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CUSTARD APPLE-BEST COMPANION FRUIT CROP FOR MIXED FRUIT CROPPING

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ABSTRACT:

Field experiment was carried out at Research Farm, Department of Horticulture, College of Agriculture, Dhule, Maharashtra (India) during 2013-14 to 2017-18 to evaluate the performance of dryland fruit crops in different combinations of different and to find out economically feasible fruit crop combinations for dryland conditions for sustainable farm income. The fruit crops namely Mango (*Mangifera indica* L.), Custard apple (*Annona squamosa L.*), Aonla (*Emblica officinalis L.*), Jamun (*Syzigium cumini L.*) and one perennial vegetable drumstick (*Moringa oleifera*) were planted in different combinations which were referred as fruit crop modules. The experiment was conducted in Randomized Block Design with eight treatments and five replications. The treatments designated as module and were Module-1 i.e. (Mango+ Custard apple + Aonla + Drumstick), Module-2 (Mango + Custard apple + Aonla) and Module-3 (Mango + Custard apple + Jamun) along with sole of each crop. Results indicated that module; Module-2 i.e. (Mango + Custard apple + Aonla) resulted in increased productivity and profitability. It was observed that Custard apple found to be best companion fruit crop because of its significant contribution in higher equivalent yield and net returns.

Keywords: *Mixed fruit cropping, module, equivalent yield, productivity and companion crop.*

INTRODUCTION:

Mixed fruit cropping systems appears to be perspective approach for dryland agriculture sustainability to provide food, nutrition and income security to the farmer (Chundawat, 1993, Chadha, 2002, Awasthi and Pareek, 2008; Malezieux, *et al.,* 2009; Gaba *et al.*, 2015, Nimbolkar, *et al.*, 2016). Moreover, mixed fruit cropping provides insurance against crop failure due to aberrant climatic conditions or pest and diseases and also increase the orchard efficiency through efficient utilization of land area and solar radiation (Thomas, 2009; Nimbolkar, *et al.*, 2016). Mixed fruit cropping system involving perennial and hardy fruit crop would be gain to dryland farmers. However, selection of fruit crops for is more important. But there are very few reports on mixed cropping involving fruit crops only. The capability of fruit crops such as mango, custard apple, aonla, Jamun, etc. under dryland conditions as a sole crop is well-known. However, their performance in mixed cropping and identifying best companion fruit crop is essential. Hence, present investigation was undertaken to assess the performance of dryland fruit crops such Mango, Custard apple, Aonla, Jamun and Drumstick in different combination and to find out suitable fruit crop combination (module) and also to identify best fruit crop for mixed fruit cropping under *dryland* conditions.

MATERIAL AND METHODS:

The field experiment over five years was conducted during 2013-14 to 2017-18 at Research Farm, Horticulture Section, College of Agriculture, Dhule, Maharashtra (India). Agro

climatically, Dhule comes under scarcity zone which receives rains mainly from south - west monsoon during June to September with the average annual rainfall of the place is 597 mm. Fruit crops namely Mango (*Mangifera indica* L.), Custard apple (*Annona squamosa L.*), Aonla (*Emblica officinalis L.*), Jamun (*Syzigium cumini L.*) and Drumstick (*Moringa oleifera*), a perennial vegetable were planted in different combinations which were referred as fruit crop module.

In the present study, mango was planted as a base crop at spacing of 10 m x 10 m and all other crops are planted in the interspaces in the mango. Among these crops, custard apple was common in all the three modules, aonla was planted in two modules *i.e.* Module-1 and Module-2, whereas drumstick and jamun were planted only in the Module-1 and Module-3, respectively. Module-1 accommodated 361 plants in a hectare area whereas Module-2 and Module-3 accommodated 370 plants in a hectare area.

The experiment was set in a Randomized Block Design (RBD) with eight treatments which were replicated five times and each treatment comprised of a unit of 2(two) plants. The treatments were assigned randomly in each replication.

