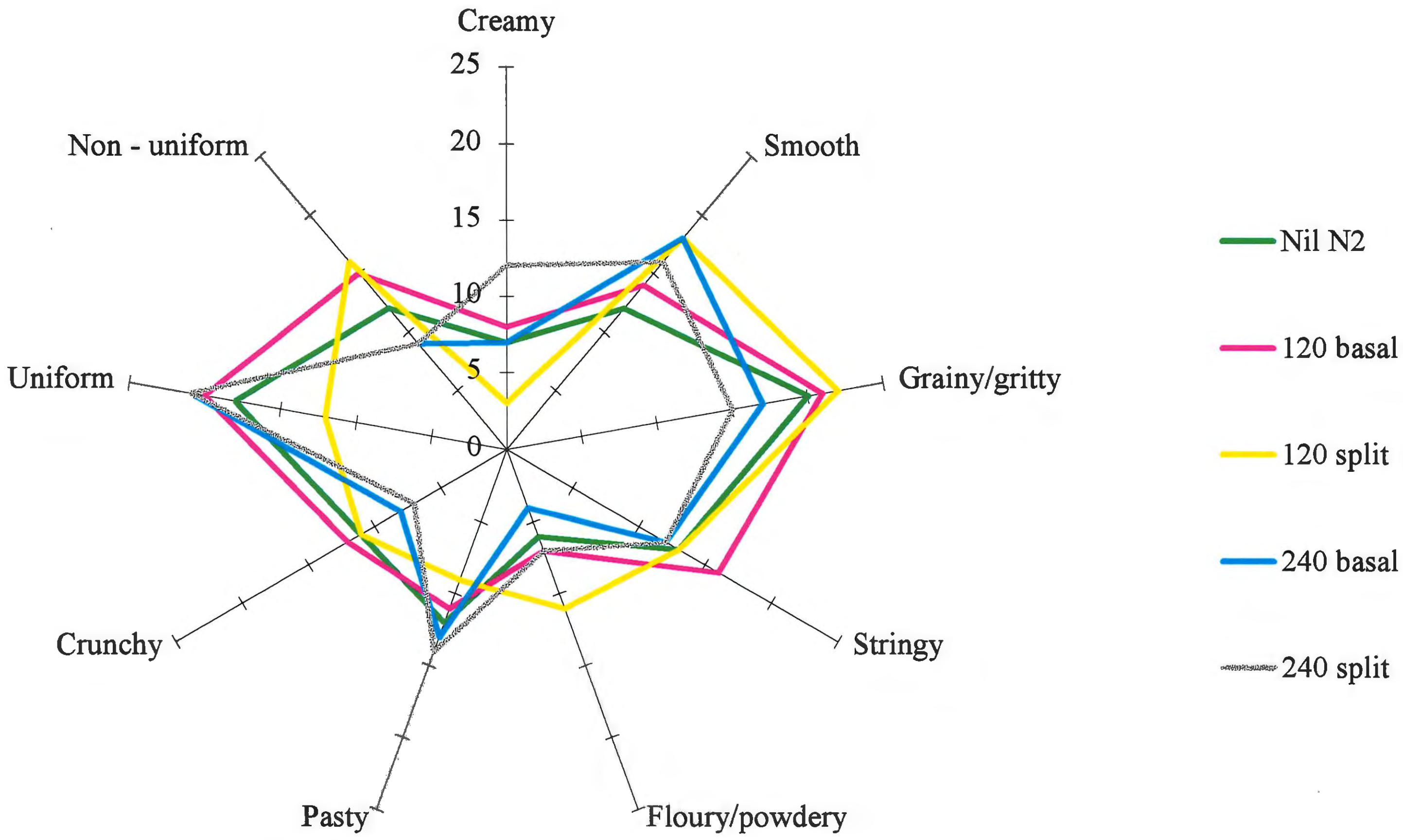

Chart 2

Frequency of Selection of Specific Descriptors for Pumpkin Flavour

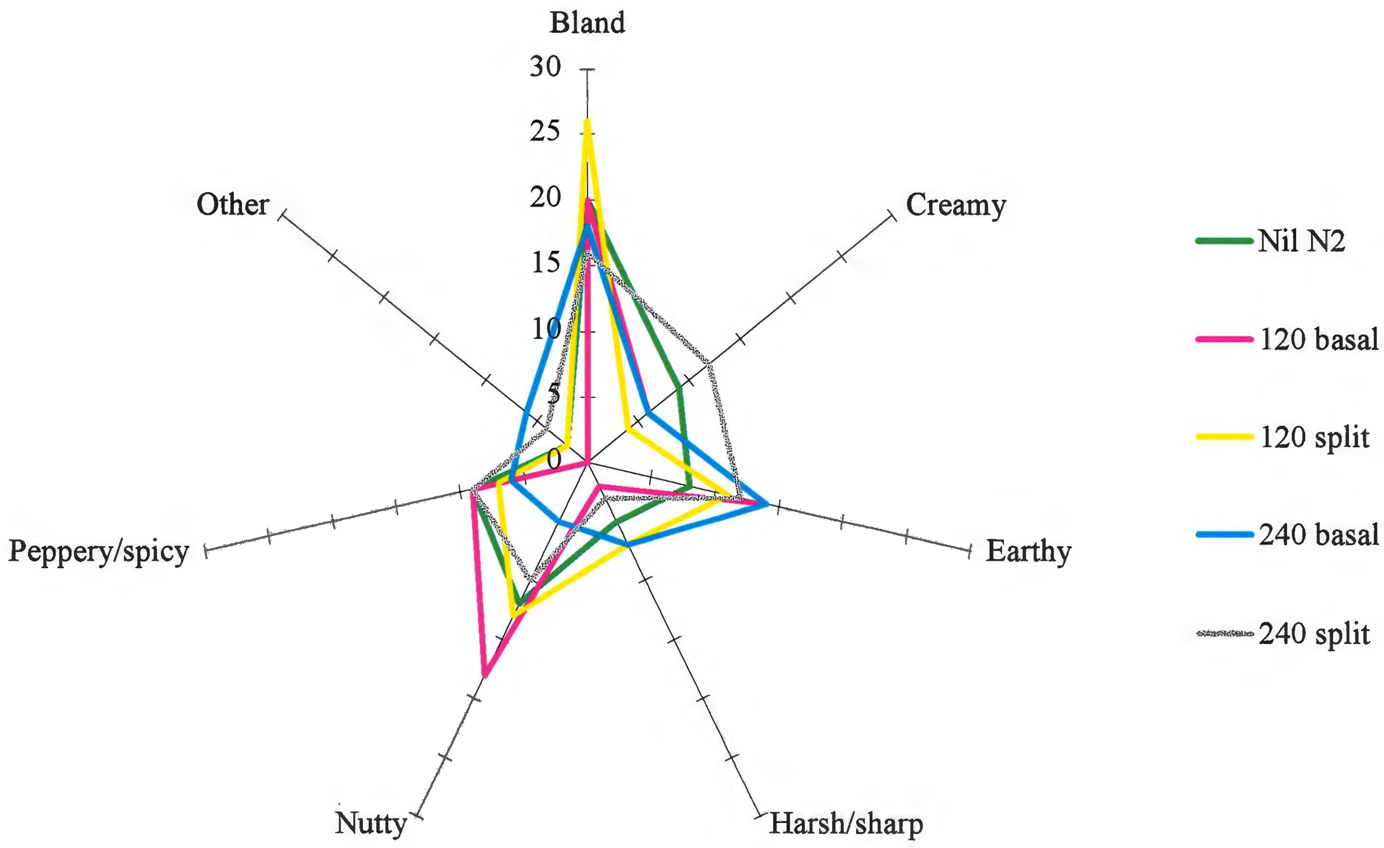

Chart 3

Mean Sensory Scores for Pumpkin Characteristics

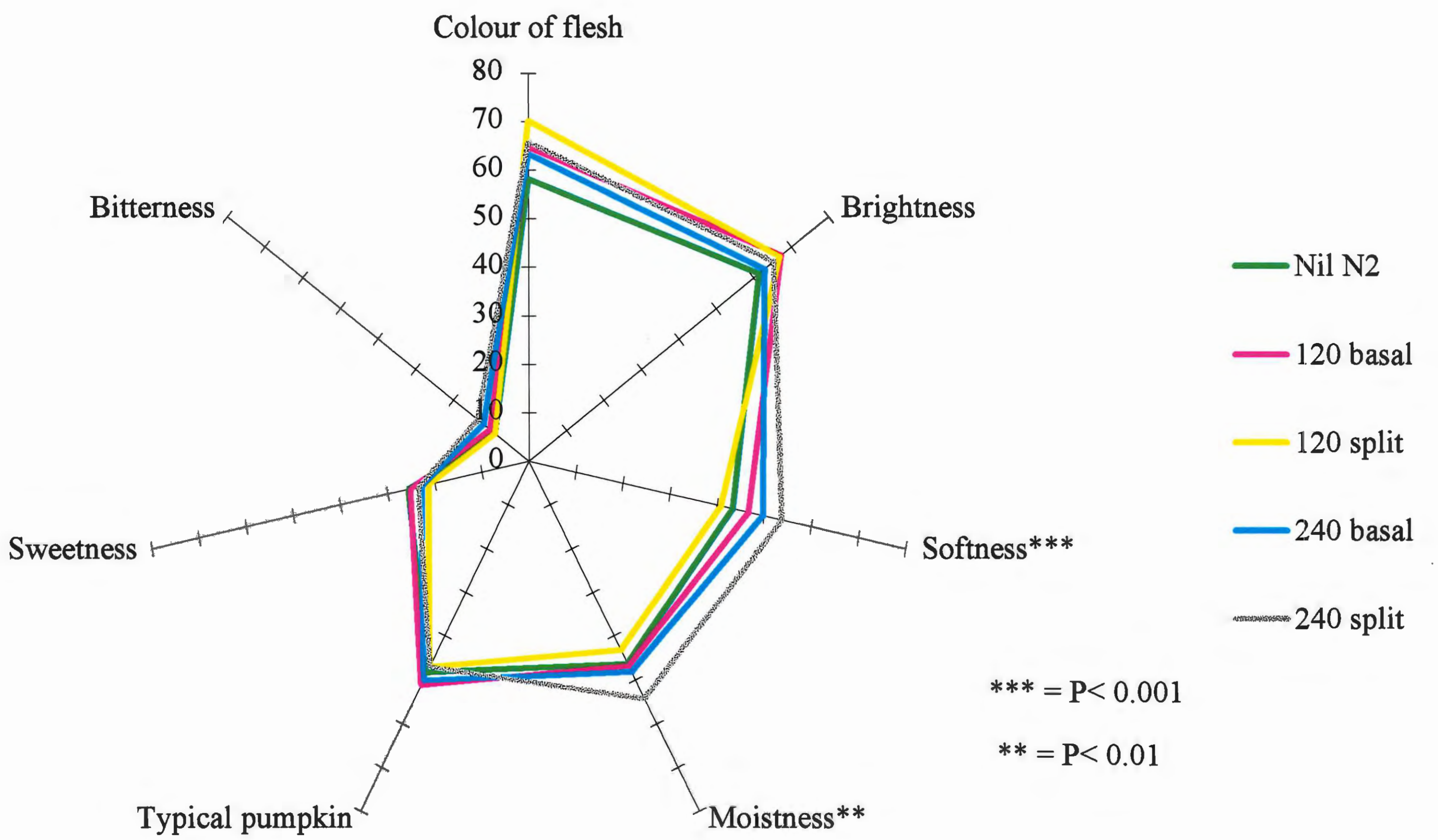

Chart 4

APPEARANCE COMMENTS

Nil Nitrogen

- Mottled
- Some greenish patches
- Spotty appearance

120 Basal Nitrogen

- Mottles looking
- Some speckles
- Patchy granulated appearance on 2 pieces
- Spotty
- Slightly mottled

120 Split Nitrogen

- Pieced looked dry & 2 pieces looked moist
- Quite a contrast of colour
- Mottled
- Small light parches throughout
- Too dark in appearance
- Some blotchy patches

240 Basal Nitrogen

- Blotchy in colour
- A little mottles in colour
- Some blotchiness
- Raw looking, like it hasn't been cooked at all

240 Split Nitrogen

- Very patchy sections of yellow
- Woody patches

TEXTURE COMMENTS

Nil Nitrogen

- 1 smooth 3 gritty
- Cooked to same extent as other samples?, very firm texture

- Needed a lot more cooking
- Texture differed between pieces
- Some pieces soft & smooth other pieces hard and crunchy
- Very inconsistent both hard and soft cubes

120 Basal Nitrogen

