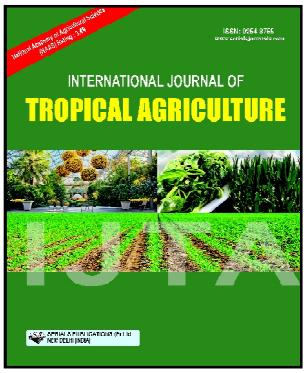

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Effect of Agro Techniques on Pollen Viability and Fruit Set in Custard apple (*Annona squamosa* L) Cv. Balanagar

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Abstract: The investigation was carried out at Instructional-Cum-Research Orchard of AICRP on Arid Zone Fruits, Department of Horticulture, Mahatma Phule Krishi Vidyapeeth, Rahuri during the year 2016-17 on 10 years old orchard, spaced at 5m x 5 m in randomized block design with nine treatments and three replications.

It involved five cover crops i.e. Maize (T_1), Bajra (T_2), Dhaincha (T_3), Jowar (T_4) and Sunhemp (T_5), two irrigation systems i.e. Sprinkler (T_6) and Foggar (T_7), Sod culture (T_8) and control i.e. conventional method (T_9).Cover crops were sown on 2nd of February 2016.

The significantly minimum number of days (21.03) required for initiation of custard apple flowering in treatment Sunhemp (T_5) as a cover crop which was at par with the treatments Dhaincha (T_3) as a cover crop (21.53), Jowar (T_4) as a cover crop (21.67) and Bajra (T_2) as a cover crop (21.80). The maximum number of flowers per branch was recorded in cover crop Bajra (T_2)(62.00) which was statistically at par with all the cover crops, Jowar (57.25),Maize (56.98), Dhaincha (56.17) and Sunhemp (55.36) respectively. Bajra sown as cover crop recorded significantly higher pollen viability percentage (88.24 %) and higher fruit set percentage (44.97%). However two irrigation system i. e. Sprinkler (T_6) and Foggar (T_7) shows less significant effect in respect of days required for initiation of flowering, number of flowers per branch, pollen viability (%) and fruit set (%) as compared to cover crops.

Highest number of fruits per tree was recorded in case of Sunhemp (142.75), followed by Bajra (139.87).The average weight of fruits per tree was significantly influenced by various cover crops cultivated with custard apple. Significantly maximum weight of custard apple fruit was recorded due to the sowing of Sunhemp as a cover crop (315.33 g), with highest fruit yield per tree (45.03 kg). Thus sowing cover crops under the canopy of custard apple trees is better for off season fruit yield of custard apple.

Key Words: Custard apple, Pollen viability, Fruit set, Agro techniques and cover crops

INTRODUCTION

The family *Annonaceae* is represented by about 128 genera and 2300 species growing widely in the tropical region of the world. In India, the family is represented by 26 genera and about 200 species found mostly in the peninsular region of India. The genus of the family Annonaceae is Annona which is adapted to tropical or subtropical conditions.

In different countries, the name custard apple is given to separate species of genus Annona. In India, the custard apple is *Annona squamosa*, in the USA, *Annona reticulata* or *Annona glabra* and in Australia *Annona atemoya*. According to Hayes (1957), the term custard apple may be applied to all the *Annona species* producing edible fruits. Sugar apple (*Annona squamosa L.*) is widely distributed throughout tropical South America and also grown commercially in Africa, Australia, China, India, Mexico, Southern United States, Philippine and Thailand.

Custard apple is grown on 35,000 ha in India mainly in the states of Andhra Pradesh,Maharashtra, Assam, Tamilnadu and grows wild in Deccan plateau and some parts of central India and the production was 2,71,000 MT. In 2015-16, the area covered under this crop was 9,750 ha and the production was 61,255 MT in Maharashtra (Anon, 2015-16).

The cultural practices including close planting, wind breaks regular irrigation in summer months, overhead spraying of water and mulching helps in enhancing setting of fruits (George and Nissen, 1988). Sowing of cover crops in orchard also creates micro-climate changes under their canopies by reducing soil and air temperature, irradiance and wind speed. These changes may significantly affect crop growth depending upon climate. Air temperature is important as excessively hot condition during critical developmental stages may greatly reduce the yield. Temperature exceeding 30ºC may induce pollen sterility and reduce the fruit yield. In custard apple, period of flowering is very important commencing from March-April, continuing up to July-August (Sahoo *et al.* 2000). The peak flowering period of custard apples coincides with the summer season in northern India when the temperature goes beyond 40^0C, humidity is extremely low, desiccating wind is prevalent and the soil is in dry condition. Neither the pollen is produced nor does fruit set occur in this situation (Hayes, 1957; Kumar *et al.*, 1977).

