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# Effect of Super Absorbent Polymer on the Growth of Mango and Tomato

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**ABSTRACT**

Field trails were conducted to evaluate the performance of a super absorbent polymer on mango and tomato for improving seedling, plant establishment and crop development at AF Ecology centre research farm, Anantapuram. Super absorbent polymer was evaluated to suggest the farmers for improving crop growth and yield when there was limited water. The parameters evaluated are crop establishment, new twig formation, flowering, fruit formation and the crop tolerance against the drought. The plant height was 208.8 cm and 191.2 cm and the crown diameter is 163.8 cm and 165.8 cm for polymer treated and not treated respectively. The average flowering per a row in tomato for polymer treated is 12.0 and for the average flowering for polymer not treated are 10.8. The effective height of tomato crop for polymer treated and not treated was 33.4 cm and 29.6 cm respectively. the growth was found to be good when it treated with super absorbent polymer. The growth parameters of plants to which super absorbent polymer applied was appreciable.

**Keywords:** *Super absorbents, Polymer, Soil conditioner and Plant parameters.*

A variety of fruit crops are cultivated in Anantapur district, namely; grape, papaya, sapota, Fig, Ber, custard apple, pomegranate, banana, guava, oranges, batavia, acid lime, mangoes, musk melon and water melon. The total area under fruit crops in the district accounts to 2.85 % to the total cropped area. The irrigated fruit cropped area to the total fruit cropped area accounts to 94.73 % and 19.27 % to the total irrigated area. It reveals the significance of irrigation in cultivating fruit crops. In Anantapur district farmers are adopting drip irrigation and sprinklers in the cultivation of fruit crops, which is a modern technology of irrigation for the economical utilization of limited sources of water. Mango (*Mangiferus indica*) is a major horticultural crop growing in India. 40% of total world's production of mango was? led by India. Mango grows both in tropical and sub-tropical conditions. Tomato (*Solanum lycopersicum*) is an important vegetable crop which is cultivating extensively in India. Kumaran (2017) experimented the effect of hydrophilic polymers on tomato yield and quality and revealed that the application of polymer terracottem 4.5 g per plant with recommended dose of manures and fertilizers (FYM 25 t + NPK 150: 100:50 kg + Azospirillium 2kg + Phosphobacteria 2 kg $ha^{-1}$) followed by Polyvinyl Alcohol 15.0 g per plant.

Yazdani *et al.*, (2007) resulted that the irrigation interval has significant effect on seed yield, total dry matter (TDM), leaf area index (LAI), crop growth rate (CGR), plant height and harvest index (HI). The heights seed yield, TDM, LAI, CGR and HI were achieved by applying 225 kg/ha polymers compared with the control (without polymer).

Woodhouse and Johnson (1991) studied on application of superabsorbent polymers on crop seedlings and resulted that the water use efficiency and dry matter production also responded positively to the presence of both the polymers tested. Chiorescu *et al.,* (2017) studied the influence of hydrogels zebasp and terracotta on the development of some aromatic plant species shown a better influence and efficiency of about 14%- 18% on the chosen plant is treated with Terracotem compared to that of Zeba SP. Basse *et al.,* (2013) observed growth and yield response of cotton cultivars to "Zeba" superabsorbent polymer and n-application under dry land conditions and resulted that the Zeba application has potential to increase soil moisture conservation, nutrients use efficiency and cotton seed yield at low water quantity and fertilizer cost. Basso *et al.,* (2013) studied on the potential of bio-char for increasing water holding capacity (WHC) for sandy soils and suggested that bio-char added to sandy loam soil increases the WHC and might increases moisture availability for the crop. Shinohara *et al.,* (1995) studied on gravel culture to find effect of the water stress on tomato fruit yield, quality and physiological condition. Volkmar and chang (1995) studied the influence of hydrophilic gel polymers on barley and canola growth and yield and resulted that application of polymers tended to increase consumptive water use.

