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EFFECT OF NITROGEN NUTRITION ON QUALITY AND STORAGE BEHAVIOUR OF PINEAPPLE

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Pineapple *(Ananas comosus* Merr.), one of the most important fruits of the tropics, is valued for its table qualities and processing attributes.

Being a fruit of great demand for processing, pineapple requires long term storage and transport. Rodriguez *et al.* (1975) reported that pineapple receiving high doses of nitrogen produced fruits of poor flavour and quality, while under moderate nitrogen availability, fruits retained the flavour components and maintained good balance of sugars and acids. That the nitrogen nutrition has got a positive influence on soluble solids and titratable acidity and an adverse effect on the weight and solid to acid ratio of citrus fruits has been reported by many workers (Reuther and Smith, 1952; Smith, 1967; Srivastava, 1967; Kefford and Chandler, 1 970). Singh and Rajput (1976) reported that nitrogen nutrition had a highly significant effect on TSS reducing sugars, ascorbic acid and pectin content of guava fruits.

The present investigation was undertaken with the object of studying the effect of different levels of nitrogen nutrition on fruit quality and storage behaviour of pineapple, cultivated variety Kew.

Materials and Methods

Fruits for the study were collected from the nutritional trial plots under All India Co-ordinated Fruit Improvement project at Vellanikkara during the year 1 977-78. The levels of nitrogen in the trial were 8g (N_1), 12g (N_2) and 16g (N_3) per plant per year. Nitrogen was applied in the form of urea as soil application in four split doses at the time of planting (May-June), August-September, November and May-June. P_2O_5 and K_2o were applied uniformly at 4g and 12g respectively per plant per year. All the P_2O_5 was applied as basal dose at the time of planting, K_2O was applied along with nitrogen in four split doses.

Fruits for quality evaluation and storage studies were collected during April at fully ripe stage. Ten fruits were collected from each replication and were stored at room temperature (30°C) and at 5°C in a refrigerator. Fruits were analysed for TSS acidity(citric), reducing sugars and total sugars by AOAC (1968) procedure. Non reducing sugars, sugar to acid ratio and brix to acid ratio were worked out. The qualitative studies were taken up at harvest, five days after storage and at maximum storage life (8 days at room temperature and 20 days in cold storage,

Results and Discussion

The data on qualitative analysis of fruits at harvest are presented in Table 1

Table 1

Effect of nitrogen nutrition on the quality of pineapple at harvest

Chemical Constituents	Treatments N_1 8g/plant	N_2 12g/plant	N_3 16g/plant	C D (p=0.05)
TSS	15.0	15.0	16.0	N S*
Acidity (citric)	0.67	0.73	0.76	N S
Reducing sugars	5.64	4.81	4.55	0.30
Non-reducing sugars	7.76	9.46	8.74	0.73
Total sugars	13.40	14.27	13.29	0.36
Sugar to acid ratio	20.00	19.55	17.49	1.35
Brix to acid ratio	22.39	20.55	21.05	1.98

* NS: Non-significant

It is evident from the data on fruit quality at harvest that the levels of nitrogen significantly influenced the reducing sugars, non-reducing sugars, total sugars, sugar to acid ratio and brix to acid ratio, whereas TSS and acidity were not significantly affected. The reducing sugars, sugar/acid ratio and brix/acid ratio were the highest at the lowest nitrogen level. The fruit quality in terms of total sugars and non-reducing sugars increased upto 12g N/plant which however was significantly reduced as the nitrogen level was increased to 16g. In TSS and acidity, an increasing trend was observed with the increase in nitrogen level upto N_3.

The trend observed in the present study in pineapple Is similar to the results obtained by earlier workers in other crops. Nitrogen treatment has been found to increase the fruit quality in sweet orange (Prasad and Govind, 1975J, TSS in Coorg Mandarin (Srivastava and Muthappa, 1972) and acidity in sweet orange, Dhillon *et al.* 1961).

Kelly (1971) and Singleton and Gortner (1965) suggested that in pineapple increasing levels of acidity contributed for higher level of TSS. !n the present study, as the nitrogen level increased, a decreasing trend in reducing sugar content was observed. This decrease in reducing sugars and increase in acidity must be due to the metabolic break-down of reducing sugars and the synthesis of acids induced by higher levels of nitrogen. Non reducing sugars and total sugars were found to increase upto 12g N and above this level decreasing trend was observed in both cases. It is indicated that increased nitrogen above 12g might have stimulated conversion of non-reducing sugars to titratable acids.

Data on the effect of nitrogen on storage behaviour of pineapple is presented in Table 2. An increasing trend was observed in TSS during storage at room temperature and in refrigerator. Maximum increase in TSS was observed for 12g N/plant at room temperature and for the lowest level of N in cold storage.