By growing cover crops like Maize, Bajra, Dhaincha, Jowar, Sunhemp and installing sprinkler irrigation and fogger irrigation in the canopy of custard apple, we can develop the microclimate and increase the fruit set and yield. Therefore, the said investigation was planned and executed at Instructional Cum Research Orchard, Arid Zone Fruit Project, Department of Horticulture, MPKV., Rahuri during the year 2016-2017 with the objectives viz., Study the effect of cover crops on pollen viability and fruit set in custard apple and study the effect of irrigation systems on pollen viability and fruit set in custard apple.

MATERIAL AND METHODS

The experiment was conducted on 10 year old trees of Balanagar variety of custard apple spaced at 5m x 5m. Healthy trees of uniform growth and vigour were selected for the experiment. The soil of experimental plot was light to medium with 1.5 m depth and good drainage. It has well leveled topography.

The experiment was started one month after harvesting of previous year fruits. The experiment was conducted in randomized block design with nine treatment and three replications during the month of January to June and following treatments were given to unit of two plants per replication. The light pruning and removal of dried and diseased branches were performed before sowing of cover crops. Cover crops were sown on 2nd of February (First week of February). All recommended inter-culture operations, manures and fertilizer applications and

removal of water shoots in custard apple were adopted from time to time.

Treatment Details

1. Maize (T_1)
2. Bajra (T_2)
3. Dhaincha (T_3)
4. Jowar (T_4)
5. Sunhemp (T_5)
6. Sprinkler (T_6)
7. Foggers (T_7)
8. Sod culture (T_8)
9. Conventional Method) (T_9)

Observations recorded

A) Growth Parameters

1. Days required for initiation of flowering
2. Number of flowers per branch
3. Number of flowers per tree
4. Percent fruit set (%)

B) Pollen studies- Testing of pollen viability using aceto-carmine.

C) Yield parameters

1. Average number of fruits per branch
2. Average number of fruits per tree
3. Average weight of fruits (g)
4. Fruit yield (kg/tree)

Statistical analysis

The statistical analysis was completed by standard statistical method suggested by Panse and Sukhatme, (1995).

Result and Discussion

The data in respect of days required for initiation of flowering, number of flowers per branch, number of flowers per tree, pollen viability and fruit set are presented in Table 1

Days required for initiation of flowering

The data on days required for initiation of flowering presented in Table indicated that, significantly minimum days required for initiation of flower due to cover crops sown in custard apple as compared to irrigation system. Among the different cover crops, significantly minimum number of days required for initiation of flowering was recorded in treatment T_5- i.e. Sunhemp (21.03) which were statistically at par with the treatments Maize (22.17), Jowar (21.97), Bajra (21.80) and Dhaincha (21.53). However two irrigation systems i. e. (T_6)- Sprinkler (29.10) and (T_7)- Fogger (32.23) shows less significant effect as compared to cover crops. Maximum days required for initiation of flowering was observed in the treatment T_9-control (Conventional Method) (41.80).

The results obtained are also in accordance with Sanewski (1988) who studied that the temperatures above 28°C, custard apples produce more vegetative growth and fewer flowers and drying of flower parts increases. Temperatures at 25°C to 28°C during flowering (October to February) are favorable for good fruit set. A relative humidity 70 % to 80 % is best for fruit set and the development of good fruit shape.

As compared with the control conventional method the treatment T_6-Fogger irrigation and T_7-Sprinkler irrigation also reduced the days required for initiation of flowering compared with Control. These results are in accordance with the George *et. al.* (1995) who studied that light applications of irrigation in the late after noon using wide-row mini sprinklers also will help opening flowers maintain their stigma receptivity until the following morning.

Number of flowers per branch

Significantly maximum number of flowers per branch was recorded in the treatment T_2-Bajra (62.00) which was statistically at par with the treatment T_4-Jowar (57.25), T_1-Maize (56.98), T_3- Dhaincha (56.17) and T_5-Sunhemp (55.36). Lowest numbers of flowers

Table 1
Effect of cover crops and irrigation systems on flowering, pollen viability and fruit set.

