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Influence of foliar application of nutrients and growth regulators on yield and quality in pineapple (*Ananas comosus* L.)

[*]ANIMESH SARKAR, A. PONGEN, A. SEMA AND S.P. KANAUJIA

Department of Horticulture, School of Agricultural Sciences and Rural Development, Medziphema Campus, Nagaland University, Nagaland – 797106

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ABSTRACT

The efficacy of plant nutrients and growth regulators were investigated in the field of summer pineapple (Ananas comosus) cv. Kew to improve the post harvest quality and shelf life of fruit in a subtropical, subhumid and acidic soil of Nagaland during 2018-19 at SASRD, Nagaland University. Calcium chloride (0.5% and 1.0%), borax (0.5% and 1.0%), 100 ppm GA_3 and 200 ppm NAA were taken to carry out an experiment following randomized block design with nine treatments and three replications. Plant nutrients and growth regulators were sprayed separately two times in plant population at 15 days interval right after fruit set and the integrated approach showed a significant response in fruit growth, yield and quality. The plants treated with 1.0% $CaCl_2$ + 200 ppm NAA showed a quite better results in physiological matrix of fruit volume (825.5 cc), fruit weight (1.5kg), juice content (67.7 ml $100g^{-1}$ pulp), yield (60.8 t ha^{-1}) and fruit firmness (23.0 lb) while the highest pulp recovery percentage (73.0%) was noticed in 1.0% borax + 200 ppm NAA. The maximum TSS (17.6 ^{0}Brix), total sugar (13.0%), TSS:acid ratio (51.9), less acidity (0.34%) and maximum shelf life (12.7 days) was observed in pineapple treated with 0.5% $CaCl_2$ + 100 ppm GA_3.

Keywords: Pineapple, kew, nutrient, growth regulator, yield, quality

INTRODUCTION

Pineapple (*Ananas comosus* L.) is an herbaceous non-climacteric fruit plant belonging to the family bromeliaceae and is one of the few bromeliads to produce edible fruit. Pineapple is the most important and famous fruit crop in India because of its relishes and it is cultivated in an area of 108 thousand ha with a total production of 1802 thousand MT (Anon, 2020). It is considered the third most important tropical fruit in world production right after banana and citrus. In India, it is abundantly grown in West Bengal, Kerala, Karnataka, Bihar, Goa, Maharashtra and almost entire north east region. In north-eastern region of India, it is the second most important fruit crop under area and production because of its congenial weather and acidic soil with rich in organic matter. The most common and commercial cultivars grown in north east region are Giant Kew and Queen.

Pineapples produced from this region are qualitatively different and said to be among the best in the world as they are very sweet (high TSS) and has less fiber (3-5%) in pulp (Sema *et al.*, 2011). So, to make it very profitable in national and global market, it is very much urgent to develop the ways to improve the yield as well as quality of fruits in order to sustain the pineapple industry. Lack of sufficient information in pineapple on its nutritional requirement with sufficient quantity in time are the main drawback to get a good quantum as well as profitable and marketable size with nutritionally enriched fruits from north east region. Deficiency of micronutrient has become a major constraint to the productivity, stability and sustainability of crops in many Indian soils and may further deteriorate due to global warming (Kumar *et al.*, 2011). Nutrients like B, Ca and Zn play an important role in various enzymatic activities and synthesis as well as synchronize the flowering with excellent fruit quality. Calcium plays an important role in maintaining the quality of pineapple to the membrane and cell wall structure. Presence of boron in plants is also fundamentally important because they are directly related to fruit formation and quality. Plant growth regulators also function as chemical messengers for intercellular communication. Gibberellins control fruit growth and development in various ways at different stages. GA_3 significantly increased the weight of pineapple fruit cv. Comte de Paris. NAA is a

Corresponding author email: asarkar1919@rediffmail.com

synthetic auxin plant hormone, which is mostly used for propagation as well as quality improvement of many fruit crops (Sarkar and Ghosh, 2006). Considering the facts for enhancing the yield, quality and shelf life of pineapple, an integrated approach was envisaged by use of exogenous application of nutrient elements like calcium and boron and growth substances like NAA and GA_3.

