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RESPONSE OF CUSTARD APPLE CV. 'ARKA SAHAN' PLANTS TO INTEGRATED NUTRIENT MANAGEMENT

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ABSTRACT : Response of custard apple cv. "Arka Sahan" plants to integrated nutrient management was carried out at Fruit Research Farm, Department of Fruit Science, College of Horticulture and Forestry, Jhalawar, India during the year 2010-11. Results indicated that different treatments of integrated nutrient sources influenced the growth and development characteristics viz. plant height, number of leaves/plant, number of primary branches/plant, rootstock girth, scion girth, East-West and North-South spread of custard apple cv. Arka Sahan during gestation period. The studies clearly revealed that treatment comprising vermicompost in combination with 50% recommended dose of fertiliz er (RDF) and biofertilizers attained significantly higher plant height, rootstock girth, scion girth, plant spread (E-W and N-S), leaf area and soil NPK content over other treatments including control. This treatment combination also resulted in significantly better impact with respect to higher vegetative growth parameters over other treatments including the control. The application of vermicompost along with 50 % N through RDF and biofertilizers provided better nutrition as it contained all the macro and micro nutrients required for growth and development of plants. It also improved physicochemical properties of soil around the treated plants by reducing pH and EC, improving water holding capacity and enriching the organic carbon and the N, P, K status of the soil over other treatments.

Keywords : *Bio-fertilizers, organic and inorganic fertilizers, growth.*

The edible fruits of genus *Annona* are collectively known as annonaceous fruits. Annonaceae family consists of 40 genera and genus *Annona* has 120 species. *Annonas* are very delicious, tropical fruit crop. Among them, custard apple (*Annona squamosa* L.) is considered the best. It has got a pleasant flavour; mild aroma and sweet taste which have a universal acceptance. Custard apple is also known as sugar apple, sweetsop, *sharifa, sitaphal* and *noi-na* in different growing regions Wenkam (17) reported that annonaceous fruits are a good source of sugar (20%), iron, calcium, phosphorus and ascorbic acid. Custard apple has been originated from the West Indies and South America and at present, cultivation of custard apple occurs in Australia, Brazil, Chile, the Egypt, India, Israel, Philippines, Spain, Sri Lanka and USA (Nakasone and Paull, 10). Plant nutrition is one of the most important inputs of fruit production and accounts for 30 per cent of its total cost of cultivation. The indiscriminate use of inorganic fertilizers and synthetic pesticides leads to a deteriorating chemical based farming scenario and the increasing use of inorganic fertilizers. There is an urgent need for an alternative nutritional package to obtain long term sustainability for fruit production as well as for maintaining soil productivity under integrated nutrient management (INM) system. Sustainable horticulture production incorporates the idea, that natural resources should be used to generate increased output and productivity. Integrated nutrient management's goal is to integrate the use of all natural and manmade sources of plant nutrients, so that crop growth and productivity increases in an efficient and environmentally benign manner without sacrificing soil productivity for future generations. Sanewski (13) suggested that the use of organic fertilizers with inorganic fertilizers as a supplement to maintain a balance and to regulate cropping. The cv. Arka Sahan is a new introduction under the subtropical conditions of Jhalawar and is a popular cultivar of custard apple in Southern India particularly Karnataka. The present investigations were undertaken to study the response of different INM treatment combinations with a view to obtaining information about the quantitative changes in growth attributes of custard apple cv. Arka Sahan.

MATERIALS AND METHODS

The experiments were conducted during the year 2010-11, at the Fruit Research Farm, Department of Fruit Science, College of Horticulture and Forestry, Jhalawar. The application of different integrated nutrient management treatments (Table 1) was realised during September, 2010 to two years old plants. The treatment combinations were

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Table 1 : Treatment combinations.

T_1	Control
T_2	Bio fertilizers (AZB 50 g + PSB 50 g + VAM 20 g/plant),
T_3	100 % N through Vermicompost (1533.33 g/plant)
T_4	100 % NPK through chemical fertilizers (Urea 50 g + SSP 200 g + MOP 50 g/plant)
T_5	75 % RDF + 25 % N through Vermicompost (37.5g Urea + 150g SSP + 37.5g MOP + 382.25g Vermicompost /plant)
T_6	50 % RDF + 50 % N through Vermicompost (25g Urea + 100g SSP + 25g MOP + 766.5g Vermicompost/plant)
T_7	25 % RDF + 75 % N through Vermicompost (12.5g Urea + 50g SSP + 12.5g MOP + 1149.75g Vermicompost /plant)
T_8	T_4 + Bio fertilizers (AZB 50g + PSB 50g + VAM 20 g/plant)
T_9	T_5 + Bio fertilizers (AZB 50g + PSB 50g + VAM 20 g/plant)
T_{10}	T_5 + Bio fertilizers (AZB 50g + PSB 50g + VAM 20 g/plant)
T_{11}	T_7 + Bio fertilizers (AZB 50g + PSB 50g + VAM 20 g/plant)

*AZB : *Azotobacter*
*PSB : Phosphate Solubilizing Bacteria
*VAM : Vesicular Arbuscular Mychorrhiza
*NPK : Nitrogen, Phosphorous and Potassium
*MOP : Muriate of Potash
*RDF : Recommended Doses of Fertilizers approved by Department of Horticulture
*SSP : Single Super Phosphate
*AZB and PSB are bioinnoculants used to assist in maintaining soil fertility are popularly known as biofertilizers.