Tr. No	*Treatment details (Cover crops/ Irrigation Systems)*	*Days required for initiation of flowering*	*Number of flowers per branch*	*Number of flowers per tree*	*Pollen viability (%)*	*Fruit set (%)*
T_1	Maize	22.17	56.98	283.36	83.80	42.90
T_2	Bajra	21.80	62.00	310.88	88.24	44.97
T_3	Dhaincha	21.53	56.17	314.23	84.01	42.20
T_4	Jowar	21.97	57.25	257.90	86.73	42.65
T_5	Sunhemp	21.03	55.36	337.76	85.01	42.23
T_6	Sprinklers	29.10	44.36	215.63	77.12	31.91
T_7	Foggers	32.23	50.97	219.00	78.56	29.43
T_8	Sod culture	34.90	47.89	219.19	74.05	29.74
T_9	Control (conventional method)	41.80	38.63	211.87	43.13	14.33
	S. E. ±	**1.03**	**2.61**	**34.60**	**2.14**	**1.02**
	C. D. at 5%	**3.10**	**7.86**	**NS**	**6.47**	**3.07**

per branch were recorded in T_9-control (38.63). Significantly treatment (T_7)- Fogger (50.97), (T_8)- Sod culture (47.89) and T_6- Sprinkler (44.36) shows less number of flowers per branch as compared to cover crops.

These results are more or less in conformity with George and Nissen, (2002) and showed that the moderate drought (Ψ_L = 21.5 MPa) reduced shoot growth by 20-30% and increased the number of flowers per lateral by about 40% compared with well-watered controls due to reduced apical dominance and increased lateral branching.

Results are also in accordance with the Abdel Aziz *et al.*, (2008) who showed that the cover crops, the cultivation methods and their interaction were insignificant in the first season whereas only the cover crops gave a significant result in the second season. In this respect, it is clear that the *T. alexandrinum* L. and *T. foenum* gave the highest value compared to the fallow treatment in Valencia orange trees. This increase could be due to the fixed nitrogen by the cover crop which influences the trees vegetative growth (Esteban, 2001).

Number of flowers per tree

There is non significant influence of sowing of cover crops and number of flowers per tree. Numerically maximum number of flowers per tree was recorded in the treatment T_5-Sumhemp (337.76), while lowest numbers of flowers per tree were recorded in T_9-control i.e. Conventional Method (211.87).

Pollen viability (%)

The data regarding pollen viability percentage presented in Table. The data revealed that pollen viability percentage was significantly influenced by the sowing of different cover crops under study.

The treatment T_2-bajra recorded significantly highest pollen viability percentage (88.24%) which was statistically at par with all other cover crops T_4-Jowar (86.73%), T_5- Sunhemp (85.01%), T_3-Dhaincha (84.01 %) and T_1-Maize (83.80%). The treatment T_7- foggers (78.56%) and T_6- sprinklers (77.12%) were statistically at par with each other. The lowest pollen viability

Kumar *et al.*, (1977) reported that maximum pollen germination was obtained in 20 per cent sucrose-agar solution. At the time of dehiscence, receptivity of stigma started disappearing and completely lost after six hours resulting in poor fruit set. It is suggested that more fruit set may be obtained if the receptivity of stigma is enhanced by auxin sprays.

Sahoo, *et al.*, (2000) recorded, the viability of pollen varied from 52.30% to 93.33% in the green type and 45.10% to 93.33% in the red type in custard apple. Hence the highest pollen viability is recorded from June to August in both varieties. Fruit set by controlled self-pollination was only 0.75%.

These results are more or less in conformity with Hellenn, *et al.*, (2012) who showed that the percentage of pollen grain germination in vitro was highest for 'Brazilian seedless' (52.5%) and lowest for cultivar Gefner (5.9%). Preliminary results indicated that pollen grains of 'Brazilian seedless' are viable and that natural or artificial pollination is essential for fruit set.

Anonymous (2015) reported that the sowing of cover crops like Bajra, Maize, Jowar, Dhaincha and Sunhemp are responsible for increasing the pollen viability percentage (85 to 90 percent) in custard apple as compared to the open condition.

Fruit set (%)

The data regarding percent fruit set and fruit retention are presented in Table. The result revealed that percent fruit set and fruit retention percentage was significantly influenced by the sowing of different cover crops in custard apple.