MATERIALS AND METHODS

The investigation was carried out at Department of Horticulture, SASRD, Nagaland University, Medziphema Campus, Nagaland during the year of 2018 to 2019. The experimental plot was situated at an altitude of 305 meters above mean sea level with geographical location of 25^0 45' 43" N latitude and 93^0 53'04" E longitude and also represents a sub-tropical temperature (8.1 ^{0}C in winter to 33.6 ^{0}C in summer), atmospheric relative humidity (46 to 97%) and moderate to high rainfall (1500 mm to 3000 mm per annum). The soil pH was 5.3 with organic carbon 15g kg^{-1}. The experiment was laid out in randomized block design with nine treatments and three replications with a plant spacing of 30 cm x 60 cm x 90 cm. The treatments were comprised of: C_0: control, C_1: 0.5% $CaCl_2$ + 100 ppm GA_3, C_2: 0.5% $CaCl_2$ + 200 ppm NAA, C_3: 1.0% $CaCl_2$ + 100 ppm GA_3, C_4:1.0% $CaCl_2$ + 200 ppm NAA, C_5: 0.5% borax + 100 ppm GA_3, C_6: 0.5% borax + 200 ppm NAA, C_7: 1.0% borax + 100 ppm GA_3, C_8: 1.0% borax + 200 ppm NAA. Plant nutrients ($CaCl_2$ and borax) and growth regulators (GA_3 and NAA) were sprayed two times separately in plant population at 15 days interval right after fruit set but the application gap between plant nutrients and growth regulators was seven days. The nutrient sources calcium as calcium chloride ($CaCl_2$) and boron as borax were sprayed by adding required amount of lime to neutralize the solution. The growth regulators gibberellic acid and naphthalene acetic acid were diluted with absolute ethyl alcohol before spraying. A sticker agent Indtron AE (non-ionic surfactant) was dissolved in the solution of growth regulators and plant nutrients for increasing residence time of the droplets on the leaves. Dry matter content was determined using hot air oven and fruit firmness by a penetrometer. Total soluble solids (TSS) were determined with the help of hand refractometer calibrated in ^{0}Brix at 20 ^{0}C with necessary correction factor. Total sugar was determined using Fehling's reagents with methylene blue as an indicator and acidity by titrating the extracted juice against N/10 NaOH using phenolphthalein as an indicator and ascorbic acid using 2, 6-dichlorophenol indophenols dye titration method following the standard procedure of A.O.A.C (1995). Crude protein was determined by adopting standard procedure of nitrogen estimation of pulp (kjeldahl method) and worked out using the formula: % crude protein= % nitrogen content × 6.25. The crude fibre content of flesh was estimated by gravimetrically after digestion with standard solution of sulphuric acid and sodium hydroxide. The fibre residue weight was then corrected for ash content after ignition. The crude fibre content was calculated by using formula suggested by Thimmaiah (2012).

