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INFLUENCE OF INTEGRATED NUTRIENT MANAGEMENT ON GROWTH AND FLOWERING OF WINTER SEASON GUAVA (*PSIDIUM GUAJAVA* L.)

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ABSTRACT

The present experiment was conducted for two consecutive years *i.e.*, 2019-20 and 2020-21, comprising ten different treatments of organic, inorganic and bio-fertilizers, replicated thrice in R.B.D. From the present investigation, it is revealed that all the growth attributes are significantly influenced by the application of different integrated treatments. The application of 75% RDF + *Azotobacter* (250g/tree) + PSB (250g/tree) (T_9) produced the highest increment in plant height (0.66 and 0.68m, respectively), trunk girth (5.35 and 5.47cm, respectively), tree canopy spread from North to South direction (0.70 and 0.73cm, respectively) and from East to West direction (0.78 and 0.82cm, respectively), number of leaves per selected shoot (32.80 and 34.60, respectively), length of the selected shoot (36.40 and 38.64cm, respectively) and diameter of the selected shoot (4.80 and 4.93cm, respectively). Flowering and fruiting parameters *viz.*, number of flowers per tree (507.18 and 516.28, respectively), number of fruits per tree (267.68 and 280.18, respectively), fruit setting per tree (52.78 and 54.27%, respectively) and physical observation of fruits *viz.* weight of fruit (215.16 and 215.39g, respectively), length of fruit (8.20 and 8.25cm, respectively), diameter of fruit (8.33 and 8.41 cm, respectively), volume of fruit (185.87 and 186.92cc, respectively) and pulp weight (210.49 and 212.06g, respectively). However, minimum fruit drop per tree (47.22 and 45.73%, respectively), number of seeds per fruit (235.00 and 235.93, respectively) and seeds weight per fruit (4.67 and 4.33g, respectively) were also found with the same treatment.

Keywords : Guava, INM, *Azotobacter*, PSB, Vegetative Growth and Physico-chemical parameters.

Introduction

Guava (*Psidium guajava* L.), 'The apple of the tropics' belonging to the family Myrtaceae is indigenous to tropical America, is one of the most important tropical/subtropical fruit, which requires a distinct winter for developing good fruit quality which is influenced greatly by the climate. It can withstand drought, up to some extent but only a few degrees of frost. It does not thrive well if the annual rainfall is more than 100 inches. Guava fruit is considered one of the most delicious and luscious fruit. Guava is one of the most promising fruit crops of India and is considered to be one of the exquisite nutritionally valuable and remunerative crops. It is the fourth most important fruit crop of India after mango, banana and citrus. Its cultivation is done throughout the tropical and sub-tropical regions of the world. In India, it has been introduced in the early seventeenth century and gradually became a crop of commercial significance all over the country, particularly in Uttar Pradesh, Bihar, Madhya Pradesh, Maharashtra and West Bengal. Integrated nutrient management involves the combined use of various plant nutrient supply systems, the use of organic manure along with bio-fertilizers and inorganic fertilizers as a cheap source of available nutrients to plants and has resulted in beneficial effects on growth, yield and quality of various fruit crops under normal spacing,therefore, keeping in view, the importance of integrated nutrient management the present experiment was planned to infer concrete information on the effect of these in respect of growth, flowering, yield and quality of winter season guava under north Indian conditions.

Materials and Methods

The present experiment was carried out in the Kalyanpur nursery area of Department of Fruit Science, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur, (U.P.), India, using ten treatments *viz.*, T_1-Control (without nutrient application), T_2-100% RDF (500:400:400g /tree), T_3-75% RDF + FYM (60 Kg/tree), T_4-50% RDF + FYM (60Kg/tree), T_5-75% RDF + *Azotobacter* (250g/tree), T_6-50% RDF + *Azotobacter* (250g/tree), T_7-75% RDF + PSB (250g/ tree), T_8-50% RDF + PSB (250g/tree), T_9-75% RDF + *Azotobacter* (250g/tree) + PSB (250g/tree) and T_{10}-50% RDF + *Azotobacter* (250g/tree) + PSB (250g/tree) replicated thrice in RBD during two successive years *i.e.*,2019-20 (Y1) and 2020-21 (Y2). A single plant is taken as a Unit. The RDF of NPK (500:400:400g/tree) fertilizers were applied in form of Urea, DAP, and MOP, respectively. Two third of the total nitrogen and full dose of phosphorus and potassium were applied during the first week of July. Rest one-third dose of nitrogen was applied in the first week of October and bio-fertilizers were applied in the rhizosphere zone of guava around the tree at a depth of 15 cm leaving 50 cm from the main trunk before flowering (first week of July). The observations were recorded on per cent fruit drop and fruit retention. The various growth parameter, physical fruit characters of *i.e.,* fruit size (length and width in cm), weight (g), volume (g/cm^3),specific gravity(g/cm^3),pulp per cent, fruit yield AOAC (1980).

