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Impact of poultry manure on fruit quality attributes and nutrient status of guava (*Psidium guajava*.) cv. L 49 plant

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ABSTRACT

Management of nutrients in guava refers (*Psisdium guajava* L.) to maintenance of the soil fertility and plant nutrient supply to an optimum level for sustaining the desired crop productivity and fruit quality through optimization of benefits from all the possible sources in an integrated manner. Qualitative and quantitative attributes of guava fruit cv. Lucknow 49 were analyzed with the aim of corresponding the nutrients to the quality of the fruit where fertilizer dose of N were manipulated in different treatments. Soil and leaf study were conducted to analyze the status of nutrients in guava. The pooled analysis of two year data indicated that after fruit harvest the highest soil organic carbon (0.72%) was obtained with the treatment comprising (*Azotobacter* + 100% N poultry manure. Soil N and P (271.36 and 19.86 kg/ha), Ca and Mg (7.12 and 2.82 meq 100/g soil), respectively, were recorded maximum with the treatment comprising *Azotobacter* + 50% N poultry manure + 50% N urea. The same treatment also showed highest leaf N and P (1.78 and 0.16%), Ca and Mg (2.09 and 0.91%) contents, respectively, on dry weight basis. The highest soil K (148.53 kg/ha) and leaf K (1.27% on dry weight basis) contents were obtained with the application of *Azotobacter* + 75% N poultry manure + 25% N urea. The pooled analysis of two year data also indicated that 50% N poultry manure + 50% N urea showed highest fruit yield (42.89 kg/plant), maximum fruit length (8.47 cm), breadth (8.02 cm), weight (248.80 g) and pulp weight (218.68 g) while, *Azotobacter* + 50% N/tree through FYM + 50% N/tree through inorganic fertilizer showed highest TSS (13.01°B), total sugars (8.68%) and minimum physiological loss in weight (13.20%) after 10 days during storage under ambient conditions. The results suggested that fertilization of guava with chemical fertilizers can be minimized when nitrogen is applied half with poultry manure and half with urea augmented with *Azotobacter*.

Key words: *Azotobacter*, India, Integrated Nutrient Management, *Psidium guajava*, Poultry manure

Guava (*Psidium guajava* L.) exceeds most other fruit trees in productivity, hardiness, adaptability and tolerance to mild cold and night frosts. Hence, it has a tremendous scope in areas where other fruit crops fail to give economical production. This has prompted several orchardists to take up guava cultivation on a commercial scale. Being hardy tree, it suits in varying agro-climatic situations and provides remunerative income to farmers. Under sub-tropical areas in Jammu region of Jammu and Kashmir, state of India, guava culture has shown tremendous potential to be the most remunerative crops for the last one decade despite of the erratic climatic conditions (drought like situations), which in turn has boosted the area under this crop. However, in order to make it more acceptable for consumer point of view, there has been a surge of interest to adopt certain measures such as Integrated Nutrient Management (INM) for making its culture ecofriendly by reducing the tradition of inorganic fertilizers, pesticides and other synthetic formulations. Since, guava fruit is beneficial to consumer and growing of this crop is commercially viable for the farmers, there has been a dynamic shift in production system, moving from subsistence cultivation to commercial production system.

Among the various factors, which affect the production and productivity of guava, nutrients assumed much more significance. These two inputs, viz. poultry manure and *Azotobacter* are essentially required to be managed in a manner, which provides maximum output. Management of nutrients in guava refers to maintenance of the soil fertility and plant nutrient supply to an optimum level for sustaining the desired crop productivity and fruit quality through optimization of benefits from all the possible sources in an integrated manner. Inadequacy of one or other nutrients at

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critical stage of fruit development, adversely affect the productivity and quality of produce (Sharma *et al.* 2013). Thus field trials, coupled with soil and leaf nutrient content have been evaluated for monitoring nutritional requirements of guava (Sharma *et al.* 2013). Characterization of soil, based on chemical and physical properties were used as guide to assess fertility level. Therefore, keeping in view the need for cost effective and ecofriendly guava production, the present investigation was undertaken to study the impact of integrated effect of poultry manure, urea and *Azotobacter* on fruit quality attributes and nutrient status of guava cv. L49 plant.

MATERIALS AND METHODS

This study was conducted on 16 year old grafted guava plants cv. Lucknow 49 having uniform vigour, size and productivity. The experiment was laid out in the research farm of Division of Fruit Science, Faculty of Agriculture, Udheywalla, SKUAST-Jammu during winter season in the sub-tropical zone at latitude of 32.43^0 North and longitude of 74.54^0 East. The winter months experience mild temperature ranging from 6.5 to 21.7 ^{0}C. The farm soil was sandy loam in texture and initial soil status of experimental orchard with regard to mechanical and chemical properties are presented in Table 1 The dose of NPK (572:207:265 g/tree) for guava tree as recommended in the package and practices for fruit crops of SKUAST-J was maintained in the experiment, where only N was manipulated through different levels. Fertilizers were applied after regulating the crop for winter season crop with 1 000 ppm NAA, applied at full bloom stage in the second week of May.

