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## Performance evaluation of deep root irrigation for okra (*Abelmoschus esculentus*)

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### Abstract

An experiment titled "Performance evaluation of deep root irrigation for okra (*Abelmoschus esculentus*) crop" was a comparative study of drip and deep root irrigation system. The area was occupied to perform three different irrigation treatments i.e, control irrigation method (T-1), drip irrigation method (T-2) and deep root irrigation method (T-3). Okra crop is selected for the experiment. The objective of the present work is to study the effect of plant growth of okra under drip and deep root irrigation systems and to estimate the yield of okra under drip and deep root irrigation systems. Growth of the crop includes plant height, number of leaves per plant, day to first flowering, average weight of the fruit, fruit length, fruit diameter and fruit colour. The yield parameters which include number of fruits per plant and yield per area. The healthy growth i.e, 152 cm plant height, 27 leaves per plant, 28g average weight of the fruit, 15.24 cm fruit length, 1.7 cm fruit diameter were recorded highest in the deep root irrigation method (T-3) than drip irrigation method (T-2). The yield parameters i.e, 21 number of fruits per plant, 0.94kg/m<sup>2</sup> yield per area were recorded highest for deep root irrigation method (T-3). Current research concludes that the deep root irrigation method gives better result for okra crop when compared with the drip irrigation method.

**Keywords:** Drip irrigation, Deep root irrigation, Okra, Growth parameters and yield

### Introduction

Water is the main principle of life and essential for socio-economic development of any region. Yet, water resources have been taken as free resources to be used without paying which leads to long term consequences of its improper management. Agriculture sector is the major consumer of water resources in India. However, increasing competition for water for individual, domestic and power sector necessitates urgent need for development of water saving technologies to ensure more crops drop in agriculture. Efficient water management in agriculture is the major challenge to ensure sustainable food production in India. Due to escalating demand of water in arid and semi-arid regions, the irrigation water availability will decline in coming years. Therefore, it is imperative to develop technologies for judicious utilization of available water in agriculture to ensure future food security of the country. It is estimated that by 2050, the population of India is likely to be 1.6 billion, resulting in increased demand for water (32%), food and energy (Bhavan).

According to National Water Policy, 2012, India has more than 18% of the world's population, 4% of world's renewable water resources, and 2.4% of world's land area. During the 20th century the world population tripled while global demand for water has increased six-fold. The challenge of water in 21st century is one both quantity and quality. If current trends persist, by 2025 two-thirds of the world's population will be living with serious water storage or no water at all. The per capita availability of water which was about 1704 cubic meter in 2010 is projected to be 1235 cubic meter in 2050. In such situation, proper utilization, planning and management of water resources is highly needed to minimize the gap between the supply and demand (GOI).

Vegetable crops are eminent source of human nutrition. These are short duration crops, which can be grown in small spaces. Considering that the world population is estimated to increase 65% by 2050, the demand for food will increase strain on fresh water resources. Commercial production of vegetable is not possible without adequate water availability

throughout the growing season. The production of vegetables has increased from 101.2 million tonnes to 184.4 million tonnes since 2004-05 to 2017- 18. Due to expected scarcity of water in future, water use efficient crop can only scope with the increasing demand (Horticulture statistics division, 2018).

Okra or Lady's finger is an annual vegetable grown in tropical and subtropical regions of the world. It is related to cotton and hibiscus and is a tall growing, annual summer vegetable. The varieties can grow up to three and half meters. The edible part is a pod. The plant may have single or branched stem. Flowers are born singly at every node oration alternate node. Okra probably had originated in Abyssinian centre of origin of cultivated plants comprising present day Ethiopia, the mountainous or the plateau region of Eritrea and the eastern higher regions of the Anglo-Egyptian Sudan. Okra has been cultivated by Egyptians since the 12th century AD and spread all over the countries. It's known for its outstanding nutritive and medicinal values. India ranks first in the production of 5.5 million tonnes of okra. (Horticulture statistics division, 2018).

Drip irrigation is a type of micro-irrigation that has the potential to save water and nutrients by allowing water to drip slowly to the roots of plants, either from above the soil surface or buried below the surface. The goal is to place water directly into the root zone and minimize evaporation. Properly designed, installed, and managed, drip irrigation may help achieve water conservation by reducing evaporation and deep drainage when compared to other types of irrigation such as flood or overhead sprinklers since water can be more precisely applied to plant roots. In addition, drip can eliminate many diseases that are spread through water contact with the foliage. Finally, in regions where water supplies are severely limited, there may be no actual water savings, but rather simply an increase in production while using the same amount of water as before. In very arid regions or on sandy soils, the preferred method is to apply the irrigation water as slowly as possible.