Results and Discussion

Growth Parameters

Increment in plant height and trunk girth

It is evident from the results that the application of 75% RDF + *Azotobacter* (250g/tree) + PSB (250 g/tree) produced a maximum increment in plant height (0.66 and 0.68m, respectively) with maximum trunk girth (5.35 and 5.47cm, respectively), whereas, minimum increment in plant height(0.45 and 0.48m, respectively) and trunk girth (3.12 and 3.31cm, respectively) were recorded under unfertilized plants (Table1).

This increment in plant height and trunk girth might be because a properly balanced combination of chemical fertilizers, organic manure and bio-fertilizers provides nutrients in proper proportion and amount at the right time resulting in the improvement in physical properties of soil, higher nutrient uptake and increased activity of micro-organisms which were manifested in the form of enhanced growth and higher carbohydrates production as explained by Mishra and Tripathi (2011)in strawberry and Singh and Tripathi (2020a) in papaya.

Canopy spread (North to South and East to West direction):

Plant spread in all directions was significantly more over control when *Azotobacter* and PSB were used in combinations with different doses of RDF. Maximum plant spread from North to South direction (0.70 and 0.73cm, respectively) and from East to West direction (0.78 and 0.82cm, respectively) during both years of experimentationwere obtained with the application of 75% RDF + *Azotobacter* (250g) + PSB (250g)/tree (T_9) which was significantly higher than the control, whereas, the minimum plant spread from North to South direction (0.28 and 0.30cm, respectively) and from East to West direction (0.26 and 0.29cm, respectively) was recorded in plants kept as unfertilized plants.

An increase in plant spread in all directions during the present experiment may be due to the better nutritional supply with the application of organic matter, stimulating and beneficial effect of bio-fertilizers insolubilizing and utilization of nitrogen which ultimately improve the soil health by improving physicochemical and biological activities of soil and biosynthesis of plant growth regulators like IAA and GA in plants. These results are in conformity with the findings of Shukla *et al.* (2009), Goswami *et al.* (2012) and Kumar *et al.* (2017) in guava.

Length and Diameter of Shoots (cm)

The data presented in Table 1 indicate that the growth of guava trees in form of length and diameter of shoots under different treatment combinations differ significantly during both the years of observation. From the data, it is obvious that the longest length (36.40 and 38.64cm, respectively) and diameter (4.80 and 4.93cm, respectively) of shoot growth was recorded with treatment of T_9-75% RDF + *Azotobacter* (250g/tree) + PSB (250 g/tree) followed by 35.80 and 36.72cm, respectively of length and 4.46 and 4.64cm,respectively diameter of shoot growth in T_{10}-50% RDF + *Azotobacter* (250g /tree) + PSB (250g /tree). The minimum length (23.80 and 25.16cm, respectively) and diameter (1.90 and 1.95cm, respectively) of shoot growth was recorded in the plants kept under control (Without nutrient application) during both years of experimentations.. In fact, the inorganic sources coupled with organic sources for major nutrients promote better growth by increasing various macro and micronutrients and increasing the 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 the vegetative vigour of the plants. These results are in close agreement with the finding of Naik and Hari Babu (2005) and Meena *et al.* (2014), where they have reported better growth of guava plants cultivar Sardar through application of inorganic sources like vermicompost and *Azotobacter*.