A total of 12 treatments replicated thrice were executed in a randomized complete block design: T_1, 100% N/tree through poultry manure; T_2, 75% N/tree through poultry manure + 25% N/tree through inorganic fertilizer; T_3, 50% N/tree through poultry manure + 50% N/tree through inorganic fertilizer; T_4, 25% N/tree through poultry manure + 75% N/tree through inorganic fertilizer; T_5, 100% N/tree through inorganic fertilizer; T_6, *Azotobacter ;* T_7, *Azotobacter* + T_1 ; T_8, *Azotobacter* + T_2 ; T_9, *Azotobacter* + T_3 ; T_{10} , *Azotobacter* + T_4 ; T_{11}, *Azotobacter* + T_5 ; T_{12} , Control (no fertilization).

Table 1 Initial status of mechanical and chemical composition of soil

Particulars	Content
Mechanical analysis	
Sand (%)	68.5
Silt (%)	18.5
Clay (%)	13.0
Chemical analysis	
pH	7.5
Electrical conductivity (dS/m)	0.11
Organic carbon (%)	0.58
Available N (kg/ha)	230.15
Available P (kg/ha)	14.45
Available K (kg/ha)	140.5
Available Ca (meq 100/g)	6.04
Available Mg (meq 100/g)	2.65
Microbial population in guava rhizosphere	
Azotobacter counts ($\times 10^4$/g soil)	6.5

Poultry manure was applied to the trees around the trunk in the first week of July. *Azotobacter* with a uniform dose of 200 g plant^{-1} was mixed in jaggery solution prepared separately for each tree and were fed to roots. Urea was applied in two split doses; viz. first half dose one month before flowering and the rest after first fruit set. P and K were worked out after subtracting the quantity of nutrients supplied by organics, and remaining full quantity was applied through single super phosphate and muriate of potash in the mid of July.

Observations on fruit size (cm) (length and diameter), fruit weight (g) and fruit volume (cm^{-3}) were based on random five fruit samples. Fruit quality parameters, viz. total soluble solids (^{o}B), total sugars (%), reducing sugar (%) and acidity (%) were determined as per standard procedures (AOAC 1995). The non-reducing sugars were calculated by subtracting reducing sugars from total sugars and multiplying the difference by standard factor 0.95. Ascorbic acid (mg/100 g of pulp) was determined by using 2, 6-dichlorophenol indophenol dye**.** The initial soil status of the research orchard was determined by collecting the soil samples from different places of orchard with the help of auger 0-90 cm depth. The collected soil sample were mixed together and finally grinded to powder form for analysis to check the initial soil status of the research orchard with regard to mechanical and chemical properties of the soil. For analyzing the final soil status, the soil samples from each treatment were collected after the fruit harvest and were subject to analysis. An observation on organic carbon (%) in soil was determined by Walkley and Black's method (Piper 1966). Available N (kg/ha) was estimated by micro-Kjeldhal's method (Subbiah and Asija 1966). Available P (kg/ha) content of the soil was extracted with sodium bicarbonate and the blue colour intensity was measured colorimatically at 660 nm wavelengths (by vanado-molybdo-phosphoric yellow colour method (Olsen *et al.* 1954). Available K (kg/ha) was determined in the neutral normal ammonium acetate extract of soil through Flame photometer. Available Ca (meq/100g of soil) and Mg (meq/100g of soil) in the soil sample were determined by EDTA method. For *Azotobacter* population, soil samples from guava rhizosphere were collected around each tree from a depth of 0-30cm. The collected samples were mixed well and kept in the polythene bags, labeled and brought to laboratory. The excess water of the soil was removed by spreading the soil in the room temperature and then isolated by serial dilution agar plating method to calculate the *Azotobacter* population, i.e. counts × 10^4/g soil (Suba 1995).

Measurements of N(%), P(%), K(%), Ca(%) and Mg(%) in leaf were recorded from 20 fully mature leaves which were collected in July before fertilizer application (BFA) and in January after fruit harvest (AFH) on each treatment all around the trees. Nutrient content in fruits and leaves for total N was estimated by micro-Kjeldhal's method (Jackson 1973) on the basis of dry weight in leaves. Total P was determined by vanadomolybdo phosphoric yellow colour method (Jackson 1973). K content was estimated by Flame photometer. The estimation of Ca and Mg was done through atomic absorption spectrophotometer.