Landis *et al.,* (2012) resulted about the application of hydrogels in the nursery and during out planting and resulted that absorptive capacity of those gels is influenced by their chemical and physical composition as well as the ion concentration of the liquid being absorbed. However, Agriculture and Horticulture are fully dependent on sustainable and renewable resource such as water and soil. New specialists are working on methods of irrigated, land protection and the most efficient use of water resources. Thus, the use of hydro-absorbent hydro gel like materials with three-dimensional structures, which have a high swelling capacity, has grown to a worldwide level in order to stimulate water retention capacity near plants for many years, reduce the amount of water used, fertilization treatments applied by reducing leachate fertilizer losses, improving soil structure by reducing erosion or improving the physical properties of compact soils through good aeration, plant wastage delays, increased productivity on unstructured soil. Hydrogels applications are linked to soil type, geographical area, and plant species. It is worth noting that hydrogels based on biopolymers have the advantage of biodegradability, biocompatibility and low toxicity. This current study aims to test Zeba to track the influence and their effectiveness on the state of vegetation in horticultural and vegetable plants such as mango and tomato. Due to its application the nutrient and water holding capacity of soils and growing media is kept in optimal conditions. In addition, roots are encouraged to grow more quickly to depths where more water is present. Hence, the present study includes growth comparison in polymer treated and non-polymer treated for mango and Tomato.

## MATERIAL AND METHODS

### Study area

The study was conducted at Accion Fraterna ecology centre , having a latitude 14.642°N and longitude 77.625°E which is located in Anantapur district of Andhra Pradesh during . According to Thronwaite climatic classification, the Anantapur district comes under dry sub humid type of climate with the moisture index of -33.3. The study region receives very low annual rainfall of 558.85 mm and falls in a short span of three to four months. The district receives 322.76 mm of rainfall in south-west monsoon period and 149.54 mm of rainfall in north-east

monsoon period. The relative humidity is 50 - 60 % in the mornings and 20 -30 % in the afternoons from February to May, and it goes up during monsoon and winter periods. The average annual temperature in Anantapur is 27.6 °C. The average annual rainfall is 526 mm. The soils of Anantapur district comprises with red soil (82 %-) and black soil (18%).

**Composition Super absorbent polymer**

The polymer is a biodegradable super-absorbent that has the role of maintaining a constant amount of moisture in the soil available to seeds, seedlings and germ plants throughout the growing season. This hydrogel made from natural corn starch swells by absorbing more than 400 times its original weight in water, and then releases it on demand from plants. Polymer also binds and releases water-soluble nutrients, preserving fertilizers in root area for a long time, creating a healthy microenvironment. Over time, polymer is decomposed and consumed by the microorganisms that live in the soil. Each polymer granule is made from corn starch and can function as a sponge that absorbs over 400 times the initial weight in water, and then forms hydrogels that slowly release moisture back to the plants as it is needed. Polymer granules bind and remove water-soluble nutrients and then store more fertilizers in the root area where they can be used by plants to create a healthier micro environment. Polymer is broken down and consumed by naturally occurring microorganisms in the soil, leaving no residue behind.

**Experiment for mango**

Mango field experiment was conducted in commercial farm of AF ecology centre located at Anantapur. The area of the farm is 11.5 acres. The geographical location of the experimental site is 34°59’45’’ N latitude and 85°33’19’’ W longitude. The soils of the experimentally site were red soils with sandy clay loam.

**Experiment details**

The commercial farm has three varieties of 3 year and 1 year age. Irrigation was provided by using drip irrigation (sub surface) system. The variety of mango plant grown in commercial farm is Benishan. It is the mostly found variety in Andhra Pradesh. One row of 3 year mango plants was selected and the type of irrigation of plants was subsurface drip irrigation. Polymer has applied to 5 plants of mango in that row alternatively. Irrigation was given daily by subsurface drip irrigation method. The plant to plant spacing was 1.5 m. The experiment was conducted in the commercial farm for 3 months. For the experiment one row of 3 year old mango plants were selected. Tree to tree spacing was 3 meters. Polymer was applied to 5 mango plants alternatively. Irrigation was given daily for the 5 plants and for two plants irrigation was given in an interval of 3 days.

**Superabsorbent polymer application for mango**

The application rate of polymer for mango is 1.5-15 grams per tree. So, polymer is applied at a rate of 14 grams per each plant alternatively. After application to 5 plants irrigation was given daily and for the other two plants at an interval of 3 days.