Number of Leaves/Shoot

The number of leaves per shoot (Tale 1) were record higher (32.80 and 34.60, respectively) during both years in the plants treated with 75% RDF + *Azotobacter* (250g/tree) + PSB (250 g/tree followed by (29.40 and 32.40, respectively)from the plants treated with 50% RDF + *Azotobacter* (250g /tree) + PSB (250g /tree). In fact, the number of leaves per shoot was proportionate to the length of shoots in different treatment combinations. This might be because the growth and development of above-ground parts of the plant are determined primarily by the activity of apical meristem. After all, the leaf primordial is formed there. The stem elongation depends initially on the new tissue formed at the apex and many of the hormonal signals which determine the later growth and development of all plant parts. It becomes clear that a higher dose of inorganic fertilizers along with manures and micronutrients increased the availability of nutrients. Similar findings have been reported by Dutta *et al.* (2009) and Gupta *et al.*(2019) in guava. Application of organic manures with biofertilizers was reported to facilitate the wider absorption of micro and micronutrient which help in better growth and development of a plant.

Reproductive Parameters

Number of Flowers and Fruits Set Per Plant

Number of flowers and fruits set per plant were significantly more over control when *Azotobacter* and PSB were used in combinations with different doses of RDF. A higher number of flowers (508.18 and 516.28, respectively) with the maximum number of fruits set (267.88 and 280.18, respectively) per plant was recorded when the plants that were fertilized with 75% RDF + *Azotobacter* (250g) + PSB (250 g)/tree (T_9), whereas, the minimum number of flowers (409.32 and 412.12, respectively) and fruits set (136.99 and 141.27, respectively) were recorded under control.

This increase in the number of flowers and fruits set in this treatment might be due to the fact that *Azotobacter* and PSB application accelerated the development of inflorescence, leaf number in autumn which results in increased levels of nutrients in assimilating area of the crop due to which the rate of dry matter production was enhanced, which is positively correlated with the number of flowers and fruits in the following spring. A proper supply of nutrients and induction of growth hormones stimulated cell division and cell elongation, which results in an increase in the number of flowers and fruits. Similar findings have been reported by Kanwar *et al.* (2020) in papaya, Gupta and Tripathi (2012)in strawberry, Tripathi *et al.* (2015a) in aonla, Katiyar *et al.* (2012) in ber.

Fruit Drop and Retention

During the present investigation significantly minimum fruit drop (47.22 and 45.73%, respectively) and maximum fruit retention (52.78 and 54.27%, respectively) over control were recorded when the plants were treated with the application of 75% RDF + *Azotobacter* (250g) + PSB (250 g)/tree (T_9). The plants under control resulted in maximum fruit drop per cent (66.53 and 65.70%, respectively) and minimum fruit retention (33.47 and 34.28%, respectively).

This increase in fruit retention and reduced fruit drops with the application of a graded dose of NPK in combination with bio-fertilizers and vermicompost might be due to the result of its association with auxin synthesis, supply of nutrients and their proportion right from starting of the experimentation to the harvesting of the crop, which might induce more flowering and retention of fruits as a result of production and supply of photosynthates at critical requirements. These findings are in agreement with the findings of Kumar *et al.* (2015) in guava cv. Sardar and Tripathi *et al.* (2015a) in aonla.

Physical Characters of Fruit

Length, Diameter, Weight and Volume of Fruit

During both years of the present investigation, it was observed that an integrated dose of different nutrients with bio-fertilizers and vermicompost has given a remarkable increase in the fruit length, width, weight and volume and they were significantly superior over control when *Azotobacter* and PSB were used in combinations with different graded doses of RDF. Longest fruits (8.20 and 8.25cm, respectively) with more diameter (8.33 and8.41cm, respectively), weight (215.16 and 216.39g, respectively) and volume (185.87 and 186.92cc, respectively)were produced from the plants fertilized with 75% RDF + *Azotobacter* (250g) + PSB (250g)/tree (Table 2). The untreated plants (control) produced fruits of significantly minimum length (5.16 and 5.23cm, respectively), diameter (5.42 and 5.51cm, respectively), weight

(140.79 and 141.57g, respectively) and volume (135.09 and136.22cc, respectively) as compared to treated plants during both years of experimentation.

This increase in fruit length, diameter, weight and volume with the use of an integrated dose of NPK along with bio-fertilizers (*Azotobacter* and PSB) due to the supply of plant nutrients and growth hormones in appropriate amount and time during the entire crop period resulted in an increased uptake of nutrients from the soil which has produced enough carbohydrates in the leaves caused more plant height and ultimately more photosynthates for translocation to the sink resulted in the better filling of fruits which produced more length, width, weight and volume of fruits.

