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Integrated nutrient management in rejuvenated guava (*Psidium guajava*) orchard under semiarid conditions of Eastern Rajasthan

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ABSTRACT

An investigation was carried out during 2010-11 to study the effect of integrated nutrients management after rejuvenating more than 25 years old guava orchard planted at 6×6 m apart under semiarid conditions of eastern Rajasthan. The results revealed that almost all treatments with combined application of organic and inorganic sources of nutrients had significantly influenced the plant growth and yield of guava fruits over control (only recommended dose of NPK, i.e. 500: 200: 500 g/plant-T_1). Among different treatments, application of 2/3 of T_1+5 kg Vermicompost+250g *Azospirillum*+250g *Azotobacter/*plant (T_{15}) significantly increased the vegetative growth of rejuvenated plants in terms of shoot length (148.99 cm), shoot diameter (11.15 mm), number of leaves per shoot (63.25), mean girth of primary branches (15.8 cm), plant spread E-W (3.96 m), N-S (3.55m), canopy volume (7.109 m^3) and also fruit diameter polar and equatorial (6.74 and 6.72 cm) and fruit weight (109.71g fruit) but the flowering behavior, fruit yield and quality parameters of guava fruit were significantly superior with the application of 2/3 of T_1+25 kg FYM+250g *Azospirillum*+250g *Azotobacter/*Plant (T_{11}). Further, this treatment (T_{11}) also influenced early flowering as less number of days required for flowering (29.31days), highest number of flowers per shoot (8.13), better fruit set (39.95%), fruit retention (58.50%) and fruit yield (15.03 kg/plant and 4.18 t/ha) in third year of rejuvenation. The fruits harvested under this treatment exhibited best quality traits, which were judged by analyzing TSS (13.93 ^{0}B), acidity (0.454%), ascorbic acid (231.21 mg/100 g), TSS:acid ratio (30.77), reducing sugar (4.61%), non-reducing sugar (3.07%) and total sugar (7.29%). Therefore, application of 2/3 quantity of recommended dose of NPK, i.e. 500:200:500 g+25 kg FYM+250g *Azospirillum*+250g *Azotobacter/*plant is recommended for harvesting more than 20% higher yield and better quality fruits from rejuvenated guava orchards.

Key words: Biofertilizer, Canopy management, Integrated nutrient management, *Psidium guajava*, Rejuvenation, Vermicompost

The guava (*Psidium guajava* L.) is successfully cultivated on a wide range of soils and climatic conditions owing to its comparative tolerance to moisture stress, salinity, cold, heat etc. The plant is precocious and prolific in bearing, prone to pruning, high productivity, good nutritive value and medicinal attributes, highly remunerative and used as a popular table fruits by all age groups of people (Saroj *et al*. 2006). The fruits are considered as 'an apple of the tropics' because of the high vitamin C content (75-260 mg/100g pulp), thiamine (0.03-0.07 mg/100 g pulp), riboflavin (0.02-0.04 mg/100 g pulp), phosphorus (22.5-40.0 mg/100 g pulp), calcium (10.0-30.0 mg/100gm pulp) and iron (20-25 mg/100 g pulp) and also good source of pectin 0.5-1.8 per cent (Shukla *et al*. 2009). Its ripe fruits are consumed fresh and also used for making different processed products like jam, jelly, cheese and nectar etc.

The productivity of guava varies significantly among various guava growing states. It varied from 7.2 tones/ha in Odisha to 29.0 tones/ha in Madhya Pradesh with average productivity of 12.0 tonnes/ha. Besides other factors, existence of large area under old and senile orchards is one of the main reasons of poor productivity of guava in the country. In semiarid region of Rajasthan also, productivity of old orchards (>25 years) are very low. In such orchards, dried and dead branches are intact coupled with overcrowding of branches resulted in competition for nutrients; light penetration and acted as shelter for insect-pests and diseases. Thereby, plants are neither healthy nor giving desired productivity. Sometimes, only tip bearing of inferior quality fruits were observed. The Central Institute for Subtropical Horticulture, Lucknow (Uttar Pradesh) has developed rejuvenation technique for such exhausted, un-productive and non-remunerative old guava orchard to restores their production potential (Kalloo 2005 and Singh *et al.* 2005). However, the proper nutrition of rejuvenated guava orchards is very essential in order to boost up the

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growth and productivity of rejuvenated plants. Considering these facts in view, an investigation was undertaken to standardize the integrated nutrient management in rejuvenated guava orchard under semiarid conditions of Eastern Rajasthan.