**Collecting data for mango Plant**

The parameters such as plant height, canopy width, no. of branches, no. of leaves, trunk diameter and no. of twigs newly formed and new leaves formed are counted. The differences in the growth of the polymer treated and non-polymer treated was identified. There is very less growth will be observed in mango plant so the data mainly collected was twig formation and new leaf formation.

**Fig 1. New twigs formed in polymer treated mango plant**

**Fig 2. Collecting data of plant parameters**

**Experiment for tomato**

**Site of field experiment**

Field experiment for tomato was conducted in institute farm at AF ecology centre. The geographical location of the experimental site is 44°40'0.159'' N and $90^0$ 45'11'' W with an. The soils of the experimental site were sandy clay loam.

**Experiment details**

The present objectives were evaluating polymer as soil amendment by giving manual irrigation. Ridge and Furrow method irrigation was given to the field. Ridges are prepared manually by the labour. Two plots were selected polymer treatment was given in one plot and one plot was not treated. The size of each plot was 3m × 3 m. Each plot has six ridges and five furrows. For the experiment two plots, plot P1 and plot P2 was selected with equal area. Each plot is divided into 6 ridges with spacing of 0.6m each. Plot P1 is treated with super and plot P2 was not treated. The field was primarily tilled with a power tiller of 4.8hp and then the field was levelled manually. The tomato field was separated in two equal plots with the help of measuring instruments and ridges are made manually in the plots. Table 1. Shows the details of ridge and furrow specifications.

**Table 1. Specification of ridges ad furrows**

| Particulars | Specifications |
|---|---|
| Number of ridges prepared | 12 |
| Spacing between ridges | 0.6 m |
| Width of ridge at the bottom | 0.3 m |
| Width of bed at the top | 0.1 m |
| Height of bed | 0.1 m |

**Irrigation method and irrigation interval**

Ridge and furrow method of irrigation was given to the plots. Irrigation was daily given to the non-polymer treated plot and for polymer treated plots irrigation interval was 3 days. For every 3 days' irrigation was given to the polymer treated field.

**Daily irrigation requirement**

Crop water requirement of tomato crop is 4000 – 5000 $m^3$/ha

Crop period of USM kapila tomato variety is 120 days

Based on Mean crop water requirement of 4500 $m^3$/ha daily irrigation requirement of crop is determined for the area of 3$m^2$ of polymer treated and 3 $m^2$ of non-treated plots.

Daily water irrigation requirement of both plots is = $\frac{4500}{120\times10000}\times 9 = 0.03375$ m3

Daily water requirement of crop is 33.75 l/day.

Total discharge capacity of the ridge and furrow system is 80 l/ day.

**Transplanting of seedlings**

The tomato seedlings of 45 days old were used for transplanting. The seedlings were transplanted in the experimental field on 18th February 2019 while field is in slightly wet condition after irrigation a day before the transplantation. Each ridge is planted with one row while placing seedlings on each bed the spacing between two plants in row is 30 cm.

**Super absorbent application for tomato**

As per UPL (United Phosphorous ltd, Australia), the application rate of super absorbent polymer was 6-15 kg/ha (14 gm of polymer was applied for 3 sq. meter area). Polymer was equally applied to each tomato plant. There was very less moisture while applying polymer in the field.

**Weed management**

Weeds are removed in the field manually. As its ridge and furrow type of irrigation weeding is most common thing we are observing. The common weeds observed in tomato field are are Garika (*cynodon dactylon*) and Tunga (*Cyprus deformis*).

**Determining crop growth parameters**

Crop growth parameters such as plant height, flowering and max width are noted in each ridge with a sample of five plants per row in experimental plots P1and P2.