The maximum gain in fruit size, weight and volume was also due to the greater mobility of the metabolites into the developing fruit, which acted as a strong metabolic sink as compared to the treatments involving a higher integrated dose of fertilizers. These results are in accordance with the findings of Mishra and Tripathi (2011), who also reported a maximum increase in size, weight and volume of strawberry fruits with the application of *Azotobacter*, PSB and vermicompost. The results are also in close conformity with the findings of Tripathi (2017) and Nayyer *et al.* (2014) in banana, Tripathi *et al.* (2015b), Tripathi *et al.* (2016) in strawberry.

Number of Seeds Per Fruit, Seed Weight and Pulp Content

From the data of both years, it is reported that the combined application of *Azotobacter* and PSB with different doses of RDF has significantly reduced the number of seeds per fruit and also given a remarkable increase in the fruit pulp content and decrease in weight of seeds per fruit. The minimum number of seeds per fruit (235.00 and 235.93, respectively), seed weight(4.67 and 4.33g, respectively) with fruits having maximum pulp (210.49 and 212.06g, respectively) were recorded which were produced from the plants fertilized with 75% RDF + *Azotobacter* (250g) + PSB (250g)/tree in plants which were kept under control. The maximum number of seeds per fruit (328.69 and 322.47, respectively), seed weight (7.67 and 7.33, respectively) with a decrease in weight of fruit pulp (133.12 and 134.24g, respectively) were recorded in plants that were kept under control during both years of experimentation.

This decrease in the number of seeds per fruit, seed weight with an increase in pulp content of fruits during the present investigation may be due to the reason that the organic manures and bio-fertilizers especially *Azotobacter* have a direct role in nitrogen fixation, PSB helps in the increasing availability of phosphorus ensure availability of all other nutrients in the balanced amount at an appropriate time, thus the production of phytohormones like substances increased and uptake of nutrients also increased, hence quality improvement reflected in fruit characters. Vermicompost is expected to hasten plant development, *Azotobacter* fixes more nitrogen in the soil and PSB ensures more availability of phosphorus to the plants, hence an increase in fruit pulp with a decrease in the number and weight of seeds per fruit in the present study is due to the cumulative effect of balanced nutrition, increased availability of nitrogen, phosphorus with the application of bio-fertilizers and vermicompost. These observations are in agreement with the findings of Tripathi *et al.* (2013) in Isabgol, Srivastava *et al.* (2014), Tripathi *et al.* (2015a) in aonla and Singh and Tripathi (2020b) in papaya.

Table 1 : Influence of Integrated Nutrient Management on vegetative growth parameters of winter season Guava cv. L-49

Treatments	Plant height increment (m)		Trunk girth (cm)		Canopy Spread (m) Y1		Canopy Spread (m) Y2		No. of leaves /shoot		Length of shoots (cm)		Diameter of shoots (cm)		No. of flowers /tree		Number of Fruits /tree	
Year	Y1	Y2	Y1	Y2	N-S	E-W	N-S	E-W	Y1	Y2	Y1	Y2	Y1	Y2	Y1	Y2	Y1	Y2
T_1	0.45	0.48	3.12	3.31	0.28	0.26	0.30	0.29	12.40	14.60	23.80	25.16	1.90	1.95	409.32	412.12	136.99	141.27
T_2	0.54	0.55	3.93	3.99	0.46	0.52	0.47	0.57	18.60	21.40	30.15	31.68	2.94	3.28	461. 18	464.20	192.91	202.29
T_3	0.60	0.62	4.62	4.71	0.60	0.68	0.62	0.71	26.20	29.60	34.60	35.18	3.92	4.26	489.21	493.10	235.40	247.10
T_4	0.52	0.54	3.86	3.92	0.41	0.47	0.45	0.51	16.40	19.60	28.26	29.72	2.68	2.96	453.30	456.16	177.96	190.40
T_5	0.58	0.59	4.49	4.57	0.56	0.62	0.59	0.66	24.60	27.80	33.26	34.28	3.56	3.94	478.62	482.26	218.25	232.93
T_6	0.50	0.52	3.79	3.86	0.37	0.42	0.41	0.46	15.20	16.20	27.40	28.14	2.34	2.58	445.12	448.21	169.59	175.33
T_7	0.55	0.57	4.20	4.31	0.51	0.57	0.56	0.61	21.80	24.20	31.60	33.21	3.26	3.61	469.42	472.38	205.23	215.73
T_8	0.47	0.49	3.39	3.48	0.32	0.36	0.37	0.39	14.20	15.80	26.38	26.92	2.24	2.36	434.56	437.28	159.96	164.02
T_9	0.66	0.68	5.35	5.47	0.70	0.78	0.73	0.82	32.80	34.60	36.40	38.64	4.80	4.93	507.18	516.28	267.68	280.18
T_{10}	0.63	0.65	5.17	5.32	0.66	0.73	0.67	0.79	29.40	32.40	35.80	36.72	4.46	4.64	498.12	501.87	251.35	262.87
SEm±	0.02	0.02	0.45	0.17	0.02	0.02	0.02	0.02	1.38	0.87	1.52	1.53	0.12	0.13	16.07	14.68	7.82	7.23
CD at 5%	0.05	0.05	1.35	0.53	0.05	0.06	0.05	0.07	4.19	2.64	4.62	4.63	0.37	0.40	48.76	44.53	23.73	21.92