MATERIALS AND METHODS

The present investigation was carried out at Instructional Farm of Department of Horticulture, Maharana Pratap University of Agriculture and Technology, Udaipur (Rajasthan) in two consecutive years, i.e. 2010 and 2011. The Experimental Block is located at 24° 34' N latitude and 73° 42' E longitude at an elevation of 582.17 meters above mean sea level. The soil of the experimental site is clay loam having soil pH of about 8.0 with electrical conductivity of 0.94 dS/m and 0.71 per cent organic carbon. The available N, P and K were 282.1, 23.0 and 305.94 kg/ha respectively. In fact, in arid and semiarid areas, low precipitation, extremes of temperature, high wind velocity, poor soil fertility, soil salinity etc. are the major constraints of farming. The guava, though, it is a hardy plant to various biotic and abiotic stresses but needs proper management with respect to nutrition, moisture management and plant canopy architecture for obtaining economic return. In older orchards, such managements should be very judicious and precise, as similar to other fruit crops, guava trees are also witness to decline in productivity after 15-20 years and becomes economically non-viable. In general, *Mrig Bahar* crop of guava is taken in eastern Rajasthan by withholding the water from January to May, in order to avoid the *Ambe Bahar* crop.

In this investigation, old guava orchard of cultivar 'Sardar' planted at distance of 6 × 6 m in 1987 (>25 years old) were headed back at 1.5-2.5 m height above the ground level depending upon the structure of individual trees during the month of May, 2009. The newly emerging shoots were allowed to grow but overcrowding shoots were thinned out and water shoots were removed in the month of October. All operations of orchard rejuvenations were followed as suggested by Singh *et al*. (2005) and uniform management practices were applied for all treatments, except integrated nutrient management (INM) treatments, so as to assess its performance. The manure and fertilizer treatments were applied in middle of June during both the year of experimentation. The first light irrigation was given immediately after application of treatment and thereafter one or two light irrigations were given before the onset of rains. The trees start growth by July with onset of rains, flowers in August-September and produced fruits during winter season (December-January).

The INM treatments comprised inorganic fertilizers (NPK), organic manures (vermicompost and farmyard manure) and biofertilizers (*Azotobacter, Azospirillum* and PSB). The total treatment combinations were seventeen, viz. T_1-(Recommended dose of NPK, i.e. 500:200:500 g/plant as control), T_2-(½ of T_1+25 kg FYM+250 g PSB/plant), T_3-(½ of T_1+25 kg FYM+250g *Azospirillum*+250g *Azotobacter*/plant), T_4-(½ of T_1+25 kg FYM+250g PSB+250g *Azospirillum*/plant), T_5-(½ of T_1+25 kg FYM+250g *Azospirillum*/plant), T_6-(½ of T_1+5 kg vermicompost+250 g PSB/plant), T_7-(½ of T_1+5 kg vermicompost+250 g *Azospirillum*+250g *Azotobacter*/plant), T_8-(½ of T_1+5 kg vermicompost+250 g PSB +250 g *Azospirillum*/plant), T_9-(½ of T_1+5 kg vermicompost+250 g *Azospirillum*/plant), T_{10}-(2/3 of T_1+25 kg FYM+250 g PSB/plant), T_{11}-(2/3 of T_1+25 kg FYM+250g *Azospirillum*+250g *Azotobacter* /plant), T_{12}-(2/3 of T_1+25 kg FYM+250g *PSB*+250 g *Azospirillum* /plant), T_{13}-(2/3 of T_1 + 25 kg FYM+250g *Azospirillum*/ plant), T_{14}-(2/3 of T_1+5 kg vermicompost+250g PSB/plant), T_{15}-(2/3 of T_1+5 kg vermicompost+250g *Azospirillum*+250g *Azotobacter*/plant), T_{16}-(2/3 of T_1+5 kg vermicompost+250g PSB+250g *Azospirillum*/plant) and T_{17}-(2/3 of T_1+5 kg vermicompost+250g *Azospirillum*/plant).

The experiment was laid out in Randomized Block Design (RBD) with four replications. The number of plants per treatment was four. Observations on vegetative growth, fruiting behavior, yield and yield attributing characters as well as quality parameters were recorded as per standard procedure and quality analysis was done as per AOAC (1984). The data were analyzed with M-STAT statistical package to test the significance of the treatments. The meteorological observations were also recorded during both the years of experimentation to interpret the experimental findings.

RESULTS AND DISCUSSION

The results of the present investigation on "Integrated nutrient management in rejuvenated guava orchard under semiarid conditions of Eastern Rajasthan" are given as follows and interpreted in the light of available literature.

Vegetative growth parameters: The vegetative vigour of a plant is largely influenced by genotype, management and edaphoclimatic parameters, as the experimental area lies in high temperature, high wind velocity, low relative humidity and erratic medium rainfall zone.