Data generated during the course of study were subjected to statistical analysis [10]. The statistical analysis was done to obtain the pooled mean from the data collected from two years of the experiment and the effects of the treatments were tested by one way analysis of variance (ANOVA). The results were expressed as means (n = 3) and means were compared among the treatments using the LSD (Least significant difference) test at the 0.05 probability level.

RESULTS AND DISCUSSION

The organic carbon, available N, P, K, Ca and Mg in soil

The available organic carbon, N, P, K, Ca and Mg after the fruit harvest revealed significant differences as shown in Table 2. The data showed that various integrated treatment combination had a significant effect on available soil organic carbon compared to control. The pooled data showed maximum organic carbon (0.72%) from the treatment receiving full dose of N through poultry manure + *Azotobacter* (T_7) while, lowest organic carbon (0.57%) was recorded under control (T_{12}). It was observed that organic manures increased the organic carbon over its initial value. The increase in soil organic carbon over initial value may be addition of bio-organic forms of N to the soil having narrow C : N ratio and high levels of activity of soil microflora. These results are in agreement with the findings of Bangoo *et al*. (1988) which stated that organic matter in soil increased with the application of organic manure.

Table 2 Status of available organic carbon, N, P, K, Ca and Mg contents of the soil as influenced by application of poultry manure, urea and *Azotobacter* in guava (Pooled data of two years)

Treatment	Organic carbon (%)	N (kg/ha)	P (kg/ha)	K (kg/ha)	Ca (meq/ 100 g soil)	Mg (meq/ 100 g soil)
T_1	0.69	240.49	16.47	144.02	6.25	2.69
T_2	0.68	242.77	17.15	146.17	6.38	2.70
T_3	0.66	260.86	18.28	145.81	6.73	2.76
T_4	0.65	260.07	18.20	145.73	6.69	2.75
T_5	0.60	250.66	18.26	145.23	6.47	2.72
T_6	0.62	236.73	14.85	143.03	6.04	2.65
T_7	0.72	248.86	17.50	144.68	6.44	2.70
T_8	0.70	258.28	17.97	148.53	6.51	2.70
T_9	0.69	271.36	19.86	148.30	7.12	2.82
T_{10}	0.66	270.46	19.69	147.39	7.06	2.75
T_{11}	0.64	267.89	19.17	146.84	6.83	2.75
T_{12}	0.57	231.36	13.14	136.16	5.95	2.64
CD (P=0.05)	0.02	2.32	1.39	1.13	0.26	0.04

The data presented in Table 2 also showed that the soil available N was maximum (271.36 kg/ha) with the treatment comprising 50% N through poultry manure + 50% N as urea augmented with *Azotobacter* (T_9) while, the lowest available N (231.36 kg/ha) was recorded under control (T_{12}). Similarly, the results so obtained on available P in soil after fruit harvest showed that with the application of 50% N in the form of poultry manure + 50% of N as urea augmented with *Azotobacter* (T_9) recorded maximum P (19.86 kg/ha) and the lowest (13.14 kg/ha) was recorded under control (T_{12}). The data on maximum available soil K (148.53 kg/ha) was recorded with the treatment comprising of 75% N supplemented by poultry manure + 25% N through urea augmented with *Azotobacter* (T_8). The minimum available soil K (136.16 kg/ha) was observed under the control. The result obtained on the soil available Ca recorded highest available soil Ca (7.12 meq/100g soil) with the application of 50% N through poultry manure + 50% N as urea augmented with *Azotobacter* (T_9). However, lowest available Ca (5.95 meq 100/g soil) was recorded under control (T_{12}). Similarly, the data on the available soil Mg showed maximum soil available Mg (2.82 meq 100/g soil) when pooled as compared to other treatments tried and the lowest soil available Mg 2.64 meq/100 g was observed under control (T_{12}). It was observed that nutrient when applied in an integrated manner plays an important role in improving the soil nutrient status and quality of fruit crops. The nutrients applied without organic manure were less effective in improving the guava production even at higher doses and more effective when applied with organic fertilizer. The causes and effective relationship among different treatments had a very positive effect in terms of yield, quality and nutrients status of guava. Available N, P, Ca and Mg were significantly increased with the application of 50% N through poultry manure + 50% N through urea augmented with *Azotobacter*. It showed marked increase in the soil available N while, the highest K was observed with the treatment comprising 75% of N through poultry manure + 25% N through urea augmented with *Azotobacter* showing statistically similarity with 50% N through poultry manure and rest of N applied through urea augmented with *Azotobacter*. It is well accepted fact that *Azotobacter* fix sufficient quantity of N in the rhizosphere, thus encouraging enough N uptake as well as available N. A build up of N in soil with different N sources and levels combined with bio-fertilizers increases the P, Ca and Mg (Gogoi *et al.* 2004) thereby found an increased available nutrients in soil after fruit harvest due to the application of *Azotobacter* and poultry manures. The evidences that poultry manure increases the organic carbon, available N, P, K, Ca and Mg in soil as reported by Albregts and Howard (1981).