- One piece was moist the other 3 were dry
- Variable from piece to piece

120 Split Nitrogen

- Astringent
- Some fibre
- Same as colour - big difference
- Slight graininess at end of chewing, more a sound than feel
- Some variation between pieces

240 Basal Nitrogen

- Although it appeared stringy it was not stringy
- One smooth 3 crunchy
- Slight graininess
- Some unevenness
- Only 1 piece was hard and gritty there were quite a difference
- Only slightly gritty & fibrous

240 Split Nitrogen

- Some samples drier than other
- This one seemed slightly crunchy/fibrous/gritty probably less cooked
- Mushie
- One very slightly stringy in one piece

FLAVOUR COMMENTS

Nil Nitrogen

- Sugary but not bland
- Softer pieces had more flavour than rest
- Overall very acceptable
- Soft pieces were sweet & hard pieces were bitter
- Hard cubes sharp/bitter flavour, soft cubes bland

120 Basal Nitrogen

- Only one piece had an earthy sharp flavour
- Only one piece tasted earthy
- Tasted more like a typical pumpkin when eating a mushie part
- Flavour that did not seem to be present in previous samples more chemical

120 Split Nitrogen

- The softer parts tasted better more of usual pumpkin
- Stringy and gritty and not very nice
- Not all uniform
- Some pieces had flavour & some did not
- Sugary
- The softer pieces had a very dirty flavour
- Had a slight sour taste

240 Basal Nitrogen

- Raw flavour
- Unpleasant chemical aftertaste
- Uneven
- Had a watery taste
- Awful weedy flavour
- Sweet flavour like rockmelon
- Savoury taste not bland
- Strange weedy flavour
- This sample is what I think of as a typical pumpkin
- Tasted like a usual pumpkin but watered down in flavour
- Mushie in appearance not inviting

240 Split Nitrogen

- Unclean flavour
- Strange flavour - unusual
- Can't put a handle on the flavour, but bloody awful
- Astringent aftertaste, metallic flavour

GENERAL COMMENTS

- 120 Basal Nitrogen sample was either undercooked or just plain terrible
- Last sample inconsistent - soft and hard between cubes

- The first 2 samples were fairly similar where as the last sample was quite different all had a crunchy mouthfeel
- Well balanced
- the least liked of the tastings this morning
- All samples were bland with no likeable characteristics
- Well rounded pumpkin - not too hard - not too soft
- The last 2 samples were very firm I presume the same cooking method was used for all samples