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Effect of Different Combinations of Organic Manures and Inorganic Fertilizers on Growth and Establishment of Custard Apple (*Annona squamosa*) cv.NMK-1 Golden

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ABSTRACT: Custard apple is a very important dry land fruit tree of India. Now-a-days, this crop is becoming popular and commercial. Due to imbalanced nutrition, diseases and pest attack and lack of adoption of advanced technology or improved production techniques the productivity of custard apple has become very low. Among these factors, probably nutrition is a key factor affecting the productivity of custard apple trees. Imbalanced and non-judicious use of chemical fertilizers is a common practice adopted by the farmers. The use of organic fertilizers with inorganic fertilizers as a supplement is a new approach to maintain a balance, regulate cropping and with a view of getting higher outcome.

Hence, a field experiment entitled "Effect of different combinations of organic manures and inorganic fertilizers on growth and establishment of custard apple (*Annona squamosa*) cv.NMK-1 Golden" was conducted during the October 2020 to February 2021, at the Central Research Farm, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj. The experiment consisted of ten different combinations of treatments of organic manures and inorganic fertilizers which was laid out in Randomized Block Design with three replications. Different proportions of organic manures and inorganic fertilizers *viz.*, Vermicompost (25%, 75%, 100%), Farm yard manure (25%, 75%, 100%), Leaf compost (25%, 75%, 100%) and RDF (25%, 75%, 100%) were applied. Results revealed that the treatment T_3 (25% RDF + 75% Vermicompost per plant) was found significantly superior over all other treatments with respect to plant growth and establishment characteristics. The plant growth parameters like plant height (30.68 cm), number of leaves per plant (25.67), number of branches per plant (2.40) and plant spread (37.18 cm), stem girth (2.71 cm), leaf area (28.16 cm^2) and days to emergence of first new leaf after treatment (6.47 days), establishment percentage (100%) and chlorophyll content (39.55%) increased significantly under T_3 treatment in custard apple cv. NMK-1 Golden. The information regarding the utility of combining these fertilizers in fruit crops is very scanty. Under prevailing conditions it is the duty of the researchers to generate the information on effectiveness and economics of these organic and fertilizers in dry land fruit crop like custard apple.

Keywords: custard apple, organic manures, inorganic fertilizers, growth, establishment.

INTRODUCTION

Custard apple (*Annona squamosa* L.) also known as sugar apple, is the most ancient dry land fruit tree in India. *Annona squamosa* L. is originated in Central America from there; it was distributed to Mexico and Tropical America (Popenoe, 1974). It is of Annonaceae family and comprises of 40 genera and 120 species of which only five of them produce edible fruits . People in south India consume the annonaceous fruits as an important part of their diet. Among the annonas, custard apple (*Annona squamosa*) is valued more than other fruits of the same family. The custard apple is commonly known as 'Sitaphal' in the South India and 'Sharifa' in North India. It is the best among annonaceous fruits growing under Indian condition. The Sitaphal is called as a 'poor man's fruit' as well as food. The fruits are medium in size (250-300 g), globular in shape, generally having green skin, conspicuous reticulation on fruit surface, non acidic in nature, having good quality and sweet pulp. It was reported (Wenkam, 1990) that these fruits are a good source of sugar (16-20%), iron, calcium, phosphorus and ascorbic acid. It helps in digestion, relaxes muscles, gives protection against heart disease.

It has been widely reported that due to non judicious use of fertilizer there is an occurrence of multi-nutrient deficiencies and overall decline in productive capacity of soil (Chhonkar, 2008). Sanewski, (1991) suggested that the use of organic fertilizers with inorganic fertilizers as a supplement to maintain a balance and to regulate cropping. The interactive advantages of

combining organic and inorganic sources of nutrients in INM have proved it superior to the sole use of these sources (Ray and Ange 1991). According to Souza, (2016), the plant extracts large amounts of nutrients from the soil. Since nitrogen is the most required nutrient, nitrogen fertilization increases the vegetative and reproductive of custard apple plant (São *et al.*, 2014). An effective, integrated approach employs organic manures, biofertilizers, chemical fertilizers, nitrification inhibitors, coated and long-persisting nitrogen fertilizers, which are the key to sustainable agriculture (Gowarikar *et al.*, 2005).

