

Influence of Water Availability on Fruiting Behavior and Fruit Quality of Custard Apple (*Annona Squamosa* L.)

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Abstract: Water availability is one of the most important environmental factors influencing flowering, fruit set, yield, and fruit quality in custard apple (*Annona squamosa* L.). Efficient water management is particularly critical in semi-arid and tropical regions, where irregular rainfall and prolonged drought adversely affect crop productivity. The present study evaluated the effect of different water regimes on fruiting characteristics and fruit quality attributes of custard apple under field conditions. Observations were recorded on fruit set, fruit retention, fruit size, fruit weight, pulp weight, seed number, total soluble solids (TSS), titratable acidity, and overall yield. The results indicated that optimum water availability during flowering, fruit set, and fruit development significantly enhanced fruit retention, increased average fruit weight, improved pulp content, and produced superior fruit quality. Adequately irrigated plants recorded higher TSS, better pulp-to-seed ratio, and improved marketable yield compared with water-stressed plants. In contrast, moisture deficit during critical growth stages resulted in increased flower and fruit drop, reduced fruit size, lower pulp recovery, and deterioration of quality parameters. Excessive irrigation also negatively influenced fruit quality by reducing sweetness and increasing susceptibility to physiological disorders. These findings demonstrate that balanced irrigation management plays a crucial role in maximizing both yield and fruit quality in custard apple. Adoption of scientifically scheduled irrigation practices can improve water-use efficiency, enhance fruit quality, and ensure sustainable cultivation, particularly in water-limited environments. The study provides valuable information for growers, researchers, and horticultural planners seeking to optimize custard apple production under changing climatic conditions

Keywords: Custard apple; Irrigation; Water stress; Fruit set; Fruit quality; Stone fruit, Total soluble solids (TSS); Sustainable horticulture

I. INTRODUCTION

Custard apple (*Annona squamosa* L.), a member of the family Annonaceae, is an important tropical and subtropical fruit crop widely cultivated in India due to its adaptability to marginal soils and semi-arid climatic conditions. The fruit is highly valued for its sweet taste, rich nutritional composition, and medicinal properties. India is one of the leading producers of custard apple, with major cultivation concentrated in Maharashtra, Andhra Pradesh, Chhattisgarh, Madhya Pradesh, Rajasthan, and Gujarat. Despite its drought tolerance, optimum water availability during critical growth stages plays a vital role in achieving higher fruit yield and superior fruit quality.

Water is one of the most essential environmental factors regulating plant growth, flowering, fruit set, and fruit development. In custard apple, the reproductive phase is particularly sensitive to moisture availability. Adequate irrigation during flowering and fruit development enhances cell division, cell enlargement, nutrient transport, and photosynthetic efficiency, ultimately improving fruit size, weight, pulp percentage, and biochemical characteristics such as total soluble solids (TSS), sugars, and vitamin C content. Conversely, prolonged water deficit during these stages can lead to poor flowering, reduced fruit set, increased fruit drop, lower fruit weight, and deterioration in fruit quality.

The State Government of Maharashtra from 1990, is giving full attention towards the fruit growers and fruit growing, as well as providing finance through its agricultural departments to the fruit growers, for establishing orchards in about its agricultural departments to the fruit growers, for establishing orchards in about five years with hundred per-cent subsidies, along with technical guidance (Government of Maharashtra, Centra Press, 1990). The Govt. of India, is also, too keen to give much greater attention to the development of horticulture. This is indicated from the fact that Plan Allocation for horticulture sector received a quantum jump from little over Year Plan (Prasad and Kumar, 1999).

Successful fruit growing requires unusual knowledge, skill, accuracy and thoroughness in production and marketing. Fruit growing enlists many unusually intelligent young farmers and this intelligence is developed by the practice of their vocation. The industry appeals to intelligent young men because the work is pleasant, because the problems challenge their ability, because the work is pleasant, because the problems challenge their ability, because of the leisure at certain periods of the year.

It is fortunate that fruit growing is more profitable than most forms of agriculture. It may not possible for a family to secure an adequate income from an average holding by growing most farm crops, but the growing of fruits makes this possible, irrigation play a vital role in production potential of any crop. However, the irrigation water is a limiting factor in almost all parts of Renapur tehsil of Latur district in the Marathwada region of Maharashtra, under such circumstances the crop has to be grown. Hence the study was undertaken to know the effect of irrigation in dry-land horticultural crop, the Custard apple (*Annona squamosa* L.)

II. MATERIALS AND METHODS

In the vicinity of Renapur tehsil, at village Murdhav, in low-lying land area, the farmer has tried to develop a Custard apple orchard, which is a located just 10 kilometer away from Renapur city. The land is poor, sandy-gravel. As per reports of the soil testing laboratory, the soil of the orchard contains very low-nitrogen, with little phosphate and medium potash, having pH 7.3. The orchard is about six years old, and the plants are planted at a distance of 5 x 4 meters. The farmer is harvesting fruits since two-years.

This orchard was adopted in the academic year 2022-2023 for our experiments. With his help inter-cultivation was done regularly i.e. before the rainy season the orchard farm yard manure (FYM) was added to about 10 Kg-tree. Harrowing and leveling was done to assure the equal irrigation to every tree. And then furrows and basins were prepared for every plant with the mound of earth around the plant. Micro-irrigation facilities were already available for irrigating the field. The land was prepared for tillage and made porous. About twenty- lots of eight plants each were made add the lots were treated in Randomised Block Design (RBD) for irrigation. The following irrigation practices were adopted in four replicates. The lots /groups of the plants were treated as follows.