The data presented in Table 1 clearly indicate that the growth of rejuvenated guava trees in form of shoot growth, shoot diameter, number of leaves per shoot, plant spread and canopy volume under different treatment combinations differ significantly during both the years of observation. In general, all growth parameters were higher in 2011 over previous year of 2010 with the advancing age of the rejuvenated trees. From the pooled analysis of data it is obvious that the longest length (148.99 cm) of new shoot growth of rejuvenated guava trees were recorded with T_{15} treatment (375:150:375 g NPK+5 kg vermicompost+250g *Azospirillum*+250g *Azotobacter*/plant) followed by 145.60 cm in T_{11} (2/3 of T_1 + 25 kg FYM+250g *Azospirillum*+250g *Azotobacter*/plant), 142.04 cm in T_{12} (2/3 of T_1 +25 kg FYM+250g PSB+250 g *Azospirillum*/plant) and 140.48 cm in T_{16} (2/3 of T_1 +5 kg vermicompost+250g PSB+250g *Azospirillum*/plant). However, the differences of shoot growth among T_{15}, T_{12} and T_{11} were non-significant. The

Table 1 Effect of integrated nutrient management on vegetative growth behavior of rejuvenated guava plants

Treatment	Shoot length (cm)			Shoot diameter (mm)			Number of leaves/shoot			Plant spread E-W (m)			Plant spread N-S (m)			Canopy volume (m^3)		
	2010	2011	Pooled	2010	2011	Pooled	2010	2011	Pooled	2010	2011	Pooled	2010	2011	Pooled	2010	2011	Pooled
T_1	133.50	144.81	139.17	9.45	9.54	9.50	59.25	60.25	59.75	3.25	3.58	3.42	3.16	3.49	3.33	1.53	3.61	2.57
T_2	117.01	126.90	121.97	8.98	9.30	9.14	49.50	50.75	50.13	3.09	3.13	3.11	2.28	2.56	2.42	0.79	1.54	1.17
T_3	123.50	134.00	128.75	9.70	9.80	9.75	56.25	57.50	56.88	3.19	3.58	3.39	3.08	3.55	3.31	1.35	3.58	2.47
T_4	121.02	131.30	126.16	9.90	10.00	9.95	54.25	55.75	55.00	2.92	3.05	2.99	2.72	3.05	2.89	1.32	2.92	2.12
T_5	118.50	128.70	123.59	9.48	9.98	9.73	51.75	53.75	52.75	2.80	3.00	2.90	2.50	2.80	2.65	1.07	2.49	1.79
T_6	117.50	127.50	122.49	9.86	9.98	9.92	49.50	51.00	50.25	2.76	2.89	2.83	3.05	3.42	3.24	1.49	3.32	2.41
T_7	126.01	136.71	131.36	10.00	10.10	10.05	54.75	57.00	55.88	2.76	3.10	2.93	2.65	3.01	2.83	1.16	3.11	2.13
T_8	122.30	132.60	127.45	9.34	9.44	9.39	55.50	57.25	56.38	3.10	3.13	3.12	2.76	3.10	2.93	1.39	3.12	2.26
T_9	119.50	129.70	124.58	9.76	9.85	9.81	53.00	55.75	54.38	2.85	3.08	2.97	2.61	2.92	2.76	1.04	2.47	1.76
T_{10}	127.80	138.62	133.18	9.20	9.32	9.26	57.25	58.00	57.63	3.00	3.15	3.07	2.81	3.15	2.98	1.52	3.16	2.34
T_{11}	138.80	152.50	145.60	11.10	11.13	11.12	61.00	62.00	61.50	3.70	4.15	3.92	3.32	3.72	3.52	3.16	7.59	5.38
T_{12}	136.30	147.80	142.04	11.05	11.12	11.09	60.75	61.75	61.25	3.59	4.02	3.81	3.28	3.68	3.48	2.48	6.06	4.27
T_{13}	131.01	142.10	136.57	10.60	10.64	10.62	57.50	59.50	58.50	3.18	3.56	3.37	3.18	3.56	3.37	1.98	4.65	3.32
T_{14}	129.30	140.20	134.74	10.30	10.35	10.33	56.00	58.00	57.00	3.21	3.28	3.24	2.82	3.17	3.00	1.69	3.58	2.64
T_{15}	142.80	155.10	148.99	11.12	11.18	11.15	62.00	64.50	63.25	3.73	4.18	3.96	3.35	3.75	3.55	4.06	10.16	7.11
T_{16}	134.80	146.20	140.48	10.90	10.96	10.93	60.00	61.00	60.50	3.57	4.00	3.78	3.26	3.66	3.46	2.38	5.34	3.86
T_{17}	132.30	143.51	137.87	10.70	10.83	10.77	58.25	59.75	59.00	3.40	3.81	3.61	3.21	3.60	3.41	1.69	4.19	2.94
SEm (±)	3.25	4.07	2.60	0.54	0.26	0.30	2.88	1.78	1.69	0.23	0.25	0.17	0.08	0.09	0.06	0.36	0.91	0.49
CD ($P = 0.05$)	9.23	11.56	7.30	1.54	0.74	0.84	8.20	5.05	4.75	0.65	0.71	0.48	0.23	0.25	0.17	1.01	2.59	1.37

minimum length (121.97 cm) of shoots were recorded in T_2 (½ of T_1+25 kg FYM+250 g PSB/plant), while rest of the treatments showed in between values with respect to shoot growth. Almost similar trend was recorded regarding shoot diameter ranging from 11.15 mm in T_{15} (375:150:375 g NPK+5 kg vermicompost+250g *Azospirillum*+250g *Azotobacter*/plant) to 9.54 mm in T_1 (Recommended dose of NPK, i.e. 500:200:500 g/plant).