The cv. NMK-1 Golden is a hybrid variety of custard apple developed by a research-oriented farmer. The fruits of this variety have fewer seeds, abundant pulp and rarely crack when ripe. Due to its higher shelf-life and uniform size this variety overcomes almost all the demerits while exporting the fruits.

The information on the utility of combining these fertilizers in fruit crops is very scanty. Under prevailing conditions it is the need of the day to generate the information on effectiveness and economics of these organic and fertilizers in dry land fruit crop like custard apple (Solanke *et al.*, 2019). The present investigations were undertaken to study the effect of different combinations of organic manures and inorganic fertilizers on growth and establishment of custard apple (*Annona squamosa*) cv.NMK-1 Golden with a view to obtain information regarding the quantitative changes in growth attributes of custard apple cv. NMK-1 Golden.

MATERIALS AND METHODS

The field experiment was conducted at the Central Research Farm, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj during the year 2020-21, situated at a latitude 25º57′ north and longitude of 80º 5′ East at an attitude of 98 meters above mean sea level (MSL). The experimental land is situated in the river basin of the Ganga and the Yamuna. Prayagraj region has a sub-tropical climate prevailing in the south-east part of Uttar Pradesh with extreme in temperatures, i.e. the winter and the summer. In winters, the temperature sometimes goes as low as 32° in December–January and very hot summer with temperature reaching unto 115° in the months May and June. During winter, frosts and during summer, hot scorching winds are also very common. The average rainfall is 1013.4 mm, with maximum concentration during July to September months with occasional showers in winters. After analyzing the soil chemical properties, it revealed that soil was sandy loam in texture, acidic in reaction (pH 6.20) medium in organic carbon (0.70%) and potassium (112.50 kg ha^{-1}), low in available phosphorus (18.0 kg ha^{-1}). The electrical conductivity of the soil was 0.15 ds m^{-1}.

The experiment was laid out in Randomized Block Design (RBD), with 10 treatments replicated thrice. Treatment was randomly arranged in each replication, divided into 5 plants, with plot size of 30 m^2 (10m×3m) each. Ten treatments combinations, comprising (i) T_0 (Control) (ii) T_1 [RDF (75%) + Vermicompost (25%)] (iii) T_2 RDF [(50%) + Vermicompost (50%)] (iv) T_3 [RDF(25%) + Vermicompost (75 %)] (v) T_4 [RDF (75%) + FYM (25%)] (vi) T_5 RDF (50%) + FYM (50%) (vii) T_6 [RDF (25%) + FYM (75%)] (viii) T_7 [RDF (75%) + Leaf Compost (25%)] (ix) T_8 [RDF (50%) + Leaf Compost (50%)] (x) T_9 [RDF (25%) + Leaf Compost (75%)].

Crop variety 'NMK-1 Golden' was transplanted manually on 23rd of October, 2020. The crop geometry was maintained as per the spacing prescribed for the particular treatments. The combinations of the mentioned treatments were applied at 30, 60, 90 and 120 days after planting.

The observations on establishment percentage and growth parameters viz. plant height, number of leaves per plant, number of branches per plant, plant spread, stem girth, leaf area, days to emergence of 1st new leaf (after treatment) and Chlorophyll Content were taken at 3, 60, 90 and 120 days after planting.

RESULTS AND DISCUSSION

A. Effect of different combinations of organic manures and inorganic fertilizers on percentage of establishment of custard apple cv NMK-1 Golden:

(i) Percentage of Establishment: The data pertaining to percentage of establishment indicates that the differences were significant only due to variations in sources of nutrition. Data enumerated in Table 1 revealed that the effect of different combinations of organic manures and inorganic fertilizers on percentage of establishment of custard apple cv. NMK-1 Golden.

Table 1: Effect of different combinations of organic manures and inorganic fertilizers on percentage of establishment of custard apple cv. NMK-1 Golden.