All levels of nitrogen recorded significant increase in acidity both at room temperature and cold storage. In contrast to the TSS, acidity showed maximum values on 20th day of storage in cold condition. Lowest level of nitrogen recorded the highest increase in acidity both in open and cold storage, whereas higher doses of nitrogen showed lesser increase in acidity during storage.

In all the treatments, the values for reducing sugar content were low for fruits kept under cold storage. But, the values on non-reducing sugar content were high and this may be attributed to the lesser rate of enzyme activity under cold storage leading to poor conversion of non-reducing sugars to reducing sugars. Further, the decreace in reducing sugar content of fruits under cold storage as against the values obtained at harvest can be due to accelerated metabolic break down of reducing sugars and synthesis of acids resulting in an increase in acid content in cold storage. At higher levels of nitrogen, the changes took place more rapidly as compared to lower levels of nitrogen when fruits were kept in cold storage. Higher levels of nit.ogen resulted in accelerate break-down of non-reducing to reducing sugars under open conditions whereas acceleration in the breaking down of reducing sugars and synthesis of acids occur under cold storage, especially under higher levels of nitrogen application.

Non-reducing sugars showed a decreasing trend during open storage and 20 days after in cold storage. However, an increasing trend was recorded in cold storage after 5 days. In open storage and in cold storage at maximum storage life of 20 days, N_2 was superior with respect to non reducing sugars. Total sugars also showed the same trend as that of non-reducing sugars both in open and cold storage, 12 g N/plant was found to be superior in respect of total sugars during storage.

Sugar to acid ratio showed a decreasing trend both in open and cold storage. In both the storage conditions, the minimum loss was observed in N_2.

Brix to acid ratio followed the same trend as that of sugars to acid ratio. Minimum loss was recorded by N_2 in open storage and N_3 in cold storage, while maximum loss was observed in N_1 under both storage conditions.

Table—2

Effect of nitrogen nutrition on quality attributes of pineapple during storage

Treatments	Composition at the commencement of storage	Composition at different storage conditions: Room temperature 30°C		Cold storage 5°C	
		5 days after	8 days after	5 days after	20 days after
Total soluble solids					
N1	15.00	16.82 [+12.13]	Fruit spoiled	17.12 [+14.13]	16.59 [+10.60]
N2	15.00	17.50 [+16.67]	Fruit spoiled	17.04 [+ 13.60]	16.36 [+ 9.07]
N3	16.00	17.62 [+ 10.13]	Fruit spoiled	17.86 [+11.63]	16.70 [+ 4.38]
CD [p=0.05] for treatment		NS			NS
CD [p=0.05] for days		2.01			0.50
Acidiiy [in citric]					
N1	0,67	1.09 [+ 62.69]	Fruit spoiled	1.200 [+79.10]	1.51 [+125.40]
N2	0.73	0.88 [+20·55]	Fruit spoiled	1.006 [+37.81]	1.42 [+94.52]
N3	0.76	0.90 [+ 18.42[	Fruit spoiled	0.860 [+13.16]	1.37 [+80.26]
CD [p=0.05] for treatment		0.128			0.29
CD [p=0.05[for days		0.092			0,13