The number of leaves per shoot also varied significantly ranging from 63.25 in T_{15} (375:150:375 g NPK+5 kg vermicompost+250g *Azospirillum*+250g *Azotobacter*/plant) to 50.13 in T_2 (½ of T_1 +25 kg FYM+250 g PSB/plant). In fact, the number of leaves per shoot was in proportionate to length of shoots in different treatment combinations. The plant spread both east-west and north-south also recorded maximum in the same treatment, i.e. T_{15} (375:150:375 g NPK+5 kg vermicompost+250g *Azospirillum*+250g *Azotobacter*/plant). This treatment (T_{15}) ultimately induced highest plant vigour in form of tree canopy volume (7.11 m^3) of rejuvenated guava trees followed by 5.38 m^3 in T_{11} (2/3 of T_1 +25 kg FYM+250g *Azospirillum*+250g *Azotobacter*/plant), 4.27 m^3 in T_{12} (2/3 of T_1 +25 kg FYM+250g PSB+250 g *Azospirillum*/plant) respectively. Whereas, the minimum canopy volume (1.67 m^3) was recorded in T_2 (-(½ of T_1 +25 kg FYM+250 g PSB/plant).

The vegetative growth parameters recorded under various treatments indicated that use of only organic source of major nutrients (NPK) is insufficient to promote better growth of rejuvenated guava trees. In fact, the inorganic sources coupled with organic sources for major nutrients promote better growth by increasing various macro and micro nutrients and increasing availability of soil nutrients. Probably, the application of organic sources and bioinoculants produced variety of growth substances and antifungal substances, which ultimately helpful in promoting vegetative vigour of the plants. These results are in close agreement with the finding of Naik and Hari Babu (2005) and Ram *et al.* (2005 a), where they have reported better growth of guava plants cultivar Sardar through application of inorganic sources like vermicompost and *Azotobacter*. Contrary to this, Athani *et al.* (2005) reported non-significant growth of plants with organic sources. The vegetative vigour of a plant is largely influenced by genotype, management and edaphoclimatic parameters, as the experimental area lies in high temperature, high wind velocity, low relative humidity and erratic medium rainfall zone.

Flowering and fruiting parameters: The flowering and fruiting behaviour of rejuvenated guava trees also influenced significantly with different nutritional treatments during both the years

Table 2 Effect of integrated nutrient management on flowering and fruiting behavior of rejuvenated guava plants

Treat-	Days taken to 50 % flowering			Number of flower/ shoot			Per cent fruit set			Per cent fruit retention		
ment	2010	2011	Pooled	2010	2011	Pooled	2010	2011	Pooled	2010	2011	Pooled
T_1	36.00	37.51	36.75	6.00	7.50	6.75	33.50	33.50	33.50	50.07	49.50	49.79
T_2	36.81	37.60	37.20	4.50	5.06	4.78	31.80	31.80	31.80	50.00	48.20	49.10
T_3	36.41	37.70	37.03	5.50	6.50	6.00	35.53	35.53	35.53	50.81	51.00	50.91
T_4	36.80	37.10	36.96	5.00	5.50	5.25	34.83	34.83	34.83	52.12	52.30	52.21
T_5	35.90	36.91	36.37	4.75	5.00	4.88	33.43	33.43	33.43	53.60	54.05	53.83
T_6	36.01	36.90	36.43	4.50	5.00	4.75	32.81	32.81	32.81	55.59	55.90	55.75
T_7	36.50	36.91	36.70	5.75	6.00	5.88	35.65	35.65	35.65	53.10	53.60	53.35
T_8	36.80	37.20	37.00	5.50	5.90	5.70	35.09	35.09	35.09	51.17	52.40	51.79
T_9	37.00	37.20	37.08	4.75	5.00	4.88	34.01	34.01	34.01	52.49	53.90	53.20
T_{10}	35.82	36.80	36.31	6.00	7.00	6.50	36.08	36.08	36.08	51.14	51.70	51.42
T_{11}	28.50	30.10	29.31	7.75	8.50	8.13	39.47	39.47	39.47	57.55	58.50	58.03
T_{12}	33.90	35.50	34.68	6.50	8.00	7.25	38.71	38.71	38.71	56.36	57.00	56.68
T_{13}	35.70	36.02	35.87	6.50	7.00	6.75	37.08	37.08	37.08	53.91	54.00	53.96
T_{14}	33.70	35.61	34.63	6.25	7.00	6.63	36.68	36.68	36.68	54.11	54.50	54.31
T_{15}	32.50	33.60	33.05	7.00	9.00	8.00	39.02	39.02	39.02	56.79	56.90	56.85
T_{16}	34.70	37.50	36.08	6.75	8.00	7.38	38.81	38.81	38.81	52.46	52.90	52.68
T_{17}	35.70	37.30	36.48	6.75	7.50	7.13	37.48	37.48	37.48	55.27	55.50	55.39
Sem±	0.90	0.92	0.64	0.45	0.19	0.24	0.24	0.24	0.24	1.31	1.32	0.93
CD (P = 0.05)	2.54	2.63	1.80	1.27	0.55	0.68	0.69	0.69	0.69	3.73	3.76	2.62