Treatment Notations	Treatment Combinations	Percentage of establishment (%)
T_0	Control	40.00
T_1	RDF (75%) + Vermicompost (25%)	80.00
T_2	RDF (50%) + Vermicompost (50%)	80.00
T_3	RDF(25%) + Vermicompost (75 %)	100.00
T_4	RDF (75%) + FYM (25%)	60.00
T_5	RDF (50%) + FYM (50%)	80.00
T_6	RDF (25%) + FYM (75%)	86.67
T_7	RDF (75%) + Leaf Compost (25%)	66.67
T_8	RDF (50%) + Leaf Compost (50%)	80.00
T_9	RDF (25%) + Leaf Compost (75%)	93.33
	F-test	**S**
	SE.d (±)	**4.77**
	CD (5 %)	**10.01**

The data shown that application of different proportions of organic manures and inorganic fertilizers viz., Vermicompost (25%, 75%, 100%), Farm yard manure (25%, 75%, 100%), Leaf compost (25%, 75%, 100%) and RDF (25%, 75%, 100%). The findings of the present investigation showed that maximum percentage of establishment of custard apple was recorded in T_3(100%) followed by T_9, which were at par with each other and the rest are significantly superior over the minimum values *viz.* T_6, T_2, T_8 and T_5. The maximum percentage of establishment in T_3 might be due to favourable environmental conditions for better growth of the plant, particularly for good development of a root system, also due to holding ample of aeration and optimum soil moisture status for better growth of the seedling, particularly for good development of a root system, ultimately the overall establishment of the plants. These results are in support with Jain *et al*., (2017); Dwivedi and Agnihotri (2018); Parmar *et al.*, (2019).

B. Effect of different combinations of organic manures and inorganic fertilizers on growth attributes of custard apple cv.NMK-1 Golden

(ii) Plant height: The perusal of the data in Table 2 revealed the significant effect of different combinations of organic manures and inorganic fertilizers on plant height (cm) of custard apple cv.NMK-1 Golden at different days interval (30, 60, 90 and 120 days after planting). The data pertaining to plant height of custard apple indicates that the differences were significant when the CD value was greater than the treatment differences. The maximum value (T_3) was found significantly superior over all the treatments when the CD value was subtracted from the same, followed by T_9, T_6, and T_2 at 30, 60, 90 and 120 days after planting of custard apple. The maximum increase in plant height in T_3 might be due to the favourable environmental condition, more water holding capacity of organic manure and supply of one or more plant nutrients by vermicompost. The supply of nitrogen by vermicompost increased the nitrogen content by cell sap in the form of protein, amides and amino acids which resulted in the cell elongation and multiplication which ultimately increased the plant height of the custard apple plants. Similar results were obtained by Karthikeyan *et al.,* (2006); Kumar *et al*., (2016).

(iii) Number of leaves per plant: The perusal of the data in Table 2 revealed the significant effect of different combinations of organic manures and inorganic fertilizers on number of leaves per plant in custard apple at different days interval. The data pertaining to number of leaves per plant of custard apple indicates that the differences were significant when the CD value was greater than the treatment differences. The maximum value (T_3) was found significantly superior over all the treatments when the CD value was subtracted from the same, followed by T_9, T_6, and T_2 at 30, 60, 90 and 120 days after planting of custard apple. The maximum number of leaves per plant in T_3 might be due to application of sufficient amount of vermicompost improves the aeration and water holding capacity of media and helps in better absorption of soil nutrients this is directly related with photosynthesis and accumulation of high carbohydrates. Similar findings were reported by Radhakrishnan *et al*., (2010); Atom (2013).

(iv) Number of branches per plant: The perusal of the data in Table 2 revealed the significant effect of different combinations of organic manures and inorganic fertilizers on number of branches per plant in custard apple at different days interval. The data pertaining to number of branches per plant of custard apple indicates that the differences were significant when the CD value was greater than the treatment differences. The maximum value (T_3) was found significantly superior over all the treatments when the CD value was subtracted from the same, followed by T_9, T_6, and T_2 at 30, 60, 90 and 120 days after planting of custard apple. The maximum number of branches per plant in T_3 might be due to prevalence of better growing conditions till first week of December followed by cessation of growth with winter during December-January and resumption of speedy growth on onset of spring during February-March. Similar results were obtained by Mandal *et al*., (2013).