Azotobacter population, N and P contents in leaf and fruit of guava

The data on *Azotobacter* population after fruit harvest are presented in Table 3. After fruit harvest the maximum amount of *Azotobacter* population (26.86×10^4/g soil) was observed in T_7 with the application of full dose of N through poultry manure augmented with *Azotobacter,* the minimum amount of *Azotobacter* population 6.43×10^4/g soil was observed in control (T_{12}). It was observed that amount of *Azotobacter* population decreases when the dose of N through inorganic fertilizer increases.

The data in Table 3 *also showed* that N content in leaves before fertilizer application recorded highest N content (1.88%) in T_9 and T_{10} while, the lowest N content (1.77%) in leaves was recorded in control (T_{12}). After fruit harvest maximum amount of N content in leaves (1.78%) was recorded from the trees receiving 50% N as poultry manure + 50% N as urea augmented with *Azotobacter* while, the amount of N content in leaves was found minimum (1.56%) in control (T_{12}). The data related to average N content in fruits of guava showed significant difference as presented in Table 3 where pooled data showed that fruit N content reached to a maximum of 1.26% under the influence of 50% N application through poultry manure + 50% N as urea augmented with *Azotobacter* (T_9) while, lowest fruit N (0.91%) was recorded under control (T_{12}). An inquisition of the pooled data revealed that the leaf P (0.25%) before fertilizer application was observed maximum under T_9 whereas, pooled data showed minimum P (0.25%) content in leaves under control (T_{12}). The pooled data after fruit harvest showed that highest leaf P content (0.28%) was recorded from the trees treated with 50% N supplemented through poultry manure + 50% N through urea augmented with *Azotobacter* (T_9). Nonetheless, lowest leaf P (0.17%) was recorded in control (T_{12}) whereas, the P content in guava fruits (0.16%) was recorded highest from the guava trees treated with 50% N through poultry manure + 50% N through urea augmented with *Azotobacter* (T_9). It was observed that N content in leaf increased with increase in the rate of N (Sharma *et al.* 2009). Goswami *et al.* (2012) reported that integrated use of organics and inorganic sources of nutrients and bio-fertilizers increase N, P and K concentrations. Increase in leaf P might be due to increased leaf N (Webster 1961).

Table 3 Effect of poultry manure, urea and *Azotobacter* on *Azotobacter* population, on leaf and fruit N and P contents of guava (% dry weight)

Treatment	*Azotobacter* counts (10^4/g soil)		Leaf N (% DW)		Fruit N (% DW)	Leaf P (% DW)		Fruit P (% DW)
	BFA	AFH	BFA	AFH		BFA	AFH	
T_1	7.35	8.22	1.82	1.66	1.02	0.20	0.21	0.11
T_2	7.21	8.04	1.84	1.67	1.07	0.21	0.22	0.12
T_3	6.94	7.43	1.85	1.72	1.14	0.22	0.25	0.15
T_4	6.64	6.82	1.84	1.71	1.13	0.22	0.25	0.14
T_5	6.48	6.45	1.85	1.68	1.11	0.21	0.23	0.14
T_6	9.33	14.00	1.81	1.60	0.98	0.20	0.19	0.10
T_7	14.92	26.86	1.83	1.67	1.09	0.21	0.23	0.13
T_8	14.37	25.44	1.85	1.69	1.11	0.21	0.23	0.14
T_9	13.54	23.04	1.88	1.78	1.26	0.25	0.28	0.16
T_{10}	11.98	19.72	1.88	1.76	1.24	0.23	0.26	0.15
T_{11}	8.18	9.76	1.87	1.72	1.20	0.23	0.26	0.15
T_{12}	6.47	6.43	1.77	1.56	0.91	0.20	0.17	0.07
CD (P=0.05)	1.88	1.97	0.03	0.04	0.08	0.03	0.03	0.03

