Journal of Pharmacognosy and Phytochemistry
Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
www.phytojournal.com
JPP 2021; 10(1): 824-826
Received: 10-11-2020
Accepted: 12-12-2020

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Effect of different sources of nitrogen on fruit quality and shelf life of custard apple (*Annona squamosa* L.) cv. Sindhan

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Abstract
A field experiment was carried out on "Effect of different sources of nitrogen on fruit quality and shelf life of custard apple (A*nnona squamosa* L.) cv. Sindhan" at Horticultural Research Farm, Department of Horticulture, B. A. College of Agriculture, Anand Agricultural University, Anand during *Kharif-rabi* season of the year 2019. The experiment was laid out in Completely Randomized Design repeated thrice with thirteen treatments. Among the different treatments soil application of 50% RDN from Urea + 25% RDN from Poultry manures + 10 ml *Azotobacter* per plant treatment was recorded significantly maximum total soluble solids (25.19 ^{0}Brix), reducing sugar (18.83%), non-reducing sugar (6.20%), total sugar (24.98%) and ascorbic acid (21.05 mg/100 g pulp).

Keywords: Custard apple, poultry manure, azotobacter, quality and self-life

Introduction
Custard apple (*Annona squamosa* L.) is a delicious and important minor fruit crop cultivated in tropical and subtropical climate. It comes under family Annonaceae and is native of the West Indies but also cultivated throughout Central America to Southern Mexico during early times. Young leaves of custard apple contain steroids, alkaloids, saponins, terpenes, tannins, phenolic substances, carbohydrates, mucilage and volatile oil (Kumar and Kumar, 2011) [3]. It has good pleasant flavour, mild aroma and sweet taste. It has a universal acceptance. Custard apple is also known as sweetsop, sugar apple, *sharifa*, *sitaphal* and *noi-na* in different parts of India. The ripened fruits are consumed mainly in fresh form. It has been great demand for custard apple in preparation of ice-cream and pudding. Due to the presence of annonaine, the leaves, stem and other portions of the plant are bitter and so the plant is not grazed by goats and cattle. Moreover, the area under custard apple cultivation is increasing day by day in India. The successful commercial cultivation of custard apple depends on many factors *viz.*, climate, soil, irrigation, fertilization as well as growing season, *etc.*
Nitrogen is one of the most important element as well as expensive input in horticultural production. Addition of organic and inorganic sources of fertilizers is not only remedy for supplementation and improvement of soil fertility and productivity but also improved soil physical condition which result more water retention as well as increase soil flora and founa.
Poultry manure is relatively resistant to microbial degradation. However, it is essential for establishing and maintaining optimum soil physical condition and important for plant growth. Poultry manure is very cheap and effective as a good source of nitrogen for sustainable crop production.
Azotobacter is a microbial inoculants freely living in the soil which are capable to fixation of nitrogen elements from non-soluble to soluble form through biological process. *Azotobacter* are used in live formulation of beneficial micro-organism and which can apply to root, soil or seed mobilize the availability of nutrients particularly by their biological activity and help to build up the lost micro flora and in turn improve the soil health (Hazarika and Ansari, 2007) [2].

Methods and Materials
The present experiment was carried out on "Effect of different sources of nitrogen on fruit quality and shelf life of custard apple (*Annona squamosa* L.) cv. Sindhan." at Horticultural Research Farm, Department of Horticulture, B. A. College of Agriculture, Anand Agricultural University, Anand during *kharif-Rabi* season in the year 2019. Anand is situated on 22^0 35' North latitude and 72^0 56' East longitudes. The climate of Anand region is semi-arid and sub-tropical type. Soil of the experimental site was loamy sand, locally known as *"Goradu"*. The soil is well drained and retentive of moisture.

The research investigation conducted on 11 years old custard apple plant cv. Sindhan which is planted 5 x 5 meter spacing and plants of Sindhan cultivar has medium size canopy, hardy, deciduous and slightly tolerant to drought condition.

The experiment was laid out in Completely Randomized Design with thirteen treatments with three repetition *viz.*, T_1- 100% RDN from Urea, T_2 - 75% RDN from Urea + 25% RDN from Vermicompost, T_3 - 75% RDN from Urea + 25% RDN from Castor cake, T_4 - 75% RDN from Urea + 25% RDN from Neem cake, T_5 - 75% RDN from Urea + 25% RDN from Poultry manure, T_6 - 50% RDN from Urea + 50% RDN from Vermicompost, T_7 - 50% RDN from Urea + 50% RDN from Castor cake, T_8 - 50% RDN from Urea + 50% RDN from Neem cake, T_9 - 50% RDN from Urea + 50% RDN from Poultry manure, T_{10} - 50% RDN from urea + 25% RDN from Vermicompost + 10 ml *Azotobacter*, T_{11} - 50% RDN from Urea + 25% RDN from Castor cake + 10 ml *Azotobacter*, T_{12} - 50% RDN from Urea + 25% RDN from Neem cake + 10 ml *Azotobacter* and T_{13} - 50% RDN from Urea + 25% RDN from Poultry manures + 10 ml *Azotobacter* per plant.