N1— 8g/plant
N2—12g/plant
N3—16g/plant

Figures in parenthesis indicate percentage increase or decrease

1	2	3	4	5	6
Reducing sugars					
N1	5.64	5.65 [+0.17]	Fruit spoiled	5.15 [—[illegible].89]	8.77 [—[illegible].1[illegible]]
N2	4.81	5.50 [+14.8[illegible]]	Fruit spoiled	4.[illegible]9 [—10.[illegible]]	8.[illegible]9 [—[illegible]5.7[illegible]]
N3	4.[illegible]5	5.[illegible] [+21.8[illegible]]	Fruit spoiled	4.05 [—1[illegible]]	2.89 [—36.4[illegible]]
CD (p=0.05) for treatment		[illegible].7[illegible]			[illegible]
CD (p=0.05) for days		0.5[illegible]			[illegible].1[illegible]
Non-reducing sugars					
N1	7.7[illegible]	[illegible]1 [—[illegible].44]	Fruit spoiled	9.67 [+[illegible]4.[illegible]1]	7.70 [—0.77]
N2	9.4[illegible]	7.9[illegible] [—16.49]	Fruit spoiled	1[illegible].38 [+80.34]	9.80 [—1.89]
N3	8.74	8.41 [—[illegible]0.98]	Fruit spoiled	11.45 [+81.01]	7.[illegible] [—1[illegible].8[illegible]]
CD (p=0.05) for treatment		NS			[illegible].58
CD (p=0.05) for days		NS			1.7[illegible]
Total sugars					
N1	13.40	10.[illegible] [—2[illegible].45]	Fruit spoiled	14.82 [+10.[illegible]0]	11.47 [—14.40]
N2	14.[illegible]7	13.[illegible] [—[illegible].1]	Fruit spoiled	[illegible].6[illegible] [+16.[illegible]2]	12.3[illegible] [—1[illegible].17]
N3	13.29	8.93 [—32.[illegible]1]	Fruit spoiled	15.[illegible] [+16.83]	10.55 [—2[illegible].[illegible]2]
CD (p=0.05) for treatment		NS			[illegible].84
CD (p=0.05) for days		NS			1.93
Sugar/Acid ratio					
N1	20.[illegible]	11.0[illegible] [—44.[illegible]9]	Fruit spoiled	13.75 [—31.[illegible]5]	[illegible]9 [—56.5[illegible]]
N2	19.[illegible]	14.6[illegible] [—[illegible]5.12]	Fruit spoiled	15.86 [—1[illegible].[illegible]7]	18.5[illegible] [—56.1[illegible]]
N3	17.49	9.7[illegible] [—44.08]	Fruit spoiled	17.30 [—[illegible]1.19]	7.[illegible] [—56.4[illegible]]
CD (p=0.05) for treatment		NS			5.76
CD (p=0.05) for days		NS			2.90
Brix/Acid ratio					
N1	[illegible]2.[illegible]9	1[illegible] [—[illegible]4]	Fruit spoiled	1[illegible].64 [—39.1[illegible]]	11.20 [—5[illegible]]
N2	[illegible]0.[illegible]	[illegible].94 [—2.4]	Fruit spoiled	17.[illegible] [—17.[illegible]0]	11.71 [—4[illegible].[illegible]0]
N3	[illegible]1.[illegible]	19.[illegible]1 [—7.[illegible]2]	Fruit spoiled	[illegible] [—[illegible]0]	12.22 [—41.95]
CD (p=0.05) for treatment		NS			6.7[illegible]
CD (p=0.05) for days		NS			[illegible]64

Based on these results, it can be stated that all the three levels of nitrogen studied, exerted considerable effect on the storage behaviour of pineapple. Lowest level of nitrogen recorded the highest increase in TSS and minimum loss of reducing sugars during cold storage *and* acidity in all storage conditions, whereas it adversely affected the reducing sugars in open storage and sugar to acid and brix to acid ratio in both storage conditions. N_1 recorded maximum reducing sugars and brix to acid ratio at harvest. So, N_1 level is found to produce fruits with maximum table quality both at harvest and in cold storage. Acidity increased with increasing levels of nitrogen at harvest, whereas during storage, lowest level of nitrogen recorded maximum increase in acidity. Nitrogen level of 12 g/plant recorded maximum quality with regard to brix to acid ratio, TSS in cpen storage and total sugars and sugar to acid ratio under both storage conditions. With storage in the open, N_2 appears to induce better juice and canning as evidenced by higher brix to acid ratio and sugar to acid ratio. Hence application of N at 12g/plant was found to be optima! for better juice quality of pineapple both at harvest and under all storage conditions. Maximum acidity and TSS at harvest were recorded at 1 6 g N/plant. Highest increase in reducing sugars during storage at room temperature and minimum loss in brix to acid ratio in cold storage were recorded by N_3 (16 g N/plant).

Summary

In studies on the effect of different levels of nitrogen nutrition on fruit quality and storage behaviour of pineapple, it was found that at harvest, the maximum reducing sugars, brix to acid ratio and sugar to acid ratio were registered at lowest level of nitrogen at 8g/plant As the level of nitrogen was increased to 12g/plant, total sugars increased, but there was a decrease as the level was further increased to 16g/plant. Acidity and TSS showed an increasing trend with increasing levels of nitrogen.

During cold storage, higher levels of nitrogen recorded a decrease in reducing sugars. Maximum increase in acidity was recorded by the lowest level of nitrogen under both storage conditions. Increase in nitrogen level upto 12g per plant was found to have a favourable influence on total sugars in both open and cold storage conditions. Better retention of brix to acid ratio in cold storage and to reducing sugars in open storage was observed when the nitrogen dose was increased to 16g/plant.

സംഗ്രഹം

കൈതച്ചക്കയുടെ ഗുണനിലവാരത്തിലും സംഭരണത്തിലും ചെടികളുടെ പാക്യജനക പോഷണത്തിന്റെ സ്വാധീനം സംബന്ധിച്ച പഠനങ്ങളിൽ, അമ്ളതാവും ബ്രിക്സും പാക്യജനകത്തിന്റെ തോതുകൂടുന്നതിനനുസരിച്ച് വർദ്ധിക്കുന്നതായി കണ്ടു.

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