i.e. 2010 and 2011. The data given in Table 2 indicate that the minimum number of days (29.31) taken to 50 per cent flowering in T_{11} (2/3 of T_1 +25 kg FYM+250g *Azospirillum*+250g *Azotobacter/*plant) followed by 33.05 days in T_{15} (2/3 of T_1 +5 kg vermicompost+250g *Azospirillum*+250g *Azotobacter/*plant) while maximum time (37.20 days) was taken in T_2 (½ of T_1 +25 kg FYM+250 g PSB/plant). Thus, flowering could be enhanced at least 4-8 days by application of T_{11} and T_{15} treatments over T_2 under same management conditions. Whereas, remaining other treatments did not induce early flowering in rejuvenated guava trees. The wide variations were observed with respect to number of flowers per shoot. About eight or more flowers were recorded in T_{11} (2/3 of T_1 +25 kg FYM+250g *Azospirillum*+250g *Azotobacter/*plant) and in T_{15} (375:150:375 g NPK+5 kg vermicompost+250g *Azospirillum*+250g *Azotobacter/*plant) treatments respectively. Good number of flowers (>7/shoot) were also recorded in T_{12} (2/3 of T_1 +25 kg FYM+250g PSB+250 g *Azospirillum/*plant), T_{16} (2/3 of T_1 +5 kg vermicompost+ 250g PSB+250g *Azospirillum/*plant) and T_{17} (2/3 of T_1 +5 kg vermicompost+250g *Azospirillum/*plant) treatments. The lowest number of flowers (4.75) was recorded in T_6 (-(½ of T_1 +5 kg vermicompost+250 g PSB/plant followed by 4.78 in T_2 (½ of T_1 +25 kg FYM+250 g PSB/plant) and 4.88 in T_5 (½ of T_1 +25 kg FYM+250g *Azospirillum/*plant). The observations indicated that higher dose of NPK (2/3rd of recommended dose) along with vermicompost/FYM and biofertilizers have better impact on inducing more number of flowers per shoot. The prolonged availability of nutrients during the growth period from vermicompost might have enhanced the flowering and increased number of flowers per shoot (Rai *et al.* 2002).

The fruit set and fruit retention were also varied significantly under different treatment combinations. Highest fruit set (39.47%) and fruit retention (58.03%) were recorded in T_{11} (2/3 of T_1 +25 kg FYM+250g *Azospirillum*+250g *Azotobacter/*plant) closely followed by T_{15} (2/3 of T_1 +5 kg vermicompost+250g *Azospirillum*+250g *Azotobacter/*plant), i.e. 39.02 per cent and 56.85 per cent respectively. Whereas, lowest fruit set (31.80%) and fruit retention (49.10%) were recorded in T_2 (½ of T_1 +25 kg FYM+250 g PSB/plant). The improvement in fruit set and fruit retention was might be due to overall improvement of health of the trees, owing to better photosynthesis and translocation of assimilates in the fruits.

Yield and yield attributing parameters: It is evident from the data presented in Table 3 that application of inorganic fertilizers, organic manures and biofertilizers significantly improved the physical characters of fruits like number of fruits/plant, fruit polar and equatorial diameter, fruit weight, fruit yield/tree and yield/hectare. The data indicate that number of fruits per tree increased in consecutive years with increasing age of the trees. The pooled analysis of data on number of fruits per tree showed that maximum number of fruits (138.33) were recorded in T_{11} (2/3 of T_1 +25 kg FYM+250g *Azospirillum*+250g *Azotobacter/*plant) followed by 133.53 fruits per tree in T_{15} (2/3 of T_1 +5 kg vermicompost+250g *Azospirillum*+250g *Azotobacter/*plant), though the differences were non-significant. Whereas, less than 120 fruits per tree were recorded in T_1 (Recommended dose of NPK, i.e. 500:200:500 g/plant as control), T_2 (½ of T_1 +25 kg FYM+250 g PSB/plant), T_3 (½ of T_1 +25 kg FYM+250g

Table 3 Effect of integrated nutrient management on fruit yield and yield related parameters.