The experiment was laid down in randomized block design with three replications. The observations like plant spread and plant height were measured by measuring scale and expressed in cm. Plant spread signifies the canopy volume in both directions i.e East West and North-South. Rootstock girth along with scion girth were recorded by digital Vernier Callipers and expressed in mm, however number of primary branches per plant were counted on three plants per unit replication. All these quantitative observations were recorded under 11 treatments at monthly intervals commencing from October, 2010 to March, 2011. Analysis of vermicompost was done before application and it contained 1.5% N. This is the basis on which different doses of Nitrogen *i.e* 25%, 50 %, 75% and 100% through vermicompost were applied in the treatments. The soil of experimental site was clayey in texture. For determining the chemical changes, soil samples were drawn from 0-30 cm depth by a distance of 1m away from the trunk in all the treatments initially and finally during the study period. The available nitrogen was estimated using method as described by Subbiah and Asija (15), available phosphorous by the method as described by Olsen *et al.* (11), available potassium by the method as described by Metson (7). Soil pH and EC was determined in 1:2 soil water suspension. Soil organic carbon was determined by Walkley and Blacks (16) method. The data values for each treatment (triplicates) were analyzed statistically using randomized block design adopting Indostat software.

RESULTS AND DISCUSSION

Maximum plant spread (E-W and N-S spread) was recorded in T_{10} treatment throughout the study period (Table 1). The maximum East-West (31.52 cm) recorded with T_{10} treatment and it was on par with T9 and T_{11} and significantly higher than all other treatments. The maximum North South spread (33.21cm) was also recorded with T_{10} treatment and this was significantly than that recorded in all higher over other treatments. The minimum plant spread E-W spread (15.14 cm) and N-S spread (18.12 cm) occurred in the control plants. Dutta *et al.* (4) also recorded the effect of bio-fertilizer along with inorganic fertilizer on growth and productivity of guava cv. L-49, their experimental findings revealed that different treatments of bio-fertilizers and inorganic fertilizer significantly increased the plant spread. Similar findings for improved growth parameters were reported by Godage *et al.* (5) for maximum tree height, East West and North South spread in guava cv. L-49 in response to the use of chemical fertilisers and biofertilizers comprising *Azotobacter* and PSB. Singh and Singh (14) observed that *Azospirillium* + VAM inoculation along with 100 % P_2O_5 showed maximum plant height and spread. Singh and Singh (14) observed that the nitrogen fixing bacteria and bio regulators had a significant effect on the growth characters in strawberry plants.

Maximum plant rootstock (9.96 mm) and scion girth (8.27 mm) were recorded in the T_{10} treatment which was significantly higher than those of plants in T_1 to T_9 treatments. The minimum rootstock girth (7.96) and scion girth (7.13) were recorded in the control plants. The beneficial response of biofertilisers on plant girth might be due to the accumulation of poly hydroxybutyric acid which gives rise to vegetative cells. Pigment production is one of the important characteristics of *Azotobacter* spp. These strains are also known to produce growth substances (Mohandas, 8). The Annual Report of AICRP on Arid Zone Fruits (1) reported the use of biofertilizers in custard apple var. "APK (Ca-1)". These studies on growth attributes

revealed that plant growth girth was highest in T9 (50% + AZB + AZS + VAM) while the lowest figure was observed in the control treatment (T_0). The canopy spread ES was maximum in T_9 (50 % + AZB + AZS + VAM) while the least was observed in T_0 (Control). The canopy spread NS was observed highest in T_7 (AZB + AZS + VAM).

The number of primary branches per plant (5.89) in the T_{10} treatment was significantly higher that all other treatments and the minimum number of primary branches (2.23) were recorded in the control plants (Table 1). The maximum plant height (46.80 cm) occurred in the plants in the T_{10} treatment resulted non significant difference over plants in T_9 and T_{11} treatments. The smallest plant height (32.65 cm) was recorded in the control treatment.

Similar trends in increase of plant growth parameters, under INM using vermicompost were recorded by Meena *et al.* (6) in dill, Choudhary and Chandra (3) in okra, Choudhary *et al.* (2) and Muhammad *et al.* (9) in guava and Rodriguez *et al.* (12) in gerbera.

