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Studies on integrated nutrient management for growth and yield of custard apple

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Abstract
A research study titled, "Studies on integrated nutrient management for growth and yield of custard apple". The research study was done in the field of student instruction and Custard apple Orchard, Department of Horticulture, School of Agricultural Sciences, G. H. Raisoni University Saikheda, Dist.- Pandhurna (M.P.) during Kharif 2023. The details of materials used in experimental they have 10 treatments with control, the experiment analysed under Randomized Block Design, with three replications. The treatment details are T_1-100% Vermicompost as per RD, T_2-100% FYM as per RD, T_3-75% Vermicompost as per RD + 100 gm Azoto-bacter + 100 gm PSB + 100 gm Rhizobium, T_4-75% FYM as per RD + 100 g Azotobacter + 100 g PSB + 100 g Rhizobium, T_5-Per plant, 100% RDF (250:125:125 NPK) grams, T_6-100 g each of Azotobacter, PSB, and Rhizobium + 75 percent RDF (188:94:94 NPK), T_7-2 kg vermin-compost + 100 g each of Azoto-bacter, PSB, and Rhizobium + 75 percent RDF (188:94:94 NPK), T_8-1.5kg of neem-cake + 100 gm of Azoto-bacter + 100 gm of Phosphate solubilizing bacteria + 75% RDF (188:94:94 NPK), T_9-100 gm each of Rhizobium, Azotobacter, and Phosphate solubilizing bacteria + 0.75 kg of Neem-cake + 1 kg of Vermi-compost + 75% RDF (188:94:94 NPK) and T_{10}- Control. The observation was recorded such as leaf area (cm^2), fruit set (%),fruit length (cm), fruit diameter (cm), no. of fruits per plant, and total soluble solids (°B). The result revealed that the maximum leaf area (21.84 cm^2), fruit set (60.58%), number of fruits per plant (10624.86 g/tree), fruit length (7.88 cm), fruit diameter (7.22 cm) and total soluble solids (22.55 °Brix) was observed under the treatments T_9, while the minimum was observed under contro in all the parameters.

Keywords: Custard apple, INM, biofertilizers, PSB and vermicompost

Introduction
The oldest fruit crop grown on dry soil in India is the custard apple. They are extensively dispersed across the tropics and subtropics, having originated in the tropical area of America. It is a member of the Annonaceae family, which includes 120 species and 40 genera, only five of which have edible fruits. There are reports that distinct annona species have diverse origins. The origin of Custard apple (*Annona squamosa* L.) is in Central America. The fruits weigh between 250 and 300 grams, have a globular shape, green skin, noticeable reticulation on the fruit surface, are not acidic, and have a sweet pulp of high quality. The fruit's edible pulp, which varies according on the species, is creamy and granular with a pleasing balance of sweetness and acidity. Proteins, fatty acids, fiber, carbs, minerals, and vitamins are all present in fruit pulp (Lizana and Reginato, 1990) [1].

Everyone like the subtle perfume and good flavor. The fruit has minerals including calcium, phosphorus, and potassium in addition to vitamin C. Custard apple is considered the best dry-land fruit crop. What is required is the most efficient use of procured resources, rather than increased inputs. In terms of energy, economy, and the environment, it is critical that plant nutrients be used efficiently by establishing an appropriate nutrients management system to ensure high output and maintain soil availability at an ideal level for high quality and yielding fruit production (Yadav, 1999) [2].

Nitrogen is a critical and expensive component in horticulture cultivation. The addition of organic and inorganic fertilizers not only supplements and improves soil fertility and production,

but it also improves soil physical condition, resulting in better water retention and increased soil flora and fauna. Poultry dung is somewhat resistant to microbial decomposition. It is, nonetheless, necessary for the establishment and maintenance of optimal soil physical conditions, as well as for plant growth. Poultry dung is a low-cost and efficient source of nitrogen for long-term crop productivity (Mulvaney *et al.*, 2010) [3].

Materials and Methods

A research study titled, "Studies on integrated nutrient management for growth and yield of custard apple". The research study was done in the field of student instruction and Custard apple Orchard, Department of Horticulture, School of Agricultural Sciences, G. H. Raisoni University Saikheda, Dist.-Pandhurna (M.P.) during Kharif 2023. The details of materials used in experimental they have 10 treatments with control, the experiment analysed under Randomized Block Design (RDF), with three replications. The treatment details are T_1-100% Vermicompost as per RD, T_2-100% FYM as per RD, T_3-75% Vermicompost as per RD + 100 gm Azoto-bacter + 100 gm PSB + 100 gm Rhizobium, T_4-75% FYM as per RD + 100 gm Azoto-bacter + 100 gm PSB + 100 gm Rhizobium, T_5-Per plant, 100% RDF (250:125:125 NPK) grams, T_6-100 g each of Azotobacter, PSB, and Rhizobium + 75% RDF (188:94:94 NPK), T_7-2 kg vermin-compost + 100 gm each of Azoto-bacter, PSB, and Rhizobium + 75 percent RDF (188:94:94 NPK), T_8-1.5kg of neem-cake + 100 gm of Azoto-bacter + 100 gm of Phosphate solubilizing bacteria + 75% RDF (188:94:94 NPK), T_9-100 gm each of Rhizobium, Azoto-bacter, and Phosphate solubilizing bacteria + 0.75 kg of Neem-cake + 1 kg of Vermi-compost + 75% RDF (188:94:94 NPK) and T_{10}- Control. The observation was recorded such as leaf area (cm^2), fruit set (%),fruit length (cm), no. of fruits per plant, fruit diameter (cm) and total soluble solids (°B).

