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# Efficacy of super absorbent polymer and irrigation scheduling on quality attributes in acid lime

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**Abstract**
The experiment was undertaken at Fruit Research Station, Imalia, College of Agriculture, JNKVV, Jabalpur during the year 2018-19. The experiment was laid out in Randomized Block Design with three replications and total 13 treatments combinations including control. Statistically analyzed data shows that among the treatments the maximum increase in fruit juice pH (2.29), juice content (51.32%) fruit volume (37.35 ml), TSS (7.41 °Brix), acidity (6.51%), ascorbic acid (30.52 mg/100g), reducing sugar (2.61%) and number of seeds/fruit (7.42) with the placement of treatment $T_6$ which was significantly superior among all the treatments and control.

**Keywords:** Acid lime, *Citrus aurantifolia* swingle, super absorbent polymer, hydrogel, irrigation scheduling, quality attributes

## Introduction
Citrus species are extensively cultivated in tropical and subtropical regions around the world and occupy premier position both in area and production. Acid lime (*Citrus aurantifolia* Swingle) is sub-tropical fruit crop and flowers thrice in a year in the month of Jan- Feb, June-July and Sep- Oct and generally known as Ambia, Mrig and Hasta bahar respectively. Acid lime is known as Kagzi lime or neembu belongs to the family Rutaceae. The word kagzi being derived from the word kagaj meaning paper, as the rind of the fruit is very thin. Acid lime fruits have great medicinal value and nutritional value being acidic. Besides it's value added products like pickle, juice, squash etc. lime peel oil, citric acid, peel powder are also in great demand in cosmetic industry.

Limes are nutritional powerhouses, loaded with Vitamin C, antioxidants and nutrients, that may help boost immunity, reduce heart risk, prevent kidney stones, checks biliousness, antihelmintic, aid iron absorption and promote healthy skin (Raman, 2019) [12]. The USDA nutrient database lists the nutritional values per 100 g of edible lime; Energy 126 kJ (30 kcal), Carbohydrates 10.5 g, Sugars 1.7 g, Dietary fiber 2.8 g, Fat 0.2 g, Protein 0.7 g, Vitamin C 29.1 mg, Calcium 33 mg, Iron 0.6 mg, Potassium 102 mg and water 88.3 g (USDA, 2019) [18].

In India production of acid lime estimated 3148.5 million tonnes from an area of 286.2 million ha with an average productivity of 11 t/ha during 2017-18. In Madhya Pradesh acid lime cultivated over 20.29 million ha with an annual production of 306.73 million tonnes and productivity of 15.11 tonnes/ha (Anonymous, 2018) [3].

Most of the fruit crops are adversely affected by the osmotic stress arising due to poor water availability and/or excess salts in the root zone. Irrigation water stress is one of the major limiting factors that affect crop, fruit growth and productivity. The higher water availability helps to avoid water stress during longer periods of water scarcity. Hydrogels are sometimes referred to "root watering crystals" or "water retention granules" because it swell like sponges to be as several times of their original size when it contact with freely available water, consequently increase soil water holding capacity and reduce irrigation frequency (Barkat *et al*., 2015) [6]. During the water release phase of the hydrogel, free pore volume will be created within the soil, offering additional space for root growth, air and water infiltration and storage. Stockosorb also strongly resists soil pressure at high soil depth without losing its swelling capacity. Consequently, water is stored in the root zone so that water and plant nutrient losses due to deep percolation and nutrient leaching can be avoided. In this way water and nutrients are available to the plant over a longer period of time (Pattanaaik *et al*., 2015) [11].

## Method and Material

The experiment was carried out at Fruit Research Station, Imalia, Department of Horticulture and the chemical analysis of fruits was done in the Post-Harvest Laboratory, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, (M.P.). Jabalpur is situated at "Kymore plateau" agro-climatic region of Madhya Pradesh at 23.10°N latitude and 79.58°E longitude having an altitude of 412.08 meter above the mean sea level. The soil of the experimental site was medium black clay loam with good drainage and uniform texture with of average NPK status. It is tenaciously sticky when wet and hard when dry. All the selected plants were healthy, uniform and received recommended agricultural practices. The experiment was laid out in randomized block design with three replications and 13 treatments, irrigation scheduling were 15%, 30%, 45% and 60% water depletion in combination with zero, 25g and 50g SAP along with control. Potassium based super absorbent polymer (SAP) granule was used. After the application of SAP, soil was filled back into the trench. Then irrigation was applied in the basin as per treatments. The TSS content of fruits was measured by using Erma Hand refractometer of 0-32° Brix range, following the procedure described in A.O.A.C. (1980) [5]. Reducing sugar and ascorbic acid contents of fruits were estimated the procedure described by Rangana (2001) [13]. Acidity was estimated by simple acid-alkaline titration method as described in A.O.A.C and by adopting the procedure described by Rangana (2001) [13]. The volume of juice was measured with the help of measuring cylinder and percentage of juice was estimated. The number of seeds per fruit was counted manually and volume of fruit was recorded by water displacement method. pH of homogenized fruit juice was determined using pH meter with glass electrode. The obtained data were tabulated and subjected to analysis of variance (ANOVA) according to Fisher (1935) [7].