K, Ca and Mg content in leaf and fruit of guava

The pooled data obtained before fertilizer application on the K, Ca and Mg content in leaf and fruit of guava are presented in Table 4 where highest K (1.21%) content was recorded in T_8 and T_9 while, lowest leaf K (1.15%) was observed in control (T_{12}). However, after fruit harvest, pooled analysis depicted that highest leaf K (1.27%) was recorded with the treatment comprising 75% N through poultry manure 25% N through urea augmented with *Azotobacter* (T_8). The lowest leaf K (1.13%) was recorded under control. The statistical difference in average K content in guava fruit was significant in pooled estimates where maximum K content in guava fruit (0.97%) was recorded in treatments T_8 (75% N as poultry manure + 25% as urea along with *Azotobacter*) while, lowest fruit N (0.83%) was recorded under control (T_{12}). The pooled data in the Table 4 also showed that before fertilizer application, maximum Ca (1.98%) content in leaves was recorded in (T_9) while, lowest Ca content (1.79%) in leaves was obtained under control (T_{12}). After fruit harvest pooled estimates showed that highest leaf Ca (2.09%) was recorded in leaves collected from trees receiving 50% N in the form of poultry manure and 50% as urea augmented with *Azotobacter* (T_9), whereas, lowest leaf Ca (1.77%) was obtained under control (T_{12}). The pooled data also showed that the maximum Ca content in fruit (0.27%) was recorded under T_9 while, the lowest fruit Ca (0.12%) was recorded under control. The data on nutrient status of leaf and fruit Mg of guava before fertilizer application are also presented in Table 4 where maximum leaf Mg (0.86%) was recorded in T_9 whereas, lowest Mg content (0.77%) was recorded in control (T_{12}). After fruit harvest, the effect of various integrated treatments on leaf Mg content reached to a highest level of 0.91% with the treatment comprising of 50% N supplemented through poultry manure + 50% N through urea augmented with *Azotobacter* (T_9) while, the lowest leaf Mg (0.64%) was recorded under control (T_{12}). The statistical analysis of the data on Mg content of fruits showed maximum fruit Mg (0.71%) content with the treatment comprising 50% N through poultry manure + 50% through urea augmented with *Azotobacter* (T_9) while, the minimum fruit Mg (0.58%) was recorded in control (T_{12}). Leaf K showed inverse relation with N. This might be because of antagonistic effect of N on K (Kumar and Nauriyal 1980). The highest fruit N, P, Ca and Mg content was observed maximum with treatment comprising half of N applied through poultry manure and rest as urea augmented with *Azotobacter* which was also found at par with treatment combination of 25% N applied

Table 4 Effect of poultry manure, urea and *Azotobacter* on K, Ca and Mg contents of leaf and fruit of guava (% dry weight)

Treatment	Leaf K		Fruit K	Leaf Ca		Fruit Ca	Leaf Mg		Fruit Mg
	BFA	AFH		BFA	AFH		BFA	AFH	
T_1	1.17	1.18	0.88	1.92	1.90	0.18	0.78	0.75	0.62
T_2	1.19	1.21	0.95	1.92	1.91	0.19	0.80	0.76	0.64
T_3	1.18	1.20	0.94	1.95	1.96	0.23	0.85	0.84	0.67
T_4	1.18	1.20	0.94	1.95	1.95	0.22	0.85	0.82	0.66
T_5	1.17	1.19	0.91	1.93	1.92	0.20	0.80	0.79	0.65
T_6	1.18	1.16	0.87	1.90	1.86	0.15	0.76	0.72	0.60
T_7	1.17	1.19	0.91	1.93	1.92	0.20	0.79	0.77	0.64
T_8	1.21	1.27	0.97	1.93	1.95	0.21	0.82	0.80	0.65
T_9	1.21	1.26	0.96	1.98	2.09	0.27	0.86	0.91	0.71
T_{10}	1.19	1.23	0.95	1.96	2.05	0.25	0.85	0.90	0.70
T_{11}	1.19	1.22	0.95	1.95	1.96	0.23	0.85	0.85	0.68
T_{12}	1.15	1.13	0.83	1.79	1.77	0.12	0.77	0.64	0.58
CD (P=0.05)	0.02	0.03	0.04	0.07	0.05	0.04	0.06	0.08	0.04

through poultry manure and rest through urea augmented with *Azotobacter.* Higher N, K, and Ca contents in leaves might have resulted in higher amount of these nutrients because of better translocation of these nutrients from the leaves during the growth and development of the fruits.

Yield and some physical quality traits of guava fruit.