RESULTS AND DISCUSSION

Physical attributes

The different treatments in summer pineapple showed a considerable variation in the physical attributes of fruit (Table 1). Fruit treated with 1.0% $CaCl_2$ + 200 ppm NAA showed maximum fruit volume (825.5 cc), fruit weight with crown (1.5 kg) and juice content in fruit (67.7ml $100g^{-1}$ pulp) whereas the highest pulp recovery percentage (73.0%) was noted by 1.0% borax + 100 ppm GA_3. The results were in conformity with the findings of Kumar *et al.* (2013) who found maximum fruit volume due to augmentation of hormones NAA @ 50 ppm and GA_3 @ 100 ppm. Sandhu (2013) indicated that application of 40 ppm NAA raised endogenous level of hormone in lemon fruit and helped in development of fruit size and juice percentage due to cell expansion by auxin like substances. Significant yield was acquired by application of plant nutrients and growth regulators. The highest yield (60.8 t ha^{-1}) was noted in plants treated with 1.0% $CaCl_2$ + 200 ppm NAA followed by 1.0% borax + 100 ppm GA_3 (52.5 t ha^{-1}). The result was also in accordance with Bakeer (2016) who recorded higher yield in manfalouty pomegranate by foliar application of 1.0% $CaCl_2$. The significant fruit weight as well as higher yield with crown (82.60 t ha^{-1}) were also noticed by Suresh *et al.* (2010) spraying with 10 ppm NAA in pineapple cv. kew. The moisture content in leaf was found to vary in between 77.8% to 90.9% during summer and the highest leaf water content (90.9%) was noticed by 0.5% $CaCl_2$ + 100 ppm GA_3.The moisture content in leaf showed a profound effect in quality improvement specially in biochemical composition of fruits (TSS and total sugar). The highest fruit firmness (23.0lb) was noted with application of 1.0% $CaCl_2$ + 200 ppm NAA followed by 1.0% $CaCl_2$ + 100 ppm GA_3 with 22.3lb. It might be the facts that calcium increased skin tensile strength by application of calcium chloride along with growth regulators. Similar findings were also found in litchi by application of calcium to minimize fruit cracking and improved skin tensile strength in cell wall of fruits (Haq and Rab, 2012; Sarkar, 2008). Qureshi *et al.* (2013) also recorded higher fruit firmness (0.883±0.02) treated with 50 ppm gibberellic acid in strawberry.

Table 1: Effect of micronutrients and growth regulators on yield and yield attributing characters in summer pineapple

Treatments	Fruit volume (cc)	Fruit weight with crown (kg)	Yield (t ha^{-1})	Pulp recovery (%)	Juice (ml $100g^{-1}$ pulp)	Dry matter (%)	Fruit firmness (lb)	Moisture in leaf (%)
C_0	532.3	0.87	29.7	64.6	41.7	3.6	14.3	77.8
C_1	619.7	1.21	44.0	69.9	53.3	2.5	20.0	90.9
C_2	790.8	1.12	46.7	65.0	62.7	2.3	16.0	84.9
C_3	639.8	1.22	44.8	67.3	52.7	3.0	22.3	86.7
C_4	825.5	1.50	60.8	70.2	67.7	2.3	23.0	88.9
C_5	703.1	1.17	42.9	65.7	49.0	2.9	19.7	88.9
C_6	689.8	1.14	49.5	69.5	59.0	2.4	16.7	87.0
C_7	735.1	1.44	52.5	64.3	59.3	2.8	20.0	80.0
C_8	683.4	1.16	46.7	73.0	61.0	2.8	16.0	83.3
SEm ±	3.19	0.06	1.06	1.01	2.26	0.27	0.84	0.70
CD (P=0.05)	9.55	0.17	3.18	3.01	6.79	0.90	2.53	2.11

C_0: control, C_1: 0.5% $CaCl_2$ + 100 ppm GA_3, C_2: 0.5% $CaCl_2$ + 200 ppm NAA, C_3: 1.0% $CaCl_2$ + 100 ppm GA_3, C_4:1.0% $CaCl_2$ + 200 ppm NAA, C_5: 0.5% borax + 100 ppm GA_3, C_6: 0.5% borax + 200 ppm NAA, C_7: 1.0% borax + 100 ppm GA_3, C_8: 1.0% borax + 200 ppm NAA