Observations were recorded on yield and yield parameters namely average fruit weight (g), number of fruits plant^{-1}, yield (kg plant^{-1}) and yield (t ha^{-1}). To assess the performance and efficiency of the modules under study and to identify most suitable module for dryland conditions, the mango equivalent yield was worked out for different crops based on prevailing market prices as suggested by Thiruvarassan, *et al.* (2014).

$$\textbf{Equivalent yield} = \frac{\text{Yield of intercrop x Market price}}{\text{Prevailing price of base (main) crop}}$$

Based on the yield of each component fruit crop in the module and cost of cultivation, economics were worked out in accordance with the prevailing market prices for all the modules for the year under study.

RESULTS AND DISCUSSION:

1. Number of fruits per plant

All the component fruit crops in the modules and grown as a sole crop exhibited differences number of fruits per plant (Table 1). In general reduction in number of fruits per plant was observed in fruit crops grown in combination (module) as compared to their sole crop, except, mango. Overall results revealed reduction in number of fruits per plant in fruit crops grown in combination in the module as compared to their sole crop, except, mango. In Module-2, mango produced 5.96 % more number of fruits than its sole crop, whereas there was considerable decrease in fruit number in Module 1 and 3. There was reduction in number of fruits in custard apple also, but least reduction (-1.15 %) was observed in the Module 2. In aonla reduction was less in Module 1 which was -3.47. There was reduction of -3.47% and -26.03 in T_1 and T_2; -1.49 % in T_3 and -7.66 % in T_1 in case of aonla, Jamun and drumstick, respectively. Results in close agreement with Muragod, *et al.* (2017) who also reported decrease in number of fruits when grown in combination compared to their sole crop. Moshiur Rahman *et al.* (2014) also stated decrease in number of fruits in coconut based cropping system. The decrease in the number of fruits per plant as compared to sole crop might be due to increased competition for light and space as well as food material shared by each component crop. Higher number of fruits in sole crop might be due to more availability of light which would have synthesized more photosynthates for reproductive growth and fruits to develop in sole crop as compared to multiple cropping systems. This indicated the best performance of mango followed by custard apple. Secondly, it was observed that even 15 year after planting, the expected yield potential of Jamun T_7 (Sole crop) was not observed as it produced) just 178.33 fruits per plant

2. Average fruit weight (g)

Fruit crops in the combination and as a sole crop behaved differently (Table 2). In general there was decrease in fruit weight in fruit crops grown in combination in the module as compared to their sole crop, except, mango and custard apple in Module-2 In mango and custard apple there was 1.72 % and 1.76 % increase in fruit weight as compared to their sole crop. Whereas the decrease in fruit weight in aonla in Module-2 (Mango+ C. apple + Aonla) was insignificant (-1.58 %). This suggests that the crops in the Module-2 (Mango+ C. apple + Aonla) were complementary to each other. In case of aonla, Jamun and drumstick the findings are in similar line with Muragod et al. (2017); and Bhukan and Pujari (2019). Moshiur Rahman *et al.* (2014) also reported decrease in fruit weight in base crop of coconut and also component fruit crops in multi storied fruit gardens. Higher fruit weight in sole crop might be due availability of more space, ample sunlight and food as compared to fruits under multiple cropping systems due to sharing by component crops. As regards the fruit, mango and custard apple registered best performance indicating their complementary behavior.

3. Yield (kg plant^{-1})

As revealed from the Table 3, fruit crops in combination and as a sole crop had significant influence of on the yield. As evident from the results, in general there was decrease in yield plant^{-1} in all the component fruit crops as compared to their sole crop, except in mango in Module-2 and Aonla in Module-3 which registered 2.43 % and 15.47 % increase in yield, respectively. In custard apple, though there was reduction in yield in all modules, but the least reduction was in Module-2 (Mango+ C. apple + Aonla) and it was -5.31 %. In, jamun and drumstick, the reduction was -5.42 % and -8.60 %, respectively. As a intercrop, custard apple exhibited better performance.