Treat-ment	Number of fruit/ tree			Polar fruit diameter (cm)			Equatorial fruit diameter (cm)			Fruit wt (g/ fruit)			Pulp/seed ratio			Fruit yield (kg/plant)			Fruit yield (t/ha)		
	2010	2011	Pooled	2010	2011	Pooled	2010	2011	Pooled	2010	2011	Pooled	2010	2011	Pooled	2010	2011	Pooled	2010	2011	Pooled
T_1	105.98	130.50	118.24	6.35	6.40	6.38	5.77	5.80	5.78	104.85	105.35	105.10	47.20	47.28	47.24	11.12	13.75	12.43	3.09	3.82	3.46
T_2	99.23	134.00	116.62	5.60	5.74	5.67	5.60	5.63	5.62	100.00	100.12	100.06	40.20	40.32	40.26	9.92	13.42	11.67	2.76	3.73	3.24
T_3	99.88	135.00	117.44	6.28	6.30	6.29	5.80	5.84	5.82	100.25	100.42	100.34	41.50	41.59	41.55	10.01	13.56	11.79	2.78	3.77	3.28
T_4	99.98	135.00	117.49	6.01	6.06	6.04	6.01	6.04	6.03	100.15	100.68	100.42	41.60	41.74	41.67	10.01	13.62	11.82	2.78	3.79	3.28
T_5	101.31	136.75	119.03	5.80	5.88	5.84	5.80	5.83	5.82	103.25	104.00	103.63	43.60	43.66	43.63	10.45	14.23	12.34	2.90	3.95	3.43
T_6	103.73	138.75	121.24	5.88	5.92	5.90	5.88	5.92	5.90	103.49	104.20	103.85	43.90	44.06	43.98	10.74	14.45	12.60	2.99	4.02	3.50
T_7	102.74	138.50	120.62	6.03	6.05	6.04	6.03	6.05	6.04	100.75	101.50	101.13	44.50	44.64	44.57	10.35	14.05	12.20	2.88	3.91	3.39
T_8	101.72	137.25	119.48	5.78	5.80	5.79	5.78	5.82	5.80	105.00	105.60	105.30	43.80	43.85	43.83	10.69	14.51	12.60	2.97	4.03	3.50
T_9	104.88	141.25	123.06	5.88	5.94	5.91	5.88	5.90	5.89	103.13	104.00	103.56	45.60	45.69	45.65	10.81	14.70	12.75	3.01	4.09	3.55
T_{10}	101.51	142.00	121.76	5.95	6.00	5.98	5.95	5.96	5.96	103.36	104.34	103.85	46.50	46.74	46.62	10.49	14.81	12.65	2.91	4.12	3.52
T_{11}	113.67	163.00	138.33	6.60	6.65	6.63	6.60	6.66	6.63	109.89	107.90	108.90	48.76	48.88	48.82	12.49	17.58	15.03	3.47	4.89	4.18
T_{12}	107.96	150.00	128.98	6.15	6.18	6.17	6.28	6.32	6.30	107.49	110.24	108.87	48.62	48.74	48.68	11.59	16.54	14.06	3.22	4.60	3.91
T_{13}	104.73	152.25	128.49	5.73	5.75	5.74	5.73	5.75	5.74	102.50	103.25	102.88	48.00	48.14	48.07	10.72	15.70	13.21	2.98	4.37	3.67
T_{14}	104.78	152.25	128.51	5.95	6.02	5.99	5.95	6.00	5.98	103.45	103.85	103.65	47.60	47.74	47.67	10.85	15.80	13.32	3.01	4.39	3.70
T_{15}	109.07	158.00	133.53	6.70	6.78	6.74	6.70	6.74	6.72	109.56	109.85	109.71	49.50	49.69	49.60	11.97	17.34	14.65	3.33	4.82	4.07
T_{16}	100.08	154.00	127.04	6.03	6.04	6.03	6.03	6.05	6.04	103.85	104.12	103.99	47.80	47.88	47.84	10.41	16.03	13.22	2.89	4.46	3.68
T_{17}	99.51	148.25	123.88	5.80	5.85	5.83	6.15	6.18	6.17	104.50	105.18	104.84	48.50	48.58	48.54	10.41	15.63	13.02	2.89	4.35	3.62
SEm±	2.80	3.48	2.23	0.19	0.15	0.12	0.19	0.15	0.122	2.16	2.14	1.52	1.12	1.15	0.80	0.38	0.50	0.31	0.10	0.14	0.09
CD (P = 0.05)	7.96	9.89	6.27	0.54	0.44	0.34	0.54	0.43	0.34	6.14	6.09	4.27	3.18	3.28	2.25	1.07	1.42	0.88	0.30	0.40	0.24

Azospirillum+250g *Azotobacter/*plant), T_4 (½ of T_1 +25 kg FYM+250g PSB+250g *Azospirillum/*plant) and T_5 (½ of T_1 +25 kg FYM+250g *Azospirillum/*plant) treatments with lowest number of fruits in T_2 (116.62). The size of fruits in form of polar fruit diameter and equatorial fruit diameter showed reversed trend among T_{11} and T_{15} treatments. The number of fruits was more in T_{11} but the fruit size was better in T_{15} treatment, though the differences were non-significant. The pulp: seed ratio also showed similar trend.