Bio-chemical attributes

Application of nutrients and growth regulators significantly influenced the biochemical attributes of pineapple fruit (Table 2). The plants treated with 0.5% $CaCl_2$ + 100 ppm GA_3 showed the highest level of T.S.S (17.6^0 Brix) with less acidity (0.34%) and maximum TSS/acid ratio (51.9) in fruit which was followed by 1.0% $CaCl_2$ + 100 ppm GA_3 application (TSS 17.3^0 Brix, acidity 0.36% and TSS/acid ratio 47.6). Qureshi *et al.* (2013) found higher total soluble solids (8.4ºBrix) in strawberry plants treated with 50 ppm GA_3 + 0.4% $CaCl_2$. Increase in TSS with higher concentration during ripening might be due to transformation of complex sugar into simpler form under the action of the phosphorylase enzyme. The total sugar content in fruit was also significantly influenced by application of nutrients and growth regulators. The total sugar content of fruit varied in between 8.4 and 12.8% due to different treatments. The maximum total sugar (13.0%) content was noticed in 0.5% $CaCl_2$ + 100 ppm GA_3 which was statistically at par with 0.5% $CaCl_2$ + 200 ppm NAA (12.8%) and 1.0% $CaCl_2$ + 100 ppm GA_3 (12.8%). These results were in alliance with the findings of Bam (2016) who got maximum TSS and total sugar content in litchi fruit cv. China spraying with 2.0% $CaCl_2$. The impact of nutrients and growth regulators on Vit-C content in fruit pulp did not show a wide variation among the treatments and it varied between 19.3 and 26.1 mg $100g^{-1}$ pulp. The maximum vit-C content was found by application with 1.0% borax + 200 ppm NAA (26.1 mg $100g^{-1}$ pulp) followed by 1.0% $CaCl_2$ + 100 ppm GA_3 (26.0 mg $100g^{-1}$ pulp) while the lowest in control (19.3 mg $100g^{-1}$ pulp). Wei *et al.* (2017) stated that boron was an important factor affecting the vit-C content in pineapple fruit and Vit-C content increased to 19.29 mg $100g^{-1}$ with the increase in the concentration of boron (4.0 mg kg^{-1}). Improvement in quality of fruit may be due to the fact that boron is associated with carbohydrate transportation within the plants. The variation in crude protein (2.1% to 3.8%) was noticed significantly by application of nutrients and growth regulators. Crude protein in pulp was lowest in control (2.1%) while others were found to be statistically at par with each other.

Table 2: Effect of micronutrients and growth regulators on physico-chemical composition in summer pineapple

Treatments	TSS (^{0}B)	Acidity (%)	TSS/acid (ratio)	Total sugar (%)	Vit-C (mg $100g^{-1}$ pulp)	Crude protein (%)	Crude Fiber in pulp (%)	Shelf life of fruit (days)
C_0	14.2	0.58	24.4	8.4	19.3	2.1	5.2	7.7
C_1	17.6	0.34	51.9	13.0	24.7	3.3	3.4	12.7
C_2	16.6	0.37	45.3	12.8	25.1	3.5	3.4	9.7
C_3	17.3	0.36	47.6	12.8	26.0	3.8	3.7	10.3
C_4	17.0	0.36	47.3	12.3	25.9	3.7	3.8	10.0
C_5	15.6	0.37	42.5	11.4	23.4	3.8	3.8	10.3
C_6	16.0	0.36	44.4	11.3	25.5	3.6	3.6	10.3
C_7	16.0	0.36	43.9	11.8	25.2	3.7	3.2	10.0
C_8	16.0	0.38	42.4	11.2	26.1	3.7	3.3	10.3
SEm ±	0.36	0.01	0.82	0.23	0.60	0.11	0.17	0.40
CD (P=0.05)	1.07	0.03	2.45	0.68	1.81	0.34	0.51	1.19

The lower fiber content in fruit pulp was noticed in treated fruits (3.2% to 3.8%) over control (5.2%). Pardo *et al.* (2014) found 1.58% crude protein and 24.14% crude fiber in mexican pineapple pulp. The harvested fruits were stored under normal room temperature to estimate the shelf life of fruit and it remained upto 7.7 to 12.7 days for marketable condition. The plants sprayed with 0.5% $CaCl_2$ + 100 ppm GA_3 enhanced the shelf life (12.7 days) of fruits during storage while the lowest was in control (7.7 days). Application of calcium played a vital role in mechanical properties of cell wall structure and provided ionic bonds between pectins, which contributed to the cohesiveness between cells and the tensile strength of producing calcium-pectate bond in middle lamella of cell walls as well as skin. These findings were in agreement with earlier findings of Lodhi and Tiwari (2017) who exhibited better quality in favour of total soluble solids, total sugar and rendering acceptable upto period of 10 days with 1.0% $Ca(NO_3)_2$ in aonla fruits.