**Fig 3. Field preparation for tomato**

**Fig 4. Transplanted tomato seedlings**

**Fig 5. Weeds in the tomato plots**

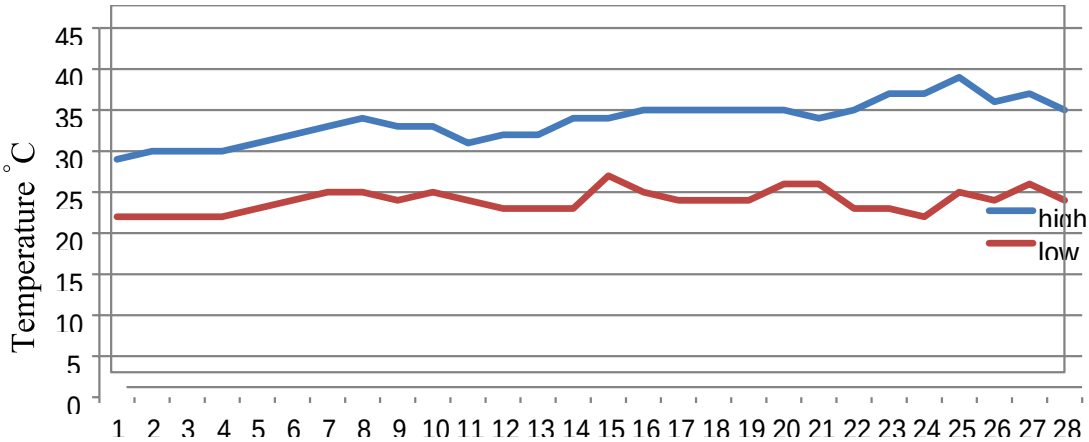


**Fig 6. Temperature change in February 2019 in Anantapur**

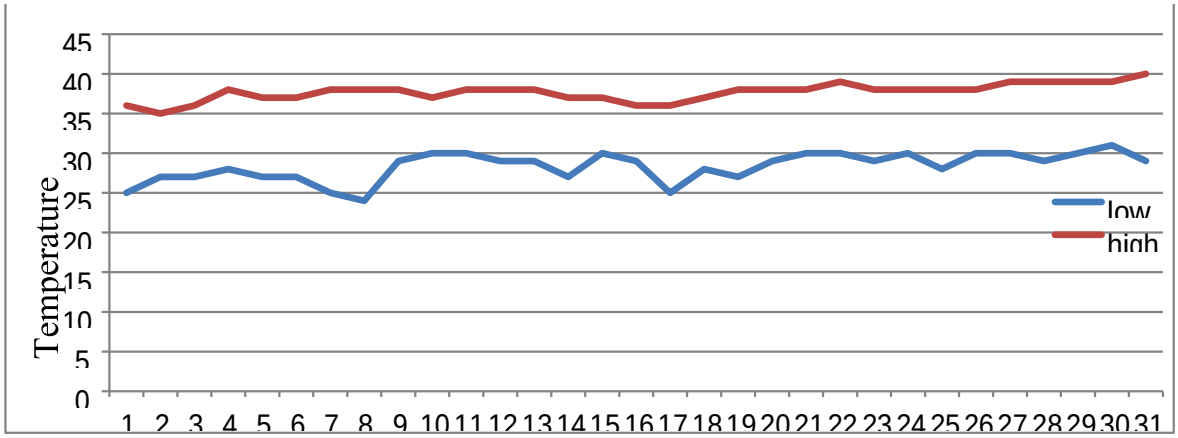


**Fig 7. Temperature change in March 2019 in Anantapur**

## RESULTS AND DISCUSSION

### Observed temperature changes

Daily temperature changes are noted using the website i.e., time and date.org in which maximum and minimum temperatures of weather are noted from the date of planting to till now i.e. April 1st and shown in following graphs. In the month of February the temperature were less when compared to the temperature in the month of March and April 2019.

### Swelling of super absorbent polymer

The applied Zeba was swelled and increases its size. The swelling of polymer is caused by the intake of excess water applied to the plants. The root hairs absorb the moisture from the swelled polymer whenever there is less moisture in the soil.