Results and Discussion

Leaf area (cm^2)

The maximum increase in leaf area (21.84 cm^2) was noted with the use of T_9 - (100 gm each of Rhizobium, Azotobacter, and Phosphate solubilizing bacteria + 0.75 kg of Neem-cake + 1 kg of Vermi-compost + 75% RDF (188:94:94 NPK)), followed by the treatments (20.87 cm^2) under the treatment (T_5) Per plant, 100% RDF (250:125:125 NPK) grams, whereas lowest leaf area (19.25 cm^2) record under T_{10} (Control). The maximum Leaf area in T_9 may be linked to the synergistic influence of vermi-compost and inorganic fertilizers at greater doses, which are reinforced by increased availability of vitamins, enzymes, macro and micro nutrients, growth hormones, humic acid, and beneficial bacteria. Athani *et al*., (2007) [4], Jain *et al*., (2012) [5], and Singh *et al*., (2018) [6] have all found similar findings.

Fruit set (%)

The maximum fruit set (60.58%) was seen with the use of T_9 - (100 gm each of Rhizobium, Azotobacter, and Phosphate solubilizing bacteria + 0.75 kg of Neem-cake + 1 kg of Vermi-compost + 75% RDF (188:94:94 NPK)), followed by the treatments (58.61%) under the treatment (T_5) Per plant, 100% RDF (250:125:125 NPK) grams, whereas minimum fruit set (50.84%) record under T_{10} (Control).

Number of fruit per plant

The maximum number of fruit / plant (63.32) was noted with the use of (100 gm each of Rhizobium, Azotobacter, and Phosphate solubilizing bacteria + 0.75 kg of Neem-cake + 1 kg of Vermi-compost + 75% RDF (188:94:94 NPK)) (T_9), followed by the treatments (62.17) under the treatment (T_5) Per plant, 100% RDF (250:125:125 NPK) grams, whereas minimum number of fruit per plant (40.25) record under T_{10} (Control).

Fruit yield/ tree (g)

The maximum fruit yield (10624.86 g/tree) was noted with the use of (100 gm each of Rhizobium, Azotobacter, and Phosphate solubilizing bacteria + 0.75 kg of Neem-cake + 1 kg of Vermi-compost + 75% RDF (188:94:94 NPK)) (T_9), followed by the treatments (9621.05 g/tree) under the treatment (T_5) Per plant, 100% RDF (250:125:125 NPK) grams, whereas minimum fruit yield (4614.39 g/tree) record under T_{10} (Control). The custard apple fruits generated by the plants getting nitrogen in the form of RDF, vermicompost, and Neem coated urea showed improvements in physical quality parameters. This may be due to the availability of nutrients in a form that is needed for Photosynthetic activity at a quicker pace, which might have allowed for the delivery of carbs to the growing fruits. and, ultimately, produced higher-quality fruits on the trees treated with this method. According to Budu (1998) [7] for sweet oranges, Marzouk *et al*., (2011) [8] and Kassem (2012) [9] for date palms, and Bakshi *et al*., (2012) [10] for papayas, the administration of 250 g N through ammonium sulphate improved the physical characteristics of the fruits. As a nitrogen inhibitor, neem-coated urea reduces the amount of nutrients that are lost from the soil. Osman *et al*., (2009) [11] showed a similar pattern of results in guava. The custard apple fruits with the lowest physical attributes on the trees that did not receive nitrogen could have been produced by poor vegetative growth due to a lack of necessary nutrients throughout the fruit growth stage, resulting in fruits with low-quality features.

Fruit length (cm)

The maximum length of fruit (7.88 cm) was noted with the use of T_9 - (100 gm each of Rhizobium, Azotobacter, and Phosphate solubilizing bacteria + 0.75 kg of Neem-cake + 1 kg of Vermi-compost + 75% RDF (188:94:94 NPK)), followed by the treatments (7.08 cm) under the treatment (T_5) Per plant, 100% RDF (250:125:125 NPK) grams, whereas minimum fruit length (5.23 cm) record under T_{10} (Control). Meena *et al*., (2007) [12] observed a similar trend in the enhancement of plant growth metrics was seen under INM using vermicompost in dill. Shukla *et al*., (2009) [13] studied guava, Gangadharan and Gopinath (2000) [14] studied gladiolus, Rodriguez *et al*., (2000) [15] studied gerbera, Choudhary and Chandra (2006) [16] studied okra, and Choudhary *et al*., (1975) [17] and Muhammad *et al*., (2000) [18] studied guava. The experimental findings indicated that different treatments of bio-fertilizers and inorganic fertilizer significantly increased plant height and spread. Dutta *et al*., (2009) [19] investigated the effect of bio-fertilizer in combination with inorganic fertilizer on the growth and productivity of guava cv. L-49. Compared to the control, the Azo-spirillium + VAM inoculation paired with 100% P2O5 resulted in the highest plant height and spread. Singh *et al*., (2009) [20] found that nitrogen-fixing bacteria and bio regulators had a substantial influence on strawberry plant development characteristics.