Results corroborate with the findings of Muragod *et al.* (2017); and Bhukan and Pujari (2019). Malezicux *et al.* 2009 assimilates the advantage of mixed cropping to a higher yield. As regards the yield per plant, custard apple registered better performance due to better fruit weight and more number of fruits per plant. Whereas, performance of Jamun was poor..

4. Yield (ton/ ha^{-1})

Mango fruit crop exhibited (Table-4) the same trend as in yield per plant and the yield was higher than the sole crop in the T_2 (Module-2) which registered highest yield of 1.23 t ha^{-1} (Table 5). The treatment T_4 i.e. sole crop of mango recorded 1.19 t ha^{-1} which was at par with T_2 (Module-2). In other two modules, mango recorded reduction in the fruit yield when compared to sole crop. In custard apple, aonla, drumstick and Jamun, there was decrement in fruit yield as compared to their respective sole crops. In custard apple, aonla, Jamun and drumstick maximum yield was observed their respective sole crop. In custard apple maximum yield of 1.21 t ha^{-1} was recorded in sole crop and the treatment T_2 - (Module 2) recorded 1.15 t ha^{-1} yields which were on par. In aonla, jamun and drumstick the maximum yield of 9.62 t ha^{-1}, 0.611 t ha^{-1} and 24.50 t ha^{-1} was observed in their respective sole crop.

As regards the yield (t ha^{-1}), 3.36 % increase in yield was noted in mango in Module-2, whereas there was extensive decrease in in yield in Module-1 and 3. Custard apple, registered reduction of -4.95 5 reduction in yield (tha^{-1}). Though there was reduction in yield in custard apple, but the reduction was very less as compared to sole crop in Module-2, suggesting their harmonizing nature.

Further, recording increase in yield in this Module i.e. Module-2 (Mango+ C. apple + aonla as compared to their sole crop might be due to production of more number of fruits and highest fruits weight. Results corroborate with the findings of Muragod *et al.* (2017); and Bhukan and Pujari (2019). Malezicux *et al.* 2009 assimilates the advantage of mixed cropping to a higher yield. As regards the yield per plant, custard apple registered better performance.

5. Mango Equivalent yield (tha^{-1})

As evident from the Table 5**,** mango equivalent yield varied significantly due to different combinations of fruit crops and sole fruit crops. All the treatments i.e. modules recorded higher mango equivalent yield than the sole mango crop. **T**he treatment T_2 (Mango + Custard apple + Aonla) i.e. Module-2 registered significantly the highest equivalent yield of 5.43 t ha^{-1}, which was significantly higher than the other modules and sole mango crop. The next best module was T_1 - (Mango + Custard apple + Aonla + Drumstick) which recorded 3.58 t ha^{-1} equivalent yields. The Module-3 recorded the low mango equivalent yield of 2.10 t ha^{-1} which was very low as compared to Module-2 (Mango + Custard apple + Aonla) and Module-1 (Mango + Custard apple + Aonla + Drumstick).

The results are in congruence with Muragod et al. (2017); and Bhukan and Pujari (2019). Higher equivalent yield of coconut than the sole crop in multi- storied fruit garden was also reported by Moshiur Rahman *et al.* (2014). Higher equivalent yield in all the modules might be due to contribution of the each component crops for overall increase in the yield under multiple cropping systems. In the present study, higher equivalent yield in Module-2 and Module-1 might be due to consistent yield performance of custard apple besides mango indicating its good

6. Economics of mango based mixed fruit cropping system

Results presented in Table 5 revealed demonstrated that all the modules studied realized good monetary returns than the sole crop. The Module 2 (T_2)(Mango + Custard apple + Aonla) recorded the maximum net returns of Rs. 1,79,050=00 per ha with B:C ratio of 1:2.30 followed by T_1 - (Module 1 i.e. Mango + Custard apple + Aonla + Drumstick) which recorded net return of Rs. 1,18,650=00 with B:C ratio of 1:1.65.