Table 2 : Influence of Integrated Nutrient Management on vegetative growth parameters of winter season Guava cv. L-49

Treatments	Fruit retention (%)		Fruit drop (%)		Length of fruits (cm)		Fruit diameter (cm)		Fruit weight (g)		Volume of fruit (cc)		Pulp weight (g)		Number of seeds /fruit		Seed weight /fruit (g)	
Year	Y1	Y2	Y1	Y2	Y1	Y2	Y1	Y2	Y1	Y2	Y1	Y2	Y1	Y2	Y1	Y2	Y1	Y2
T_1	33.47	34.28	66.53	65.70	5.16	5.23	5.42	5.51	140.79	141.57	135.09	136.22	133.12	134.24	328.69	322.47	7.67	7.33
T_2	41.83	43.58	58.53	56.42	6.20	6.29	6.18	6.23	188.39	189.96	157.66	158.69	18.06	183.96	282.33	278.48	6.33	6.00
T_3	48.12	50.42	51.88	49.58	7.76	7.79	6.89	6.92	198.69	199.34	172.81	173.65	193.36	194.34	252.45	250.66	5.33	5.00
T_4	39.26	41.74	60.74	58.26	5.92	6.01	5.98	6.08	184.69	185.35	152.47	153.82	178.02	179.02	291.44	288.69	6.67	6.33
T_5	45.60	48.30	54.40	51.17	7.59	7.62	6.41	6.52	195.32	196.69	169.45	170.29	189.65	191.36	263.48	260.45	5.67	5.33
T_6	38.10	39.12	61.10	60.88	5.79	5.84	5.79	5.90	181.92	182.89	146.29	147.66	174.92	176.22	298.42	294.83	7.00	6.67
T_7	43.72	45.67	56.28	54.72	7.41	7.45	6.28	6.39	190.83	192.54	163.35	164.86	184.83	186.87	273.66	271.74	6.00	5.67
T_8	36.81	37.51	63.19	62.19	5.56	5.66	5.61	5.72	177.67	178.31	141.68	142.60	170.34	171.31	308.48	305.82	7.33	7.00
T_9	52.78	54.27	47.22	45.73	8.20	8.25	8.33	8.41	215.16	216.39	185.87	186.92	210.49	212.06	235.00	235.93	4.67	4.33
T_{10}	50.46	52.38	49.54	47.62	7.93	7.99	7.50	7.59	202.24	203.84	180.03	181.83	197.24	199.17	242.66	239.67	5.00	4.67
SEm±	1.81	2.20	1.95	3.22	0.55	0.53	0.55	0.35	9.91	6.87	5.12	6.64	10.63	8.96	11.33	17.90	0.54	0.61
CD at 5%	5.49	6.68	5.92	9.76	1.66	1.61	1.67	1.06	30.06	20.83	15.53	20.14	32.24	27.17	33.35	54.30	1.64	1.84

Conclusion

It may be concluded from the present investigation, that the soil application of 75% recommended dose of fertilizers with 60Kg of farm yard manure per plant produced a yield at par with 100 % RDF. The good quality of fruit harvested with soil application of 75% recommended dose of fertilizers with 60Kg of farm yard manure per plant. It may be recommended that the application of 75% recommended dose of fertilizers with 60Kg of farm yard manure per plant produces good quality of fruit and other attributes.

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