Fruit diameter (cm)

The maximum fruit diameter (7.22 cm) was noted with the application of (100 gm each of Rhizobium, Azotobacter, and Phosphate solubilizing bacteria + 0.75 kg of Neem-cake + 1 kg of Vermi-compost + 75% RDF (188:94:94 NPK)) (T_9), followed by the treatments (6.77 cm) under the treatment (T_5) Per plant,

100% RDF (250:125:125 NPK) grams, whereas minimum fruit diameter (5.11 cm) record under T_{10} (Control). This study evaluates various nutrient management practices, including organic supplements and microbial inoculants, on custard apple yield and fruit quality. It provides insights into how combinations of reduced chemical fertilizers with organic inputs can enhance fruit size and other quality parameters. Variations in fruit diameter observed across different treatments can be attributed to the types and amounts of nutrients supplied, including nitrogen sources and organic supplements. The combination of reduced chemical fertilizer (75% RDF), organic supplements like Vermicompost, Neem cake, and microbial inoculants (Azotobacter, PSB, Rhizobium) consistently contributed to larger fruit sizes compared to the control and even treatments with higher RDF alone. This underscores the importance of balanced nutrition and the role of organic inputs in enhancing fruit quality parameters in custard apple cultivation. This is conformity with Saha *et al.*, 2016 [21] in Custard Apple.

Total Soluble Solids (^{0}Brix): The maximum total soluble solids (TSS) (22.55 ^{0}Brix) was found in T_9 (100 gm each of Rhizobium, Azotobacter, and Phosphate solubilizing bacteria + 0.75 kg of Neem-cake + 1 kg of Vermi-compost + 75% RDF (188:94:94 NPK)) followed by T_5 (plant received Per plant, 100% RDF (250:125:125 NPK) grams) (21.88 ^{0}Brix), and minimum (19.35 ^{0}Brix) in T_{10} (Control). Based on the current study's findings, applying nitrogen from various sources was found to increase the quality of custard apple fruits. This might be because the assimilation of ammonium into plant metabolites doesn't take as much energy as the absorption of nitrate because ammonium doesn't need to be reduced. By absorbing lower nitrogen, plants may be able to preserve energy that they may employ to produce more secondary metabolites' (Elwan and Abd El-Hamed, 2011) [22]. Furthermore, other than urea, ammonium sulphate produced fruit with a greater grade. This discrepancy may result from ammonium sulfate's capacity to lower soil pH, which may favor plants' availability and absorption of nutrients in slightly alkaline soils (Guler, 2005) [23].

Table 1: Effect of integrated nutrient management on growth and yield parameters of custard apple

Treat.	Leaf Area (cm^2)	Fruit Set (%)	No of fruit/ plant	Fruit yield tree (g)	Fruit Length (cm)	Fruit diameter (cm)	Total Soluble Solids (°B)
T_1	19.58	52.25	53.16	6680.04	5.65	5.55	19.58
T_2	19.35	51.26	52.22	6351.31	5.55	5.25	19.48
T_3	20.35	53.54	57.23	7725.45	6.11	5.68	20.21
T_4	20.25	52.47	54.25	7305.22	5.85	5.55	19.66
T_5	20.87	58.21	62.17	9621.05	7.08	6.77	21.88
T_6	20.45	55.34	58.55	8332.45	6.23	6.25	21.55
T_7	20.65	56.42	60.25	8677.14	6.46	6.33	21.58
T_8	20.84	56.55	61.32	9137.00	6.57	6.58	21.63
T_9	21.84	60.58	63.32	10624.86	7.88	7.22	22.55
T_{10}	19.25	50.84	40.25	4614.39	5.23	5.11	19.35
S.Em.±	0.032	0.130	0.276	141.558	0.032	0.028	0.035
CD at 5%	0.095	0.385	0.819	420.591	0.094	0.084	0.103

Conclusion

The highest value of all the parameters was achieved with the application of T_9 - (100 gm each of Rhizobium, Azotobacter, and Phosphate solubilizing bacteria + 0.75 kg of Neem-cake + 1 kg of Vermi-compost + 75% RDF (188:94:94 NPK)), followed by the treatments T_5 - 100% RDF (250:125:125 NPK) per plant and T_8 - 1.5kg of neem-cake + 100 gm of Azoto-bacter + 100 gm of Phosphate solubilizing bacteria + 75% RDF (188:94:94 NPK). The lowest was observed under T_{10} (Control).

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