The increased returns from tree crop combinations over sole crops are also supported by the study of Margate and Magat (1983); Reddy and Sudha (1989); Bhuva *et al.* (1988); Shahapurmath *et al.* (2003); Marimuthu (2005); Nath *et al.* (2007); Swain and Padhi (2011) and Moshiur Rahman *et al.* (2014); Muragod et al. (2017); and Bhukan and Pujari (2019). Baghel *et al.* (2003), and Swain and Padhi (2011) have also reported the profitability of mango based cropping systems either by annual or perennial crops. However, higher equivalent yield and more returns also depend upon the complementary nature of intercrops planted.

In the present study, custard apple exhibited consistent performance over the period of study in respect of fruit weight, number of fruits per plant resulting in better yield per plant per hectare. Moreover it realized good selling prices every year. This would have resulted in more equivalent yield and more return in Module-2 followed by Module-1. Although aonla also exhibited consistent performance with respect to yield and yield characteristics, the selling prices realized were marginal. But its contribution in equivalent yield and returns is commendable in Module-2 and Module-1. The performance of Module-3 was rather poor as compared to Module-2 and Module-1. This could be attributed to the poor performance of Jamun as the number of fruits and yield was underprivileged even after 14 years of planting. This clearly suggests that custard apple had significant contribution in all the

modules recording higher equivalent yield and higher returns. Thus, it can be said that custard apple is the best companion fruit in mixed fruit cropping. Results are in close agreement with the results reported by Muragod et al. (2017); and Bhukan and Pujari (2019).

CONCLUSION:

Results revealed that Module 2(Mango + Custard apple + Aonla) found to be more promising and would be advantageous to dryland regions. Gaba *et al.* (2015) avowed the importance of multiple cropping systems as drivers for providing multiple ecosystem services rather than just provisioning. Further, custard apple can be grown as best companion inter crop in mixed fruit cropping system because of its significant contribution in equivalent yield as well as highest B:C ratio in all the modules.

REFERENCES:

Awasthi, O. P.; Pareek, O. P. 2008. Horticulture-based cropping system for arid regions-a review. *Range Management and Agroforestry*, 29 (2): 67-74.

Baghel, B.S., Rajesh Tiwari and Nishith Gupta., 2003. Productivity and profitability of mango based intercropping system under rainfed agro-climatic conditions of Madhya Pradesh. *South Indian Horticulture*, 52(1-6):1-4.

Bhukan A.S.; Pujari, C.V., 2019.Performance of Fruit Crop Modules Under Rainfed Conditions. Bull. Env. Pharmacol. Life Sci. 8 (2): 50-55.

Bhuva, H.P., Katrodia, J.S., Patil, G.L.; Chundawat, B.S. 1988. Response of intercropping on economics and effect on main crop on Mango under South Gujarat conditions. *Acta. Hort.*, 231: 316-320.

Chadha, K.L. 2002. Diversification of Horticulture for food, nutrition and economic security. *Indian J. Hort.*, 52 (2): 137-140.

Chundawat, B.S. 1993. Intercropping in orchards. *Advances in Hort.*, 2(2):763-775.

Gaba Sabrina, Francoise Lescorret, Simon Bousocq, Jerome Enjalbert, Philippe Hinsinger, Etienne- Pascal Journet, Marie-Laure Navas, Jacques Wery, Gaetan Louarn,Eric Malezieux, Elise Pelzer, Marion Prudent, Harry Ozier- Lafontaine. 2015. Multiple cropping systems as drivers for providing multiple ecosystem services: from concept to design. Agronomy for Sustainable Developement.35 (2):1-18

Malezieux, E., Crozat, Y.; Dupraz, C.; Laurans, M.; Makowski, D.; Ozier-Lafontaine, H.; Rapidel, B de Tourdonnet, S.; Valantin-Morison, M.,2009. Mixing plant species in cropping systems: concepts, tools and models- A review. Agron. Sustain. Dev. 29:43–62.

Margate, R.Z.; Magat, S.S. 1983.Coconut based multi-story cropping. *Philipp. J. Crop Sci.*, 8 (2): 81- 86.