(v) Plant spread: The observational data pertaining to plant spread (cm) in North-South(N-S) direction and East-West(E-W) direction indicates that the difference were significant only due to variations in sources of nutrition. The perusal of the data in Table 2 revealed that the effect of different organic manures and inorganic fertilizers on plant spread at different days interval. The data pertaining to plant spread of custard apple indicates that the differences were significant when the CD value was greater than the treatment differences. The maximum value (T_3) was found significantly superior over all the treatments when the CD value was subtracted from the same, followed by T_9, T_6, and T_5 at 30, 60, 90 and 120 days after planting of custard apple. The maximum plant spread in T_3 might be due to the use of increased volume of vermicompost with combination of other inorganic fertilizers enhances the vegetative growth of custard apple (in T_3). Similar findings were reported by Bhobia *et al.,* (2005); Devashi (2012); Bhatnagar and Singh (2015); Kumar *et al.,* (2017); Dwivedi and Agnihotri (2018).

(vi) Stem girth: The perusal of the data in Table 2 revealed the significant effect of different combinations of organic manures and inorganic fertilizers on stem girth (cm) of custard apple cv. NMK-1 Golden at different days interval. The findings of the present investigation showed that maximum increase in stem girth of custard apple was recorded in T_3 followed by T_9 and T_6, which were at par with each other at 30, 60, 90 and 120 days after planting and the rest are significantly superior over the minimum values *viz.* T_2, T_1 and T_5. The maximum increase in stem girth in T_3 might be due to better nutrient availability leading to higher production of photosynthetically functional leaves in this media finally resulting in better stem girth of plants. Similar findings were reported by Borah *et al.,* (2008); Sharma *et al.* (2015); Kumar *et al.,* (2017); Dwivedi and Agnihotri (2018).

(vii) Leaf area: The perusal of the data in Table 2 revealed the significant effect of different combinations

of organic manures and inorganic fertilizers on leaf area (cm^2) of custard apple cv. NMK-1 Golden at different days interval. The data pertaining to leaf area of custard apple indicates that the differences were significant when the CD value was greater than the treatment differences. The maximum value (T_3) was found significantly superior over all the treatments when the CD value was subtracted from the same, followed by T_9, T_6, and T_2 at 30, 60, 90 and 120 days after planting of custard apple. The maximum leaf area in T_3 might be due to the synergistic effect of vermicompost and inorganic fertilizers at higher dose augmented by enhanced availability of macro and micro nutrients, growth hormones, vitamins, enzymes, humic acid and beneficial microbes. Similar findings were reported by Athani *et al*., (2007); Jain *et al*., (2012) ; Singh *et al*., (2018).

Table 2: Effect of different combinations of organic manures and inorganic fertilizers on growth parameters of custard apple cv. NMK-1 Golden.

Treatment Symbols	Treatment Combinations	Growth Parameters							
		Plant Height (cm)	No. of Leaves per plant	No. of Branches per plant	Plant spread (cm)	Stem Girth (cm)	Leaf Area (cm^2)	Days to emergence of 1st new leaf (after treatment)	Chlorophyll Content (%)
T_0	Control	21.72	14.33	0.13	25.27	1.30	20.66	18.73	33.84
T_1	RDF(75%) + Vermicompost(25%)	23.10	15.00	0.40	25.60	2.02	23.17	11.33	36.85
T_2	RDF(50%) + Vermicompost(50%)	24.04	16.33	0.67	26.18	2.06	24.02	11.33	36.84
T_3	RDF(25%) + Vermicompost(75%)	30.68	25.67	2.40	37.18	2.71	28.16	6.47	39.55
T_4	RDF (75%) + FYM (25%)	22.53	14.67	0.40	25.98	1.72	21.03	18.00	34.90
T_5	RDF (50%) + FYM (50%)	22.94	14.67	0.47	26.97	1.86	21.93	16.33	35.81
T_6	RDF (25%) + FYM (75%)	24.60	16.60	0.80	27.06	2.30	25.52	10.67	37.02
T_7	RDF(75%) + Leaf Compost (25%)	22.41	14.00	0.40	25.45	1.74	23.08	18.67	35.76
T_8	RDF(50%) + Leaf Compost (50%)	22.85	16.07	0.53	26.49	1.76	24.37	15.00	35.89
T_9	RDF(25%) + Leaf Compost (75%)	24.81	19.07	0.93	28.91	2.48	25.90	7.33	37.64
	F-test	S	S	S	S	S	S	S	S
	SE.d (±)	0.55	1.24	0.17	0.44	0.05	0.25	1.11	0.49
	CD (5 %)	1.16	2.61	0.35	0.93	0.11	0.53	2.33	1.04