The highest fruit yield (15.03 kg/tree) was recorded in T_{11} (2/3 of T_1 +25 kg FYM+250g *Azospirillum*+250g *Azotobacter/*plant) followed by 14.65 kg/tree in T_{15} (2/3 of T_1 +5 kg vermicompost+250g *Azospirillum*+250g *Azotobacter/*plant) and 14.006 kg/tree in T_{12} (2/3 of T_1 +25 kg FYM+250g PSB+250 g *Azospirillum/*plant) while lowest yield (11.67 kg/tree) was recorded in T_2 (½ of T_1 +25 kg FYM+250 g PSB/plant). On per hectare basis also these two treatments (T_{11} and T_{15}) gave more than 4 tonnes/ha fruit yield, which was significantly higher over most of the treatments. The observations indicated that on an average 0.7 tonnes/ha more fruit yield can be harvested every year from these two treatments (T_{11} and T_{15}) over recommended dose of fertilizers (T_1). The experimental findings revealed that the combined application of inorganic fertilizers and biofertilizers had positive influence on vegetative and reproductive growth, which ultimately led to realization of higher yield. In fact, combined application of organic and chemical fertilizers might have better influence on synthesis and translocation of metabolites ultimately accumulated in the tissues (Palaniappan and Annadurai 2000) responsible for yield parameters.

Quality parameters: Besides productivity, fruit quality is another concern in rejuvenated orchards. In the present investigation of integrated nutrient management of rejuvenated guava orchard, the fruit quality parameters, viz. TSS, acidity, ascorbic acid, TSS: acid ratio, reducing, non-reducing and total sugar content were analyzed under each treatment. Data given in Table 4 reveal that among various treatments, maximum TSS (13.93 ^{0}B) was recorded in T_{11} (2/3 of T_1 +25 kg FYM+250g *Azospirillum*+250g *Azotobacter/*plant) followed by 13.06 ^{0}B in T_{15} (2/3 of T_1 +5 kg vermicompost+250g *Azospirillum*+250g *Azotobacter/*plant) and 12.98 ^{0}B in T_{12} (2/3 of T_1+25 kg FYM+250g *PSB*+250 g *Azospirillum/* plant). Though, the differences among T_{15} and

Table 4 Effect of integrated nutrient management on quality parameters of fruits from rejuvenated guava plants

Treat-ment	TSS (^{0}Brix)			Acidity (%)			Ascorbic acid (mg/100g)			TSS/ acid ratio			Reducing sugar (%)			Non-reducing sugar (%)			Total sugar (%)		
	2010	2011	Pooled	2010	2011	Pooled	2010	2011	Pooled	2010	2011	Pooled	2010	2011	Pooled	2010	2011	Pooled	2010	2011	Pooled
T_1	11.23	11.32	11.28	0.520	0.496	0.508	203.00	203.32	203.16	21.60	22.82	22.21	3.71	3.71	3.71	2.49	2.50	2.50	5.90	5.91	5.90
T_2	11.20	11.30	11.25	0.527	0.505	0.516	202.50	202.77	202.63	21.29	22.40	21.84	3.45	3.46	3.46	2.61	2.64	2.62	5.76	5.80	5.78
T_3	11.50	11.56	11.53	0.510	0.487	0.498	213.50	213.67	213.59	22.55	23.76	23.15	3.74	3.75	3.74	2.63	2.67	2.65	6.06	6.10	6.08
T_4	12.20	12.36	12.28	0.521	0.497	0.509	211.75	211.89	211.82	23.41	24.87	24.14	3.64	3.65	3.65	3.33	3.35	3.34	6.63	6.65	6.64
T_5	12.40	12.85	12.63	0.511	0.487	0.499	227.01	227.11	227.06	24.27	26.36	25.31	3.61	3.62	3.61	3.40	3.50	3.45	6.67	6.76	6.72
T_6	12.40	12.78	12.59	0.502	0.479	0.490	225.25	225.57	225.41	24.70	26.69	25.69	3.64	3.65	3.65	3.49	3.49	3.49	6.78	6.79	6.79
T_7	12.48	12.88	12.68	0.503	0.480	0.491	220.00	220.20	220.10	24.81	26.84	25.83	3.76	3.77	3.76	3.02	3.07	3.04	6.45	6.50	6.47
T_8	12.20	12.35	12.28	0.492	0.469	0.481	221.25	221.37	221.31	24.80	26.31	25.55	3.51	3.52	3.52	3.54	3.58	3.56	6.71	6.74	6.72
T_9	12.30	12.42	12.36	0.504	0.481	0.492	224.50	224.57	224.54	24.40	25.82	25.11	3.58	3.59	3.59	3.07	3.10	3.08	6.33	6.36	6.34
T_{10}	12.60	12.74	12.67	0.495	0.472	0.484	223.25	223.44	223.35	25.45	26.98	26.22	3.57	3.57	3.57	2.79	2.79	2.79	6.04	6.05	6.05
T_{11}	13.40	14.46	13.93	0.465	0.444	0.454	231.15	231.27	231.21	28.87	32.66	30.77	4.59	4.62	4.61	3.16	2.98	3.07	7.37	7.22	7.29
T_{12}	12.95	13.00	12.98	0.478	0.456	0.467	227.50	227.61	227.56	27.16	28.58	27.87	4.51	4.53	4.52	2.78	2.76	2.77	6.93	6.93	6.93
T_{13}	12.10	12.60	12.35	0.485	0.463	0.474	225.00	225.25	225.12	24.95	27.23	26.09	4.52	4.52	4.52	1.69	1.70	1.69	5.90	5.91	5.90
T_{14}	12.23	12.84	12.54	0.481	0.459	0.470	226.75	226.90	226.83	25.43	27.98	26.70	4.51	4.52	4.52	1.69	1.70	1.69	5.89	5.91	5.90
T_{15}	13.00	13.12	13.06	0.475	0.453	0.464	228.50	228.64	228.57	27.44	29.02	28.23	4.57	4.58	4.58	2.80	2.81	2.81	7.01	7.02	7.02
T_{16}	12.58	12.69	12.64	0.481	0.459	0.470	220.40	220.50	220.45	26.18	27.65	26.92	4.51	4.52	4.51	2.47	2.48	2.47	6.63	6.65	6.64
T_{17}	12.80	12.96	12.88	0.484	0.462	0.473	224.50	224.59	224.54	26.48	28.11	27.30	4.51	4.53	4.52	2.50	2.49	2.50	6.66	6.67	6.67
SEm±	0.31	0.30	0.22	0.01	0.01	0.01	5.43	5.39	3.82	0.57	0.60	0.42	0.10	0.10	0.07	0.12	0.16	0.10	0.07	0.16	0.09
CD (P = 0.05)	0.88	0.87	0.61	0.03	0.03	0.02	15.45	15.31	10.74	1.63	1.72	1.17	0.29	0.29	0.20	0.33	0.47	0.28	0.10	0.47	0.25