**Fig 8. Swelling of super absorbent polymer**

**Table 2. Plant parameters as influenced by polymer on mango plants**

| Parameters | | Polymer treated | Polymer not treated |
|---|---|---|---|
| Tree height(cm) | | 208.8 | 191.2 |
| Trunk height(cm) | | 114 | 94.6 |
| Trunk diameter (cm) | | 11.6 | 11 |
| Canopy diameter (cm) | | 163.8 | 165.8 |
| Number of branches | | 10.6 | 8.4 |
| Number of twigs | New | 4.4 | 3.4 |
| | Old | 22.2 | 23.6 |
| Number of leaves per twig | New | 16.6 | 11.4 |
| | Old | 14.6 | 13.4 |

**Growth parameters**

Crop growth parameters like plant height and width of individual plants on each plot are noted at intermediate stage of crop growth. For mango, all the tree data was collected and an average data presented. For tomato Sample of 5 plants on each ridge are separately noted and carried on all ridges of each plot and found out uniformity of plant growth in both plots to understand favourable optimum plant growing conditions and environment.

There is slight difference in the growth of mango plants for polymer treated and for not treated plants. As the mango tree growth parameters like height, width and canopy diameter were not be determined for short span. Form the Table 2. it is revealed that the parameters like twigs formation and new leaves were mainly considered, the average no. of twigs is 4.4 for polymer treated and for not treated it is 3.4.

**Table 3. Effect of polymer on the growth of tomato**

| Particulars | Polymer treated | control |
|---|---|---|
| No. of plants at planting | 60 | 60 |
| No. of plants after 30 days | 46 | 44 |
| Healthy plants | 38 | 35 |
| Flowered plants after 60 days | 35 | 33 |

The above table 3. Indicates the no. of plants survived after stopping of irrigation for three consecutive days. In polymer treated may be the moisture accumulation in the root zone helps the plants to withstand more. All the parameters are more in polymer treated plants but fruit formation is slow in polymer treated plants.

**Table 4. Effect of polymer on the growth of tomato at 60 days**

| Plant height (cm) | | Plant width (cm) | | Stem dia (cm) | | Number of flowers per plant at 60 days | |
|---|---|---|---|---|---|---|---|
| Polymer treated | Control | Polymer treated | control | Polymer treated | control | Polymer treated | control |
| 39.0 | 29.2 | 19.2 | 15.8 | 2.6 | 2.6 | 12 | 10 |
| 33.6 | 32.6 | 17.6 | 20.8 | 2.2 | 2.3 | 14 | 13 |
| 37.4 | 39.6 | 21.2 | 19.8 | 2.8 | 2.3 | 20 | 16 |
| 39.4 | 25.0 | 18.4 | 16.4 | 2.7 | 2.4 | 8 | 12 |
| 27.8 | 30.4 | 16.8 | 18.2 | 2.4 | 2.5 | 12 | 10 |
| 23.2 | 20.8 | 15.6 | 15.2 | 2.0 | 2.2 | 6 | 4 |

From the above table, average plant height is 33.4cm for polymers treated and control it is 29.6 cm. The average flowering is 12 per tree for polymer treated and for controlled is 10.83 per tree (Table 4.). The flowering was good in polymer as compared to not treated but the fruit formation was early for not treated but for polymer treated it was delayed.

## CONCLUSIONS

In Anantapur, the climatic condition is drought type, the water availability is also less in these regions. The rainfall in these regions was very less that the crops cannot survive without frequent irrigation. The application of polymer in this condition will help to retain the moisture in these soils. These granules hold the excess moisture while precipitation occurs and whenever irrigation given. A superabsorbent polymer applied to mango and tomato in these conditions was found to be appreciable. In mango, the average plant height is 208.8 cm and 191.2 cm and the crown diameter is 163.8cm and 165.8 cm for polymer applied and not applied respectively. The plant growth parameters such as plant height, width, flowering and fruit formation was effective in the polymer applied crop. The average flowerings per a row in tomato for polymer treated are 12.0 and for the average flowering for not treated are 10.8. The average effective height of tomato crop for polymer treated and not treated was 33.4 cm and 29.6 cm respectively. The growth was found to be good when it treated with super absorbent polymer. The results obtained shows the plant survival rate in the super absorbent treated plants was 58.3% where as 55% for under control as the results show that the differences were only very small and polymer can be applied along with fertilizer maybe somewhat gives better result as we applied only polymer without fertilizer may be in granular form, powdered or otherwise in the liquid form.

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