The soil application of full dose of *Azotobacter*, different manures and half dose of Urea were applied as basal dose in last week of June whereas, remaining half dose of Urea given in last week of August. One plant was selected randomly in each treatment of respective repetition for recording data on various traits *i.e.*, Total Soluble Solids (ºBrix), reducing sugar (%), non-reducing sugar (%), total sugar (%), ascorbic acid (mg/100 g pulp), acidity (%) and fruit shelf life (days). The data pertaining to all the characters studied were subjected to the statistical analysis of variance technique as described by Steel and Torrie (1980) [5].

Result and Discussion

Effect on fruit quality parameters

Total soluble solids (ºBrix)

The total soluble solids were significantly affected by soil application of Urea, *Azotobacter* and different manures. The significantly maximum total soluble solids (25.19 º Brix) was recorded with soil application of 50% RDN from Urea + 25% RDN from Poultry manure + 10 ml *Azotobacter* per plant (T_{13}) treatment. It was statistically at par with T_6 (50% RDN from Urea + 50% RDN from Vermicompost per plant) treatment and T_{12} (50% RDN from Urea + 25% RDN from Neem cake + 10 ml *Azotobacter*) treatment. However, lowest total soluble solids (22.69 º Brix) were obtained with T_8 (50% RDN from Urea + 50% RDN from Neem cake) treatment. Its might be due to more absorption of nitrogen and phosphorus may have drawn regulatory role as enhanced vegetative growth and photosynthesis which led to accumulation of higher quantity of carbohydrates, starch and other metabolites ultimately translocation toward the fruits and also improve endogenous factors affecting in quality of fruit and during ripening of fruits the carbohydrate reserves of the stem and roots are drawn upon heavily by fruits which might have resulted into improve total soluble solids (TSS) contents in fruits. Inoculation of different *Azotobacter* strains in soil thereby increase fruit sugars in tomato (Antipchuk *et al.*, 1982) [1]. The similar result was also accordance with the findings of Osman and Rhman (2010) [4].

Reducing sugar (%)

The reducing sugar was significantly affected by soil application of Urea, *Azotobacter* and different manures. The significantly highest reducing sugar (18.83%) was recorded with soil application of 50% RDN from Urea + 25% RDN from Poultry manure + 10 ml *Azotobacter* per plant (T_{13}) treatment which was statistically at par with T_9 (50% RDN from Urea + 50% RDN from Poultry manure) treatment, T_{10} (50% RDN from Urea + 25% RDN from Vermicompost + 10 ml *Azotobacter*) treatment, T_{12} (50% RDN from Urea + 25% RDN from Neem cake + 10 ml *Azotobacter*) treatment, T_6 (50% RDN from Urea + 50% RDN from Vermicompost) treatment and T_7 (50% RDN from Urea + 50% RDN from Castor cake) treatment. However, the minimum reducing sugar (15.84%) was found with T_1 (100% RDN from Urea) treatment. Its might be due to the beneficial effect of poultry manure and *Azotobacte*r on the total leaf area of plant which reflected in more carbohydrates production through photosynthesis which accelerated metabolic transformation of starch and pectin into soluble compounds and prompt translocation of sugars from leaves to the developing fruits. The result was agreed with the findings of Osman and Rhman (2010) [4].

Non reducing sugar (%)

The non-reducing sugar was significantly affected by soil application of Urea, *Azotobacter* and different manures. The significantly maximum non-reducing sugar (6.20%) was recorded with soil application of 50% RDN from Urea + 25% RDN from Poultry manure + 10 ml *Azotobacter* per plant (T_{13}) treatment which was statistically at par with T_6 (50% RDN from Urea + 50% RDN from Vermicompost) treatment, T_{11} (50% RDN from Urea + 25% RDN from Castor cake + 10 ml *Azotobacter*) treatment and T_5 (75% RDN from Urea + 25% RDN from Poultry manure) treatment. However, the lowest non-reducing sugar (5.20%) was obtained with T_8 (50% RDN from Urea + 50% RDN from Neem cake) treatment. Its might be due to better availability of nitrogen in soil from poultry manure and *Azotobacter* results more absorption of nitrogen may have drawn regulatory role as enhanced vegetative growth and photosynthesis which led to accumulation of higher quantity of carbohydrates, starch and other metabolites and during ripening of fruits the reserves carbohydrate of the stem and roots translocation toward the fruits which may improve reducing sugar contents in fruits. The results were also accordance with the findings of Osman and Rhman (2010) [4].