T_{12} were non-significant with respect to TSS. Whereas, the variations in per cent acidity was very meager among various treatments but minimum acidity (0.454 %) was recorded in T_{11} (2/3 of T_1 +25 kg FYM+250g *Azospirillum*+ 250g *Azotobacter*/plant) closely followed by 0.464% in T_{15} (2/3 of T_1 +5 kg vermicompost+ 250g *Azospirillum*+250g *Azotobacter*/plant) and maximum (0.516%) under T_2 (½ of T_1 +25 kg FYM+250 g PSB/plant). There were wide variations in ascorbic acid content of fruits in various treatments ranging from 202.63 mg/ 100 g to 231.21 mg/100 g but followed the same trend as in case of TSS. The TSS: acid ratio is the computed value obtained after dividing TSS by acidity, which indicates the proper blend of sweetness of fruits. Thus, higher TSS and lower acidity has resulted maximum value of TSS: acid ratio (30.77) in T_{11} (2/3 of T_1 +25 kg FYM+250g *Azospirillum*+250g *Azotobacter*/plant) while minimum (21.84) in T_2 (½ of T_1 +25 kg FYM+250 g PSB/plant).

The reducing sugar, non-reducing sugar and total also followed the same trend giving good response in T_{11} (2/3 of T_1 +25 kg FYM+250g *Azospirillum*+250g *Azotobacter*/ plant) followed by 13.06 ^{0}B in T_{15} (2/3 of T_1 +5 kg vermicompost+250g *Azospirillum*+250g *Azotobacter*/plant) and 12.98 ^{0}B in T_{12} (2/3 of T_1 +25 kg FYM+250g PSB+250 g *Azospirillum*/ plant), respectively. In general, quality parameters were poor in T_2 (½ of T_1 +25 kg FYM+250 g PSB/plant), even over T_1- (Recommended dose of NPK, i.e. 500:200:500 g/plant as control). This indicated that drastic reduction of in recommended dose of inorganic fertilizers are not feasible, though partially it was substituted by application of 25 kg FYM+250 g PSB/plant.

The results obtained in this study indicated that vegetative vigour of rejuvenated guava trees were higher in T_{15} while the reproductive behavior, yield attributing and quality parameters were better in T_{11} followed by T_{15} and T_{12}. This might be due to combined application of organic sources and inorganic fertilizers, which acted complementary and supplementary to each other and resulted into balance and steady supply of desired nutrients for photosynthesis and carbohydrates metabolism in T_{11} and T_{12}, owing to balance vegetative and reproductive phase but T_{15} treatment induces vigourous vegetative growth than reproductive phase. Thus, treatment T_{11} proved to be beneficial over other treatments for obtaining good yield and quality fruits from rejuvenated guava orchards.

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