An inquisition of the pooled data in Table 5 revealed that various integrated nutrient treatments exhibited a significant influence on yield/tree. Guava trees had maximum yield of 42.89 kg/tree under T_9 (50% N supplemented through poultry manure + 50% N through urea augmented with *Azotobacter*) during the winter season while, the lowest yield (18.93 kg/tree) was obtained under control (T_{12}). This increase in yield attributes might be due to contribution of poultry manure and *Azotobacter* on more C/N ratio and greater uptake of nutrients. This may have lead to better metabolic activities in the tree which ultimately lead to high protein and carbohydrate synthesis. The increase in guava yield apparently might also be resulted from improved soil chemical and physical properties that were induced by integration of organic with inorganic fertilizers. These results are in agreements with the findings of Pereira *et al.* (1999) and Umar *et al.* (2008) who reported beneficial effects of combined application of organic manures and inorganic fertilizers on yield. The pooled data revealed that T_9 (50% N through poultry manure + 50% through urea augmented with *Azotobacter)* maintained the superiority as far as fruit length was concerned where maximum fruit length, 8.47cm was recorded and minimum fruit length (7.31cm) was obtained under control (T_{12}). Fruit diameter reached to a maximum of 8.02cm under T_9 (50% N through poultry manure + 50% through urea augmented with *Azotobacter*). All the treatments combinations tried resulted in significant increase in fruit diameter as compared to control (7.17cm). An examination of the pooled data revealed that various treatment combinations had significant effect on fruit weight which reached to a maximum of 248.80g under T_9 (50% N through poultry manure + 50% through urea augmented with *Azotobacter)* while, minimum fruit weight (126.99g) was obtained under control. The pooled data pertaining to the fruit volume in Table 5 showed maximum fruit volume (257.88/cm) in T_9 (50% N through poultry manure + 50% through urea augmented with *Azotobacter)* and the minimum fruit volume (124.50/cm) was obtained under control. Pooled data showed that pulp weight was observed maximum (218.68 g) in T_9 (50% N through poultry manure + 50% through urea augmented with *Azotobacter)* and minimum (94.13g) in control. (T_{12}). The pooled data also showed minimum specific gravity in T_9 and T_{10} registered the value 0.97 and maximum specific gravity was recorded (1.02) under control (T_{12}). The increase in fruit size (length and diameter), weight, volume and pulp weight might be due to

Table 5 Effect of poultry manure, urea and *Azotobacter* on yield, fruit size, weight, volume and specific gravity of guava fruit

Treatment	Yield (kg/ plant)	Length (cm)	Diameter (cm)	Fruit weight (g)	Fruit volume (cc)	Pulp weight (g)	Specific gravity
T_1	25.16	7.80	7.45	157.84	157.86	125.17	1.00
T_2	26.95	7.82	7.49	159.65	159.66	127.08	1.00
T_3	38.33	8.19	7.82	192.46	197.43	160.47	0.98
T_4	37.19	8.14	7.79	190.01	194.92	157.96	0.98
T_5	33.54	7.90	7.55	171.95	173.70	139.57	0.99
T_6	22.38	7.56	7.23	139.60	138.23	106.89	1.01
T_7	30.39	7.88	7.52	170.96	172.71	138.50	0.99
T_8	35.64	7.97	7.62	182.07	183.92	149.65	0.99
T_9	42.89	8.47	8.02	248.80	257.88	218.68	0.97
T_{10}	41.66	8.41	7.99	245.49	253.17	213.54	0.97
T_{11}	38.96	8.28	7.87	237.21	243.32	205.24	0.98
T_{12}	18.93	7.31	7.17	126.99	124.50	94.13	1.02
CD (P=0.05)	4.26	0.15	0.10	1.20	2.51	1.20	0.01

the applied biofertilizers that increased the level of tree growth regulators in trees which cause hormones to favour cell enlargement (Slankis 1973). The increased weight of fruits with nutrient application might have first improved the internal nutritive condition of tree leading to increased growth and vigour associated with photosynthesis and translocation of assimilates in the fruits. Such assumption gains support from the findings of Pereira *et al.* (1999) in guava, who reported increased rate of translocation of photosynthetic products from leaves to developing fruits which increased fruit weight.

Total soluble solids (TSS), acidity, sugars, ascorbic acid and pectin content of guava fruit.