In the present study variations in soil pH were evident (Fig.1). The lowest soil pH (7.20) was observed in T_{10} treatment. The reduction in soil pH might be due to acidification and mineralisation processes by production of organic acids which occurred as a result of better enzymatic activities in response to the combined effect of VAM, PSB and Vermicompost in addition with Inorganic fertilisers. It is likely that the phosphate solubilized by the bacteria could be more efficiently taken up by the plant through a mycorrhizal pipeline between roots and surrounding soil that allows nutrient translocation from soil to plant. Similarly variations in soil EC were recorded after completion of study period in response to different integrated nutrient management treatments. The lowest soil electrical conductivity (0.35 dSm^{-1}) was observed under T_{10} treatment which was on par with T_{11} and these results were significantly lower over all other treatments (Fig.2).

With carbon content percentage of the soil the maximum organic carbon content (%) was recorded under T_{10} treatment (0.82%) which was significantly higher than all other treatments (Fig.3). The data depicted in Fig. 5 revealed the variation in phosphorous content of custard apple cv. Arka Sahan orchard soil during study period. The phosphorous content significantly increased under T_{10} treatment (25.13 kg hha^{-1}) and was found significantly higher over other treatments. The highest nitrogen content (382.93 kg ha-1), phosphorous content (25.13 kg ha^{-1}) and potassium content (392.44 kg ha^{-1}) was recorded in T10 treatment (Figs.4, 5 and 6). These amounts were significantly higher than all other treatments. The data elucidated in Fig. 6 reveals the variation in potassium content of custard apple cv. Arka Sahan orchard soil during study period. The potassium content significantly increased under T_{10} treatment (392.44 kg ha^{-1}) and was found significantly higher over other treatments.

Table 2 : Effect of INM on growth of custard apple.

Treatments	Plant Spread (cm)		Rootstock girth (mm)	Scion girth (mm)	No. of primary branches per plant	Plant height (cm)
	East-West	North-South				
T_1	15.14 (21.31)	18.12 (21.77)	7.96 (11.17)	7.13 (8.35)	2.23	32.65 (13.05)
T_2	16.67 (22.30)	23.43 (24.76)	8.21 (12.92)	7.20 (9.09)	2.33	33.72 (15.43)
T_3	19.98 (22.50)	24.44 (24.56)	8.45 (13.11)	7.38 (10.81)	2.54	34.25 (17.09)
T_4	21.13 (22.56)	24.52 (24.27)	8.49 (13.65)	7.42 (9.27)	2.89	34.96 (17.43)
T_5	21.51 (23.05)	27.31 (23.35)	8.62 (13.42)	7.47 (9.53)	3.10	35.39 (17.88)
T_6	25.62 (23.58)	27.36 (23.74)	8.72 (14.43)	7.57 (10.67)	3.48	37.12 (14.14)
T_7	25.02 (26.68)	28.23 (24.85)	8.82 (14.54)	7.60 (8.72)	3.89	38.16 (15.00)
T_8	25.81(24.14)	29.05 (26.19)	8.98 (15.12)	7.94 (10.58)	4.10	40.42 (14.82)
T_9	28.85(29.08)	30.88 (27.34)	9.26 (16.47)	8.04 (10.43)	4.20	43.12 (19.11)
T_{10}	31.52 (30.08)	33.21 (29.92)	9.96 (18.99)	8.27 (13.28)	5.89	46.80 (20.68)
T_{11}	31.20 (28.55)	32.14 (27.79)	9.64 (17.84)	7.99 (10.05)	4.92	43.65 (19.65)
C.D (P= 0.05)	3.76	4.58	0.61	0.48	0.20	3.54

*Values in parentheses are *Arc Sine* reconverted values.

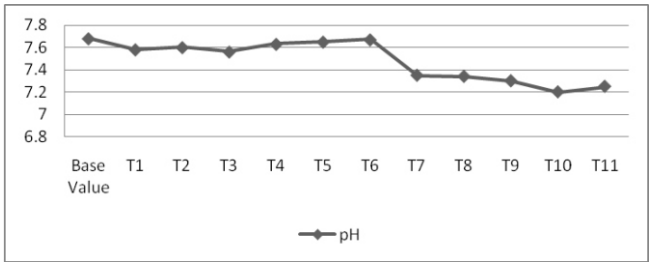

Fig.1 : Effect of INM treatments on soil pH of custard apple cv. Arka Sahan.