Marimuthu, R. 2005. Multi species cropping systems in coconut garden. *Madras Agric. J.* 92 (7-9):404-406.

Moshiur Rahman, M., Madon, M., Gopal, Saha; Rashid, A.S.M.H. 2014. Productivity and profitability of different fruit crops grown in multi-story fruit garden. Res. *J. Agriculture and Environment Management.* 3(6):304-309.

Muragod, S. V., Pujari, C. V., Patil, R. V. and Patil, S. D., 2018. Multiple Fruit Cropping - A Sustainable Way for Doubling the Income of Farmer. Contemporary Research in India. Special Issue, 4: 183-189.

Nath V., Das, B., Yadav, M.S., Kumar, V.; Sikka, A.K. 2007. Guava – A Suitable Crop for Second Floor in Multi-Storied Cropping

System in Upland Plateau of Eastern India. *Acta. Hort.* 735:277-295.

Nimbolkar, P.K., A. Chandrakant, C. Subhash and H. Firoz, 2018. Multi-storied cropping system in horticulture-a sustainable land use approach., 8 (55): 3016-3019.

Panse, V.G.; Sukhatme, P.V. 1995. Statastical methods for agriculture workers. ICAR, New Delhi, pp.125-128.

Reddy, Y.V.R.; Sudha, M. 1989. Economics of Agroforestry system in black soils under Dryland Agricultural conditions. Ph.D. Thesis submitted to the University of Agricultural Sciences, Dharwad.

Shahapurmath, G.B., Shivanna, H.; Girisha, V.H. 2003. Performance of Arecanut based mixed cropping system. *Karnataka J. Agric. Sci.,* 16 (2):254-259.

Swain, S.C.; Padhi, S.K. 2011. Evaluation and economic analysis of mango based intercropping systems in rainfed upland. *National J. Life Sciences*, 8(2): 95-99.

Thiruvarassan, S. Maheswarappa, H.P.; Subramani, T. 2014. Evaluation of Coconut Based Multispecies Cropping Systems for East Coast Region Of Tamil Nadu. *Journal of the Andaman Science Association.* 19(1):59-64.

Thomas George, 2009. Coconut based banana production system. In: Banana- New Innovations. (Eds) Singh H.P. and M.M. Mustaffa. Westville Publishing HOUSE, New Delhi, pp176-181.

Table 1. Number of fruits per plant in different fruit crops under modules (different crop combinations), and in sole crops. (Pooled over 5 years).

Treatments	Number of fruits per plant				
	Mango	**C. apple**	**Aonla**	**Jamun**	**Drumstick**
T_1 Module -1 (Mango+ C. apple + Aonla + Drumstick)	52.33 (-21.16)	54.02 (-30.50)	1265.0 (-3.47)	--	240.8 (-7.66)
T_2 Module -2 (Mango + C.apple + Aonla)	70.34 (+5.96)	76.83 (-1.15)	969.4 (-26.03)	--	--
T_3 Module -3 (Mango + C. apple + Jamun)	46.54 (-29. 68)	58.86 (-24.27)	--	175.66 (-1.49)	--
T_4 Sole Mango Crop	66.38	--	--	--	--
T_5 Sole Custard apple Crop	--	77.73	--	--	--
T_6 Sole Aonla Crop	--	--	1310.6	--	--
T_7 Sole Jamun Crop	--	--	--	178.33	--
T_8 Sole Drumstick Crop	--	--	--	--	260.8
S.E. ±	2.142	1.041	--	--	--
CD at 5 %	6.601	3.210	--	--	--

Table 2. Average weight of fruit indifferent fruit crops under modules (different crop combinations), and in sole crops. (Pooled over 5 years).