The data in Table 6 revealed that there was marked increase in total soluble solids with the application of organics, inorganics and biofertilizer. The pooled data showed that highest total soluble solids (13.01ºBrix) was recorded in T_8 (75% N/tree through poultry manure + 25% N/tree through urea augmented with *Azotobacter*) and the lowest total soluble solids (11.62ºBrix) was recorded under control (T_{12}). Treatments did not seem to have any significant effect on the titratable acidity of guava fruit and showed non–significant differences among the treatments as depicted in Table 6. The statistical analysis of sugars (total, reducing and non-reducing) revealed significant difference in pooled estimates and are presented in Table 6. The highest increase in total, reducing and non-reducing sugars (8.68, 4.90 and 3.59%, respectively), were recorded from fruits harvested from trees receiving 75% N through poultry manure + 25% through urea augmented with *Azotobacter* (T_8) as compared to control (7.10, 4.24 and 2.72%, respectively). Data pertaining to the ascorbic acid content of guava fruit harvested from trees under various treatments indicates that the highest ascorbic acid content (215.35mg/100g of pulp) was recorded in fruits harvested from trees receiving full dose of N through poultry manure augmented with *Azotobacter* (T_7). The lowest value (186.27 mg/100 g of pulp) of ascorbic acid was obtained under control (T_{12}). Pectin content was significantly influenced by the integrated use of poultry manure, urea and *Azotobacter* which are presented in Table 6 In the pooled data maximum pectin content (0.74%) was recorded in fruits harvested from trees receiving 50% N as poultry manure + 50% N through urea augmented with *Azotobacter* (T_9) and lowest pectin (0.50%) was recorded under control (T_{12}). The improvement in fruit quality might be due to improvement in soil physical properties, water holding capacity, structure, porosity, bulk density, hardiness and the essential nutrients in poultry manure that play significant role in improving the fruit quality (Joy and Paul 2008). Increase in total soluble solids and sugars were due to improvement in balanced macro-micro nutrient supply and hormonal secretions through organic manure and biofertilizers**.** A perusal of the data related to ascorbic acid content would revealed that full dose of N through poultry manure augmented with *Azotobacter* gave better performance with regard to ascorbic acid contents of fruits. It was observed that combined application of organic and inorganic fertilizer enhanced the content manifold. These results are in conformity with the findings of Dey *et al.* (2005) who recorded highest ascorbic acid with the treatment combination of 50% N applied through poultry manure and half through NPK. The increase in pectin content with the application of 50% N through poultry manure and rest through urea augmented with *Azotobacter* is in consonance with findings of Kumar *et al.* (1996) who reported that increasing levels of N significantly increased the pectin content of guava.

Table 6 Effect of poultry manure, urea and *Azotobacter* on total soluble solids (TSS), acidity, sugars, ascorbic acid and pectin contents of guava fruit

Treatment	TSS (ºBrix)	Titratable acidity (%)	Total sugars (%)	Reducing sugars (%)	Non-reducing sugars (%)	Ascorbic acid (mg/100 g pulp)	Pectin (%)
T_1	12.22	0.43	7.63	4.47	3.00	213.32	0.62
T_2	12.64	0.44	8.16	4.69	3.30	211.75	0.64
T_3	12.63	0.45	8.01	4.63	3.22	208.09	0.68
T_4	12.58	0.46	7.87	4.58	3.13	207.14	0.67
T_5	12.46	0.52	7.75	4.52	3.06	193.71	0.65
T_6	11.79	0.49	7.43	4.32	2.95	190.29	0.56
T_7	12.23	0.44	7.69	4.50	3.03	215.35	0.64
T_8	13.01	0.45	8.68	4.90	3.59	214.40	0.65
T_9	12.97	0.46	8.50	4.87	3.45	211.29	0.74
T_{10}	12.87	0.48	8.35	4.78	3.39	210.09	0.73
T_{11}	12.68	0.53	8.23	4.75	3.31	196.82	0.68
T_{12}	11.62	0.50	7.10	4.24	2.72	186.27	0.50
CD (P=0.05)	0.09	NS	0.06	0.04	0.09	2.24	0.02

NS: non significant.

Physiological loss (%) in weight of guava fruit during storage under ambient conditions

The data pertaining to physiological weight loss of guava fruits during storage after 2, 4, 6 and 10 days as affected by different treatments are presented in Fig 1. The pooled data showed significant differences where minimum weight loss during storage after two days (1.14%), four (3.22%), six (5.39%), eight (8.19%) and after 10 days (13.20%), respectively was observed where the trees were treated with 75% N supplemented through poultry manure and rest of N through urea augmented with *Azotobacter* (T_8) while, guava fruits showed maximum physiological loss in weight after two days (2.14%), four (7.43%), six (14.12%), eight (19.45%) and after ten days (24.95%) respectively in T_{12} during storage under ambient conditions. The shelf life of guava fruits was found to be 11 days after harvest in the present study as compared to other treatments tried, it was observed that guava fruits with specific gravity <1.00 was found best in prolonging the shelf life. The minimum physiological loss in weight in guava fruit may be due to the