(viii) Emergence of 1st new leaf after treatment: The observational data pertaining to days taken for the emergence of 1st new leaf after treatment indicates that the differences were significant only due to variations in sources of nutrition. The perusal of the data in Table 2 revealed that the effect of different combinations of organic manures and inorganic fertilizers on days to emergence of 1st new leaf (after treatment). The data pertaining to days to emergence of 1st new leaf (after treatment) of custard apple indicates that the differences were significant when the CD value was greater than the treatment differences. The minimum value (T_3) was found significantly superior over all the treatments when the CD value was subtracted from the same, followed by T_9, T_6, and T_2 at 30, 60, 90 and 120 days after planting of custard apple. The minimum days to emergence of 1st new leaf (Days after treatment) in T_3 might be supported by the fact that vermicompost increases the surface area, absorbability and stimulates the hormonal activity in plants. These findings are in accordance with Ram *et al*., (2007); Meena *et al*., (2017).

(ix) Chlorophyll content: The perusal of the data in Table 2 revealed the significant effect of different combinations of organic manures and inorganic fertilizers on chlorophyll content (%) of custard apple cv. NMK-1 Golden at different days interval. The data pertaining percentage of chlorophyll content of custard apple indicates that the differences were significant when the CD value was greater than the treatment differences. The minimum value (T_3) was found significantly superior over all the treatments when the CD value was subtracted from the same, followed by T_9, T_6, and T_1. The maximum chlorophyll content in T_3 might be due to the favourable environmental conditions, ample sunlight and temperature. It may be also due to the use of increased volume of vermicompost which increased the nitrogen level, further nitrogen may have increased the chlorophyll content of leaves and resulted in synthesis of carbohydrates. Similar findings were reported by Athani *et al*., (2007); Bhandari *et al*., (2017); Kumar *et al*., (2017); Singh *et al*., (2018).

CONCLUSION

On the basis of results obtained, it is concluded that the treatment T_3 having RDF(25%) + Vermicompost (75 %) was found best in terms of growth parameters viz., plant height (30.68 cm), number of leaves per plant (25.67), number of branches per plant (2.40), plant spread (37.18 cm), stem girth (2.71 cm), leaf area (28.16 cm^2), days taken to emergence of 1st new leaf after treatment (6.47 days) and chlorophyll content (35.55 %). The maximum chlorophyll content (39.55%) of custard apple cv. NMK-1 Golden was observed with treatment T_3. Moreover, the treatment T_3 also showed 100% establishment of the custard apple plants cv.NMK-1 Golden. On the basis of the above findings the best combination of organic manures and inorganic fertilizers was RDF (Recommended Dose of Fertilizer)

(25%) with Vermicompost (75%) as observed in all the parameters of custard apple plant.

However, these findings are based on one season trial. Therefore, further evaluation trials are needed to substantiate the findings.

FUTURE SCOPE

Based on the present investigations it may be concluded that, there is a good interactive effect of different combinations of organic and inorganic fertilizers on growth attributes like plant height, number of leaves per plant, number of branches per plant, plant spread, stem girth, leaf area, days taken to emergence of 1st new leaf after treatment and chlorophyll content as well as establishment of custard apple. These technologies would help in improving establishment percentage and vegetative parameters of custard apple seedlings, it also helps in early growth and helps to meet the increasing demand of growers as of custard apple plants.

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Conflict of Interest. As a Corresponding Author, I Suchismita Naik, confirm that none of the others have any conflicts of interest associated with this publication.

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