Treatments	Average Weight of Fruit (g)				
	Mango	C. apple	Aonla	Jamun	Drumstick
T_1 Module -1 (Mango + C. apple + Aonla+ Drumstick)	164.16 (-4.86)	156.69 (-1.93)	25.96 (-10.32)	--	60.54 (-8.77)
T_2 Module -2 (Mango + C.apple + Aonla)	175.62 (+5.96)	162.60 (+1.76)	28.49 (-1.58)	--	--
T_3 Module -3 (Mango + C. apple + Jamun)	163.07 (-29.88)	155.43 (-2.72)	--	18.85 (-2.48)	--
T_4 Sole Mango Crop	172.56	--	--	--	--
T_5 Sole Custard apple Crop	-	159.78	--	--	--
T_6 Sole Aonla Crop	--	--	28.95	--	--
T_7 Sole Jamun Crop	--	--	--	19.33	--
T_8 Sole Drumstick Crop	--	--	--	--	65.86
S.E. ±	0.672	0.443	--	--	--
CD at 5 %	2.071	1.328	--	--	--

Table 3. Yield (Kg/plant) in different fruit crops under modules (different crop combinations), and in sole crops. (Pooled over 5 years).

Treatments	Yield (Kg/plant)				
	Mango	Custard apple	Aonla	Jamun	Drumstick
T_1 Module -1 (Mango+ C. apple + Aonla + Drumstick)	8.57 (-27.92)	8.55 (-35.07)	33.43 (+15.47)	--	15.72 (-8.60)
T_2 Module -2 (Mango+ C. apple + Aonla)	12.18 (+2.48)	12.47 (-5.31)	27.08 (-6.45)	--	--
T_3 Module -3 (Mango+ C. apple + Jamun)	7.88 (-33.72)	9.22 (-29.99)	--	3.31 (-5.42)	--
T_4 Sole Mango Crop	11.89	--	--	--	--
T_5 Sole Custard apple Crop	--	13.17	--	--	--
T_6 Sole Aonla Crop	--	--	28.95	--	--
T_7 Sole Jamun Crop	--	--	--	3.50	--
T_8 Sole Drumstick Crop	---	--	--	--	17.20
S.E. ±	0.335	0.242	--	--	--
CD at 5 %	1.033	0.748	--	--	--

Table 4. Yield (t/ha) in different fruit crops under modules (different crop combinations), and in sole crops. (Pooled over 5 years).

Treatments	Yield (t/ha)				
	Mango	Custard apple	Aonla	Jamun	Drumstick
T_1 Module -1 (Mango+ C. apple + Aonla + Drumstick)	0.86 (-27.73)	0.79 (-34.71)	2.04 (-78.79)	--	1.42 (-94.20)
T_2 Module -2 (Mango+ C. apple + Aonla)	1.23 (+3.36)	1.15 (-4.95)	4.87 (-49.37)	--	--
T_3 Module -3 (Mango+ C. apple + Jamun)	0.79 (-36.61)	0.85 (-29.75)	--	0.595 (-2.61)	--
T_4 Sole Mango Crop	1.19	--	--	---	--
T_5 Sole Custard apple Crop	--	1.21	--	--	--
T_6 Sole Aonla Crop	--	--	9.62	--	--
T_7 Sole Jamun Crop	--	--	--	0.611	--
T_8 Sole Drumstick Crop	--	--	--	--	24.50
S.E. ±	0.035	0.022	--	--	--
CD at 5 %	0.110	0.067	--	--	--

Table 5. Mango Equivalent yield (t/ha) and Cost: Benefit ratio.

Treatments details	Equivalent yield (t/ha)	Cost of cultivation (Rs)	Monetary returns (Rs)	Cost: Benefit ratio
T_1- Module 1 (Mango + Custard apple + Aonla + Drumstick)	3.58	71710	118650	1:1.65
T_2- Module 2 (Mango + Custard apple + Aonla)	5.43	77860	179050	1:2.30
T_3- Module 3 (Mango + Custard apple + Jamun)	2.10	48520	69380	1:1.43
T_4- Sole Mango	1.19	26570	39700	1:1.49
S. E. ±	0.10	--	--	--
C. D. at 5%	0.29	--	--	--