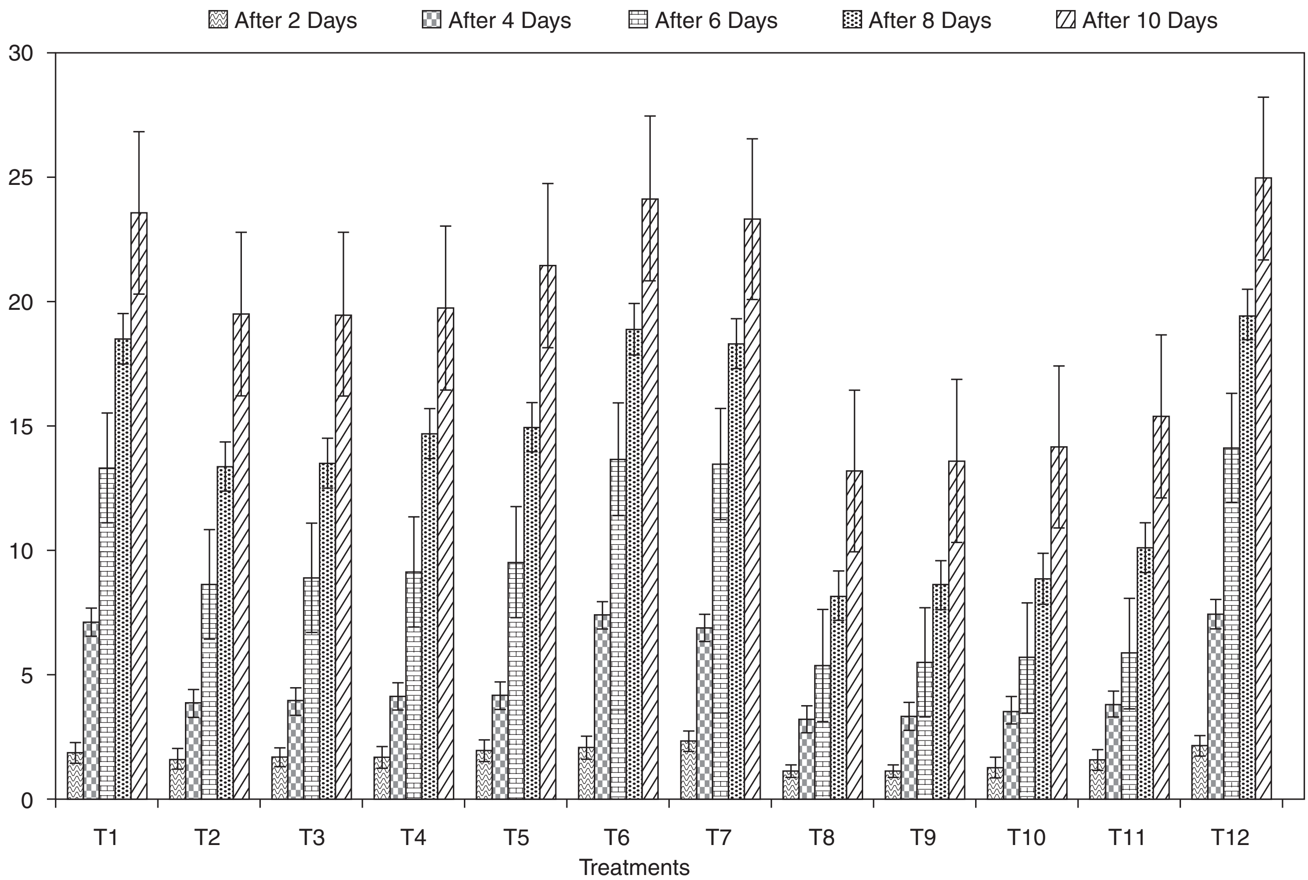

Fig 1 Effect of poultry manure, urea and *Azotobactor* on percent physiological loss in weight of guava fruit during storage under ambient conditions.

integration of organic and inorganic fertilizers, which might have accelerated the better uptake and accumulation of Ca and P (Kumar *et al.* 2001). It has been observed that when organic status of the soil was increased, it would also have helped to certain extent the maintenance of cell wall turgidity as the Ca is one of the important constituents of cell wall (Sharu and Meerabai 2001).

Integrated nutrient management system standardized the schedule of manure and fertilizer application of guava for sustaining the soil fertility to enhance the production potential and reduce the requirement of chemical fertilizers. The findings have clearly indicated that there was a positive effect of fertilizers when N was manipulated from different sources, viz. poultry manure, biofertilizers and inorganic fertilizers. The experiment also showed that water requirement of the crop goes down drastically due to organic manure used in the experiment that increases the organic matter in the soil and improves its water retention capacity. Also, it was found that INM practices have high social value of general acceptability, inexpensive, natural form of farming, and environmentally friendly. Based on the experimental results obtained, it may be finally concluded that for fully grown mature guava tree, application of 50% N applied though urea could be replaced when poultry manure was applied @ 19 kg/tree in combination with urea @ 620 g/tree and *Azotobacter* @ 200 g/tree for increasing the yield, quality and nutrient status of guava cv. Lucknow 49. At the same time, these forms of fruit culture, viz. integrated nutrient management could effectively enforce high standards while, moving towards more ecologically sustainable methods of fruit production.

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