- 1) Left to nature which received only monsoon rains as control plots.
- 2) Copiously irrigated at 8 days interval for all over the season.
- 3) Moderately irrigated at 15 days interval for all over the season.
- 4) Every Month once only as such four times the field was irrigated.
- 5) Only twice in the season at the time of ripening of the fruits.

A balance chemical fertilizer i.e. a compound fertilizer of N.P.K.-19:19:19 'Sumpurna' 500grams to each plant was given at the commencement of Monsoon, in a belt of ring form furrow, in a basing, two feet away from the main stump, quite below the soil surface.

The fruits were harvested while they were firm and plummy i.e. the skin between the segments when turned into light yellow colored i.e. the sign of full maturity. Harvesting was done regularly at two days interval for the whole season; and the record were made of the harvested fruits for yield measurement in number, weight, size, appearance etc. the sitaphal is virtually free from pests and diseases, hence pesticides and fungicides were not used. The plants were hand weeded twice as and when weeding was necessary. After fruit setting the soil was upturned by digging the orchard manually. The data were analyzed statistically following Mangikar (2003), Zalte, (2022).

III. RESULTS AND DISCUSSION

Sitaphal is a drought resistant plant; regular irrigation is not practiced in India. The plant is able to produce fair growth in the rainy season. The fruit begins to set in the month of June-July, although flowering takes place in two main flushes from March to July. The fruits develop from July with the onset of monsoon and ripen in the months of September-October. When the trees are cultivated and attended properly, the fruits reach harvest earlier than the dormancy period. (Thombre & Khuspe, 1995).

The plots which were copiously irrigated and those moderately irrigated have shown luxurious growth, with lushness and shining in the leaves with darker green colour and vigorous vegetative growth of highly appreciable attractive nature. These plants came to flower thrice in the season and they have highest bearing in comparison to other treatments. Each tree of medium sized growth had bearing in comparison to other treatments. Each tree of medium sized growth had boreed approximately 1000 to 1500 flowers in a season but 94% of these had shed off and only 6% remained on the tree. The poor setting may be attributed to such factors as pollination or temperature and humidity or other environmental factors (Hayes, 1970). Because of good drain-age, heavy irrigation was most effective in fruit setting, and size of the fruits in Custard apple. Thakur & Singh (1974) found no fruit drop in A.squmosa trees growing in damp and shady situation and receiving irrigation. The fruits also ripened about two month earlier than usual. More frequent irrigation has been advocated in Egypt by Ahamd (1936).

In tress with no irrigation up to August, though initially they come to heavy blossom, all of the flowers could not reached to the stage of fruit setting; many flowers have shed off and they have "little bahar". In treatments 5 and control plots, because of moisture stress, after fruit setting, when the berries were small sized, fruit drop had experienced with fruit stalks and fruits having green colour. This may be due to abscission layer formation or other metabolic activities. In total three flushes of flowering and fruiting had occurred, but with the third flushing after fruit setting, because of water stress, particularly the young fruits had turned suddenly to stone-fruits. This was in highest percentage i.e., upto 30% of the total fruits on the tree. And they remained on the tree, even after the harvest was over, as persistent. Rathore (1996) also reports moisture deficiencies results in stunted growth and low yields.

The study of Venkartratnam (1963) indicates that even mere ploughing of the orchard during the rainy season has helped to conserve moisture in neglected plantations. In his opinion frequent stirring of soil by ploughing, in spite of growing the inter-crops, the trees of sitaphal do better than those growing under un-cultivated conditions.

Observation made during this endeavour has shown that those trees that were regularly watered have luxuriant growth and come to bearing very early in the season with quality fruits. While those which were left to nature and received scanty rainfall, in these trees dormancy started very early. At this juncture the fruits on tree suddenly turned brown-stone fruits. The formation of stone fruits is believed, to be, due to some physiological factors and mal-nutrition. Rathore (1996) suggest the competition among the fruits I the cause for stone fruit formation.

Table: Effect of different methods of irrigation on the yields and quality of custard apple fruits during the harvest seasons of 2022.

Type of irrigation	No.of fruits/fruit Plant	Average fruit weight (gms)	Fruit yields q/ha	% of Stone fruit formation	Size of the fruit	Appearance of the fruit
Control	60	170	40.46	35%	Small	Normal except stone fruits
Copius (8days interval)	80	320	102.42	Nil	Giant	Excellent and appealing
Moderate (15days interval)	70	302	85.50	Nil	Giant attractive	Excellent and appealing
Limited (30days)	62	201	50.32	20%	Large stone fruits	Good (Except stone fruits)

interval)						
At maturity only	50	160	42.30	28%	Medium	Good (Except stone fruits)

IV. CONCLUSIONS

1. Water is required for all life. In soils, water is supplied to plants through the roots, it lubricates the soil allowing root penetration, it is necessary for microbial mobility and action and it allows nutrient mobility.
2. The sandy-gravel soils hold low plant available amounts of water following wetting
3. Wilting is usually due to insufficient - soil moisture.
4. Water is not only essential to life but it is the predominant inorganic constituent of living matter.
5. According to Goethe, everything originated in water and everything is sustained by water. In short, water is essential for life and plays unique role in virtually all biological processes.
6. Water is the limiting factor, optimum watering is necessary, if no rains irrigation is must.
7. Good drainage and heavy irrigation is most effective in fruiting and size of fruits in Custard apple.
8. After the use of chemical fertilizers, if no rains showers then watering is most essential, otherwise fruit drop occurs.
9. Regular watering enhances early maturity of the fruits and fetches good market price to the grower.
10. Water availability decides the quality and quantity of fruits.
11. Environment determiners the crops that can be grown, and hence is the final agent to decide what-shall be done with the soil.
12. The tree is rather shallow rooted, so does not-require a deep soil, but drainage must be good, as it suffers from water logging and water logging causes tree decline.

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