## Result and Discussion

As for the chemical fruit quality the present result in Table 1 and 2 showed that ascorbic acid, total soluble solids, acidity, reducing sugar, pH and juice content improved significantly with application of polymers. Maximum amount of TSS observed with the Treatment $T_6$ (7.41 °Brix) followed by treatment $T_5$ (7.38 °Brix) and minimum was with control. Increases in TSS by polymer may be attributed to improve metabolic and metabolic activities, leading to the synthesis of high amounts of acids, metabolites and glucose. These reserves, which were produced, may have contributed to the original composition of TSS (Sendur Kumaran, 2016) [14]. With increasing water availability in root zone fruit TSS increased (Keivanfar *et al*., 2019) [9]. This is agreement with the finding, different studies also showed that SAP and water regime treatments increased TSS. Ahmed and fahmy 2019 [2]; Pattanaaik *et al.,* (2015) [11] on Khasi mandarin; Torkashvand *et al.,* 2017 [17]; Sendur Kumaran *et al*., 2016 [14]; Zoghdan and Abo El-Enien, 2019 [19] on naval orange trees; Keivanfar *et al*., 2019 [9] and Barakat *et al.,* (2015) [6] on Grandnain Banana plants.

**Table 1:** Bio-chemical changes in acid lime as influenced by SAP and water depletion

| Treatments | TSS (°Brix) | Acidity (%) | Reducing sugar (%) | Ascorbic acid (mg/100g) |
|---|---|---|---|---|
| $T_0$:Control | 6.53 | 5.76 | 1.65 | 24.85 |
| $T_1$: No polymer + 15% water depletion | 7.00 | 6.02 | 1.97 | 26.64 |
| $T_2$: 25g polymer + 15% water depletion | 7.27 | 6.10 | 2.19 | 29.16 |
| $T_3$: 50g polymer + 15% water depletion | 7.33 | 6.19 | 2.32 | 29.41 |
| $T_4$: No polymer + 30% water depletion | 6.97 | 5.97 | 1.95 | 26.07 |
| $T_5$: 25g polymer + 30% water depletion | 7.38 | 6.33 | 2.28 | 30.19 |
| $T_6$: 50g polymer + 30% water depletion | 7.41 | 6.51 | 2.64 | 30.52 |
| $T_7$: No polymer + 45% water depletion | 6.87 | 5.87 | 1.88 | 25.84 |
| $T_8$: 25g polymer + 45% water depletion | 7.00 | 5.98 | 2.11 | 28.08 |
| $T_9$: 50g polymer + 45% water depletion | 7.13 | 6.05 | 2.24 | 28.63 |
| $T_{10}$: No polymer + 60% water depletion | 6.75 | 5.81 | 1.85 | 25.17 |
| $T_{11}$: 25g polymer + 60% water depletion | 6.97 | 5.98 | 2.05 | 26.91 |
| $T_{12}$: 50g polymer + 60% water depletion | 7.00 | 6.01 | 2.08 | 27.40 |
| SEm± | 0.12 | 0.07 | 0.10 | 0.51 |
| CD at 5% Level | 0.37 | 0.20 | 0.29 | 1.51 |

As per the result maximum amount of acidity was obtained under treatment $T_6$ (6.51%) as compared to other treatments and minimum under control. The obtained results are in similar findings with the Keivanfar *et al*., 2019 [9] on granny smith apple; Pattanaaik *et al.,* (2015) [11] on Khasi mandarin, Torkashvand *et al.,* (2017) [17] and Zoghdan and Abo El-Enien, 2019 [19] on naval orange trees.