Total sugar (%)

The total sugar was significantly influenced by soil application of Urea, *Azotobacter* and different manures. The significantly maximum total sugar (24.98%) was found with soil application of 50% RDN from Urea + 25% RDN from Poultry manure + 10 ml *Azotobacter* per plant (T_{13}) treatment which was statistically at par with T_9 (50% RDN from Urea + 50% RDN from Poultry manure) treatment. However, the minimum total sugar (21.10%) was found with T_1 (100% RDN from Urea) treatment. Its might be due to application of *Azotobacter and* poultry manure with lower dose of inorganic fertilizers might have exhibited regulatory role on the absorption and translocation of carbohydrates and various metabolites which affects the sugar content of fruits. The improvement of total sugar attribute might be due to improvement of soil physical properties such as porosity, water holding capacity, dreased bulk density and tendency of soil toward neutral pH range which turn increased microbial biomass in rhizosphere resulting continuous supplement to the

plant. The results were in close conformity with the findings of Osman and Rhman (2010) [4].

Ascorbic acid (mg/100 g pulp)

The ascorbic acid was significantly influenced by soil application of Urea, *Azotobacter* and different manures. The significantly maximum ascorbic acid (21.05 mg/ 100 g pulp) was found with soil application of 50% RDN from Urea + 25% RDN from Poultry manure + 10 ml *Azotobacter* per plant (T_{13}) treatment which was statistically at par with T_{10} (50% RDN from Urea + 25% RDN from Vermicompost + 10 ml *Azotobacter*) treatment. However, minimum ascorbic acid (17.10 mg / 100 g pulp) was obtained with T_4 (75% RDN from Urea + 25% RDN from Neem cake) treatment. It might be due to soil application of *Azotobacter* along with poultry manure improved physical condition of soil, enhanced root development by mycellial network of microorganisms, more moisture retention and thus improved absorption of water and continuous supply of nitrogen and other essential minerals which enhance photosynthesis of plant resulting more starch reserve in shoots and roots which is translocation from shoots to fruits during maturation helps in formation of ascorbic acid. The result was also accordance with the findings of Osman and Rhman (2010) [4].

Acidity (%)

The data indicated non-significant effect of soil application of Urea, *Azotobacter* and different manures on fruit acidity. However, numerically minimum acidity (0.26%) was obtained with T_{13} (50% RDN from Urea + 25% RDN from Poultry manure + 10 ml *Azotobacter*) treatment.

Shelf life (Days)

The result indicated non-significant effect of soil application of Urea, *Azotobacter* and different manures on shelf life (days). However, numerically highest shelf life (6.68 days) was obtained with T_{13} (50% RDN from Urea + 25% RDN from Poultry manure + 10 ml *Azotobacter*) treatment.

Table 1: Effect of different sources of nitrogen on fruit quality parameters of custard apple cv. sindhan

Sr. No.	Treatment details	Total soluble solids (ºBrix)	Reducing sugar (%)	Non-reducing sugar (%)	Total sugar (%)	Ascorbic acid (mg/100 g pulp)	Acidity (%)	Shelf life (Days)
T_1	100% RDN from Urea	23.65	15.84	5.26	21.10	17.23	0.35	5.64
T_2	75% RDN from Urea + 25% RDN from Vermicompost	22.69	16.48	5.40	21.94	18.42	0.32	6.31
T_3	75% RDN from Urea + 25% RDN from Castor cake	23.67	17.23	5.65	22.88	17.90	0.33	5.68
T_4	75% RDN from Urea + 25% RDN from Neem cake	22.93	16.54	5.53	22.07	17.52	0.31	6.17
T_5	75% RDN from Urea + 25% RDN from Poultry manure	23.08	16.43	5.88	22.31	17.40	0.26	5.77
T_6	50% RDN from Urea + 50% RDN from Vermicompost	24.06	17.47	6.10	23.57	18.74	0.29	5.95
T_7	50% RDN from Urea + 50% RDN from Castor cake	23.07	17.39	5.27	22.66	17.93	0.32	5.88
T_8	50% RDN from Urea + 50% RDN from Neem cake	22.86	16.74	5.20	21.88	18.20	0.29	5.89
T_9	50% RDN from Urea + 50% RDN from Poultry manure	23.23	18.64	5.45	24.28	18.11	0.30	6.14
T_{10}	50% RDN from Urea + 25% RDN from Vermicompost + 10 ml *Azotobacter*	23.84	17.72	5.62	23.30	19.68	0.31	6.03
T_{11}	50% RDN from Urea + 25% RDN from Castor cake + 10 ml *Azotobacter*	23.87	17.14	6.07	23.21	19.15	0.26	6.10
T_{12}	50% RDN from Urea + 25% RDN from Neem cake + 10 ml *Azotobacter*	24.39	17.52	5.65	23.17	19.28	0.27	6.33
T_{13}	50% RDN from Urea + 25% RDN from Poultry manures + 10 ml *Azotobacter*	25.19	18.83	6.15	24.98	21.05	0.23	6.68
	SEm±	0.40	0.50	0.10	0.40	0.59	0.02	0.20
	C.D. at 5%	1.15	1.45	0.29	1.15	1.71	NS	NS
	C.V.%	2.90	5.02	3.08	3.00	5.50	15.43	5.82

Conclusion

From the foregoing discussion, it can be concluded that the soil application of 50% RDN from Urea + 25% RDN from Poultry manure + 10 ml *Azotobacter* per plant improve fruit quality of custard apple cv. Sindhan.

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