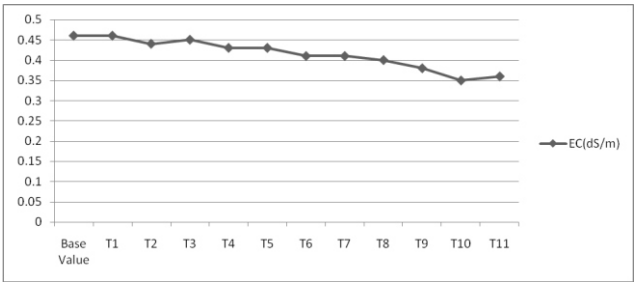

Fig.2 : Effect of INM treatments on soil EC (dSm^{-1}) of custard apple cv. Arka Sahan

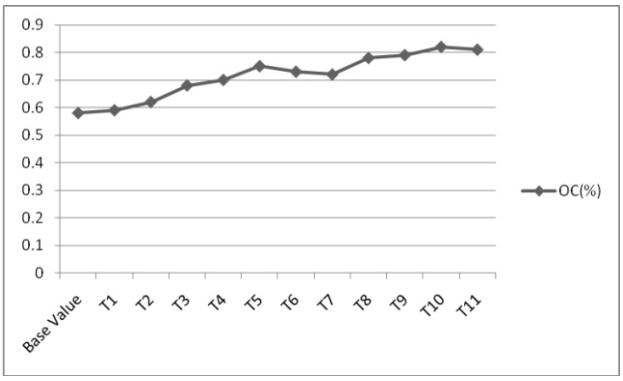

Fig.3 : Effect of INM treatments on soil O.C. (%) of custard apple cv. Arka Sahan.

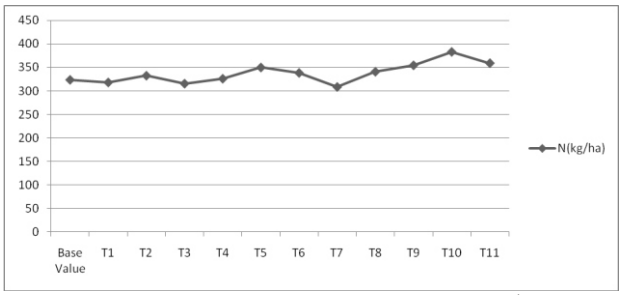

Fig.4 : Effect of INM treatments on soil N($kgha^{-1}$) of custard apple cv. Arka Sahan.

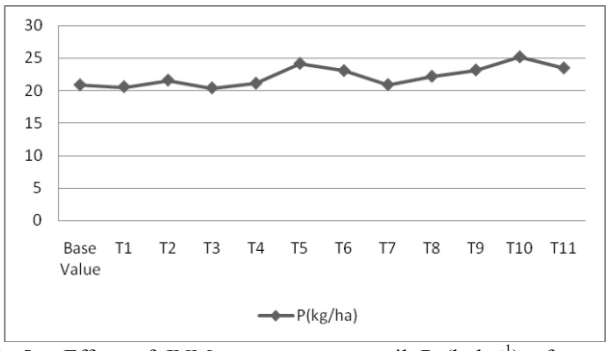

Fig.5 : Effect of INM treatments on soil P ($kgha^{-1}$) of custard apple cv. Arka Sahan.

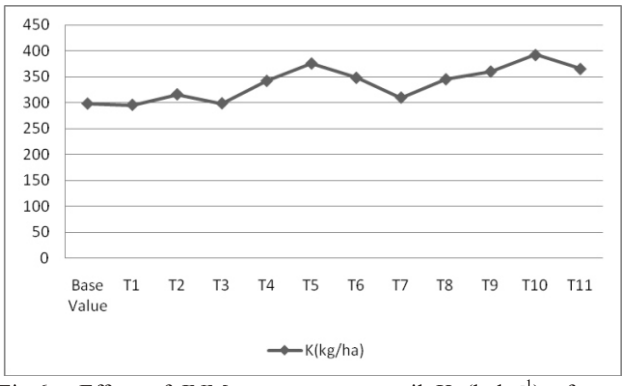

Fig.6 : Effect of INM treatments on soil K ($kgha^{-1}$) of custard apple cv. Arka Sahan.

Conclusions

On the basis of the present results, it is concluded that an application of 50 % recommended dose of fertilizer (RDF) along with 50 % N through vermicompost supplemented with bio-fertilizers comprising of *Azotobacter* (50 g), PSB (50 g) and VAM (20 g) maximised plant growth parameters (plant height, plant spread, rootstock girth, scion girth etc.) of custard apple cv. Arka Sahan under Jhalawar conditions and it may be introduced under field conditions in Jhalawar Provence. The reduction in soil pH under T_{10} treatment might be due to acidification and mineralisation processes which occurred as a result of better enzymatic activities in response to the combined effect of VAM, PSB and Vermicompost in addition with Inorganic fertilisers. The better nitrogen content under T_{10} treatment could be attributed to Azotobacter nitrogen enrichment of soil along with growth promoting effects of phosphorous solubilising bacteria (PSB), vesicular arbuscular mycorrhizae (VAM) and 50% recommended dose of inorganic fertilizer.

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