Significantly maximum fruit set percentage (44.97%) was observed in the treatment T_2-Bajra which is statistically at par with the rest of the treatments. The treatment T_1-Maize(42.90%),T_4-Jowar (42.65%), T_5- Sunhemp (42.23%) and T_3-Dhaincha (42.20%) were statistically at par with each other. In respect of irrigation system i.e. T_7- Foggers (29.43%) and T_8- Sod culture (29.74%) were statically at par with each other. The lowest fruit set was recorded in T_9-control (conventional method) (14.33%).

Cover crops have the advantages not only to increase water-holding capacity but also to modify the microclimate under the tree canopy. These advantages reduce tree stress which can positively affect on the fruit set percentage and negatively affect on fruit drop percentage.

These results are more or less in conformity with Abdel-Aziz *et al.*, (2008) observed that the effect of the interaction on the fruit set percentage was not significant whereas both the cultivation methods and the cover crops had significant differences on fruit set in Valencia orange trees. Both the *T. alexandrinum* L. and *T. foenum* cover crops decreased the percentage of total fruit drop without significant differences between them compared with the fallow treatment.

Patel and Patel (2013) reported that the influence of wheat straw mulch and different plant growth regulators on fruit set, yield and quality of custard apple. Maximum flowering duration and fruit retention was observed with wheat straw mulch + GA3 (5 t/ha + 50 ppm) treatments. Highest number of fruits, fruit yield, fruit diameter and fruit pulp were also recorded under same treatments.

These results are in accordance with the Anonymous (2015) who have observed that sowing of the cover crops like Bajra, Maize, Jowar, Dhaincha and Sunhemp showed higher fruit set percentage ranging from 25 to 32 percent as compared to the control i.e.conventional Method (5.21%).

Yield Parameters

The data regarding average number of fruits per branch, average number of fruits per tree, average weight of fruits and fruit yield per tree are presented

in Table 2. Average number of fruits per branch were significantly influenced due to the association of different cover crops, those were recorded to be maximum with Bajra (28.12) followed by Jowar (25.40). The lowest number of fruits were registered in conventional method (8.60) of cultivation. Highest number of fruits per tree were recorded with Sunhemp (142.75) as cover crop, which was at par with Bajra (139.87), Dhaincha (132.69), Maize (120.43) and Jowar (109.84). The lowest number of fruits per tree were registered in control (29.84).

Table 2
Effect of cover crops on yield and yield contributing characters.

Tr. No	*Treatment details (Cover crops/ Irrigation Systems)*	*Average number of fruits per branch*	*Average number of fruits per tree*	*Average weight of fruits (g)*	*Yield (Kg/tree)*
T_1	Maize	24.33	120.43	286.67	34.39
T_2	Bajra	28.12	139.87	262.33	36.57
T_3	Dhaincha	21.80	132.69	239.67	30.49
T_4	Jowar	25.40	109.84	289.33	31.92
T_5	Sunhemp	23.10	142.75	315.33	45.03
T_6	Sprinklers	13.30	67.46	271.33	18.47
T_7	Foggers	15.89	65.59	296.67	19.48
T_8	Sod culture	13.35	65.85	274.67	17.98
T_9	Control (conventional method)	8.60	29.84	192.33	5.73
	S. E. ±	**0.78**	**12.03**	**8.31**	**3.09**
	C. D. at 5%	**2.36**	**36.24**	**25.04**	**9.19**

Significantly maximum weight of fruit was recorded in the treatment with Sunhemp (315.33 g), and was at par with the treatments of Foggers (296.67 g), Jowar (289.33g) and Maize (286.67 g). The lowest weight of fruit was recorded in Control (192.33 g). Highest fruit yield per tree was recorded in the treatment with Sunhemp (45.03 kg) which was at par with the treatment of Bajra (36.57 Kg). There was decrease in canopy temperature from 0.2 to 2.6^{0}C, while increase in relative humidity from 0.5 to 4.3 % due to the cultivation of cover crops, which could improve the productivity of custard apple (George *et al.* 1992). . The results obtained during present investigation pertaining to fruit set and fruit yield are in agreement with those obtained by Abdel Aziz, *et al.* (2008). Thus it can be concluded that sowing of cover crops, especially, Bajra or Sunhemp, under the canopy of custard apple tree is better for off season fruit yield.

CONCLUSIONS

The current investigation reveals that sowing cover crops is a promising tool for improving flowering, pollen viability, fruit set and yield of custard apple. Thus it can be concluded that sowing of cover crops i.e. Bajra, Sunhemp, Jowar, Maize, Dhaincha under the canopy of custard apple tree is better for improving pollen viability, fruit set and fruit yield in custard apple for fetching better market prices.

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