**Table 2:** Fruit quality changes in acid lime as influenced by SAP and water depletion

| Treatments | pH of juice | Juice content (%) | Fruit volume (ml) | No. of seeds/fruit |
|---|---|---|---|---|
| $T_0$:Control | 1.80 | 39.37 | 28.90 | 5.87 |
| $T_1$: No polymer + 15% water depletion | 1.92 | 40.14 | 31.27 | 6.53 |
| $T_2$: 25g polymer + 15% water depletion | 2.12 | 46.78 | 34.87 | 6.07 |
| $T_3$: 50g polymer + 15% water depletion | 2.15 | 47.75 | 34.87 | 6.53 |
| $T_4$: No polymer + 30% water depletion | 1.87 | 40.01 | 30.80 | 6.40 |
| $T_5$: 25g polymer + 30% water depletion | 2.21 | 49.44 | 35.33 | 7.33 |
| $T_6$: 50g polymer + 30% water depletion | 2.29 | 51.32 | 37.35 | 7.42 |
| $T_7$: No polymer + 45% water depletion | 1.83 | 39.94 | 30.20 | 5.40 |
| $T_8$: 25g polymer + 45% water depletion | 2.06 | 43.23 | 33.92 | 6.07 |
| $T_9$: 50g polymer + 45% water depletion | 2.10 | 46.03 | 34.03 | 7.27 |

| | | | | |
|---|---|---|---|---|
| $T_{10}$: No polymer + 60% water depletion | 1.82 | 39.81 | 30.00 | 6.73 |
| $T_{11}$: 25g polymer + 60% water depletion | 1.94 | 42.13 | 31.53 | 5.73 |
| $T_{12}$: 50g polymer + 60% water depletion | 2.00 | 42.73 | 32.55 | 6.00 |
| SEm± | 0.05 | 1.89 | 0.83 | 0.35 |
| CD at 5% Level | 0.15 | 5.52 | 2.42 | 1.04 |

The fruit was of largest size. The reducing sugar and ascorbic acid content in these fruits was also recorded highest with treatment $T_6$ 2.64% and 30.52 mg/100 g, respectively, which was also significantly higher than that of control at 5% level of significance. The lowest value of reducing sugar and ascorbic acid contents was found in case of control. This was due to the smallest size of fruits (Pattanaaik *et al*., 2015) [11]. Decrease in vitamin C content under water stress may be attributed to increase in activity of ascorbic acid oxidase enzyme responsible for the destruction of ascorbic acid content in the plants. The application of natural polymers led to reduction in the ascorbic acid oxidase enzyme in the plants might be the reason for enhanced ascorbic acid content in tomato fruit due to supply of sufficient amount of water and nutrients to the plant in water deficit condition. (Ahmed and Fahmy 2019) [2]. Similarly, Sendur kumaran (2016) [14] also reported an increase in ascorbic acid content and TSS in tomato due to the application of hydrophilic polymer. These results are in close conformity with the results reported by Josefa M. Navarro *et al*., 2010 [8], Pattanaaik *et al*., 2015 [11]; Torkashvand *et al.,* 2017 [17]; Abd El-Rhman and Mohamed (2015) [1] on olive trees. However, Barakat *et al.,* (2015) [6] on Grandnain Banana plants; Zoghdan and Abo El-Enien, 2019 [19] on naval orange trees and Mikiciuk and Mikiciuk 2010 [10] on strawberry.

Regarding the pH values, lowest value was observed in plants that grown under control and highest with treatment $T_6$ (2.29) followed by $T_5$. These results were confirmed to Sendur kumaran (2016) [14] who reported an increase pH in tomato due to the application of hydrophilic polymer. Decrease in the pH of fruits when exposed to water stress may be due to change in the acid content as malic and citric acid (Thybo *et al*., 2006and Anthon *et al*., 2011) [16, 4].

The highest fruit volume was measured under treatment $T_6$ (51.32 ml) followed by $T_5$ and lowest under control. This might be due to the large fruit size as compared to other treatments. The maximum juice percent was obtained with treatment $T_6$ (37.35%) followed by $T_5$ and minimum with control. Juice percent decreases as the level of water shortage increases (Ahmed and Fahmy 2019) [2]. Similarly, Sendur kumaran (2016) [14] also reported an increase in juice content in tomato due to the application of hydrophilic polymer. These results are in line with Ahmed and Fahmy 2019 [2] and Sendur kumaran 2016 [14].

Highest number of seed per fruit was recorded under Treatment $T_6$ (7.42) as compared to other treatments and lowest value under control. There was significant positive relation between seed number and weight of the fruit (Shrestha et al., 2012) [15].

## Conclusion

The results showed that using a super absorbent polymer (SAP) and Irrigation regime has positive significant effects, on bio-chemical attributes of acid lime. Most of the attributes are found better with the application of SAP at high dose (50 g/tree) and with 30% water depletion in soil. The application of SAP in soil led to enhance vegetative growth and fruit quality of acid lime. It also improved water holding capacity of soil, which provides a favourable atmosphere for better vegetative growth and ultimately improved yield.

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