Therefore, it may be concluded that the summer pineapples treated with 1.0% $CaCl_2$ along with 200 ppm NAA was the best concentration for crop improvement like yield and quality of fruits, while 0.5% $CaCl_2$ combined with 100 ppm GA_3 gave a satisfactory result in context of biochemical attributes and better shelf life of fruit.

REFERENCES

Anonymous (2020) *Pocket book of Agriculture Statistics*. Ministry of Agriculture and Farmers Welfare. Directorate of economics and statistics. Govt. India.

A.O.A.C. (1995) *Official Method of analysis*. Association of official analytical chemist, Washington D.C, USA. 14th Edn.

Bakeer, S.M. (2016) Effect of ammonium nitrate fertilizer and calcium chloride foliar spray on fruit cracking and sunburn of manfalouty pomegranate trees. *Scientia Horticulture* **209**: 300–308

Bam, G. (2016) Impact of chemicals in management of fruit cracking in litchi *cv* china. *M.Sc. thesis,* Department of Horticulture, SASRD, Nagaland University, Nagaland.

Haq, I. and Rab, A. (2012) Foliar application of calcium chloride and borax on fruit skin strength and cracking incidence in litchi (*Litchi chinensis* Sonn.). *African journal of biotechnology* **11** (10): 2445-2453.

Kumar, M., Swarup, A., Patra, A.K. and Chandrakala, J.U. (2011) Micronutrient fertilization under rising atmospheric CO_2 for micronutrient security in India. *Indian Journal of Fertilizers* **7**(7): 52-60.

Kumar, R., Tiwari, R. and Kumawat, B.R. (2013) Quantitative and qualitative enhancement in guava (*Psidium guajava* L.) cv. Chittidar through foliar feeding. *International Journal of Agricultural Sciences* **9** (1): 177-181

Lodhi, D.K and Tiwari, R. (2017) Effect of calcium nitrate on physico-chemical changes and shelf-life of aonla (*Emblica officinalis* Gaertn.) fruits. *Annals of plant and soil research* **19**(1): 32-36

Pardo, M.E.S., Cassellis, M.E.R. Escobedo1, R.M. and Garcia, E.J (2014) Chemical characterisation of the industrial residues of the pineapple (*Ananas comosus*). *Journal of Agricultural Chemistry and Environment* **3**: 53-56

Qureshi, K.M., Chughtai, S., Qureshi, S.U. and Abbasi, N.A. (2013) Impact of exogenous application of salt and growth regulators on growth and yield of Strawberry. *Pakistan Journal of Botany* **45** (4): 1179-1185

Sandhu, S. (2013) Improving lemon [*Citrus limon* (L.) Burm.] quality using growth regulators. *Journal of Horticultural Science* **8** (1): 88-90

Sarkar, A. and Ghosh, B (2006) Effect of different growth regulators on fruit retention and yield of Mango cv. Amrapalli in new alluvial zone of West Bengal. *The Horticulture Journal* 19 (2): 73-75.

Sarkar, A. (2008) Orchard management practices for quality litchi (*Litchi chinensis* Sonn.) production*. Ph.D thesis*. Faculty of Horticulture, BCKV, Nadia, W.B.

Sema, A., Maiti, C.S. and Dietholhou. (2011) Pineapple cultivation in North East India- a prospective venture. *Acta Horticulturae* 902: 69-78

Suresh, C.P., Pal, R., Deb, P., Bhutia, K.D., Roy, A. and Hasan, M.A. (2010) Effect of NAA and Ethrel on yield and quality of pineapple (*Ananas comosus* L.), Newsletter of the pineapple Working Group, *International Society of Horticultural Science*. Hawaii **17**: 20

Thimmaiah, S.K. (2012) Standard methods of biochemical analysis. Kalyani publisher, Ludhiana, Punjab.

Wei, C., Ma, Z., Liu, Y., Qiao, J. and Sun, G. (2017) Effect of plant growth regulators on fruit crops. *International Conference on Biotechnology and Bioengineering* pp: 1-5