Deep root irrigation is not new, but is probably under-utilized, it's development started in 2013 and the irrigation system was launched in April 2017. Trials have shown water use reductio of as much as 70%. The Deep root irrigation unit has been tested and shown to save water up to 50% compared to traditional irrigation, while allowing more water available to the roots of the plant.

Deep root irrigation was invented in response to the immense amount of water lost to surface irrigation methods in agriculture due to evaporation and runoff. Especially critical in areas of prolonged drought or where groundwater supplies are in critical shortage or have been depleted. Traditional surface methods like micro-sprinklers and drip emitters inefficiently apply water on top of the soil, requiring longer irrigation sets and greater amounts of water to sustain plant vitality. By starting the watering process under ground the deep root irrigation provides a hyper-efficient delivery system of water and nutrients requiring significantly less inputs and less energy for equal and often superior results.

## 2. Methodology

Surampalem is a Village in Gandepalli, Mandal in East Godavari District of Andhra Pradesh State, India. It belongs to Andhra region. It is located 62 Km towards North from District headquarters Kakinada. This site is located at 17° 4' 52.68"N latitude and 82° 3' 25' E longitude. The climate is comparatively equitable and although it is very warm in May with a maximum temperature of 44°. The annual rainfall of the district is 1565 mm. The main soils in the district are alluvial (Clay loamy) red soils, sandy loams and sandy clay. There are mostly alluvial soils in Godavari delta area and sandy clay soils at tail end portions of Godavari. There are red loamy soils in uplands and agency area of the district. The soil type in the experimental site is red clay loam.

**2.1 Experimental Site:** The area of about 13.71 m × 9.14 m was selected in Aditya University at Agricultural Engineering department farm. The selected site was properly pulverized using tractor mounted Rotavator during land preparation before cultivation. The area was divided into three plots to perform three different irrigation methods. Each plot dimensions were 4.5m×9.14m. Okra seeds were sown in the first plot to perform control irrigation method by maintaining row to row and plant to plant spacing equally. Then the drip irrigation system was arranged in the experimental site of second plot with 7 laterals at a distance of 0.6m from each other. The drip irrigation system was designed and installed such a way to maintain required pressure at the end of the plot so that uniform water distribution at each emitter head is obtained.

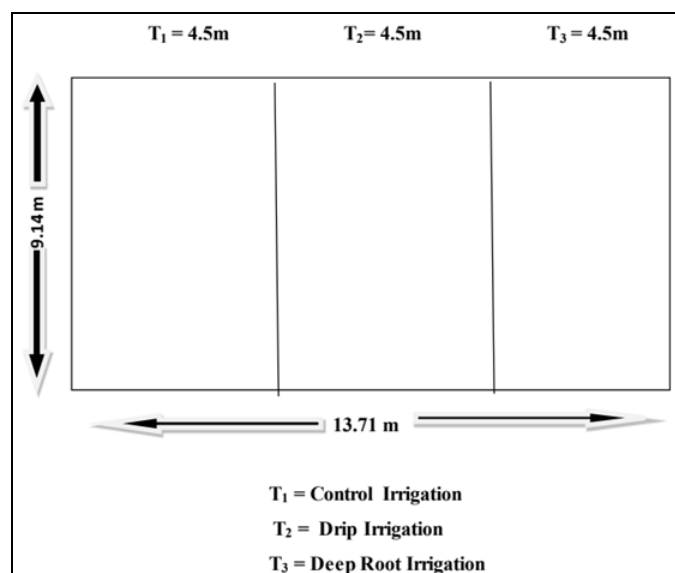


**Fig 1:** Layout of the Experimental Plot

## 2.2 Installation of Pipeline Setup

The lateral polyethylene pipes of 16 mm diameter were installed in 7 rows. The distance between two laterals and plant to plant distance was 0.6m. The pressure compensating emitters were fixed into laterals with a punch hole at a distance of 0.6m. Each lateral contains 15 emitters. A total of 105 emitters were used in a drip plot. The water

into drip plots was delivered by pumping water from submersible pump through long main PVC pipeline of 76.2 mm diameter which was connected with sub main. Under drip irrigation system, water was delivered to the plant root zone directly at a slow and low-pressure rate (8lph) in small amounts through emitters for watering the plants.



**Fig 2: Installation and Sowing**

In the same manner laterals were installed in the third plot for deep root irrigation method. A PVC pipe of diameter 50.8mm is placed at 0.7m depth in the middle of the two

laterals. Hand driller is used to drill the holes on the PVC pipe. A 12mm drill bit is used to drill the holes in a continuous manner as shown in Fig 3.



**Fig 3: Filling the Gravels**



**Fig 4: PVC Pipe Installed**

## 2.3 Pre and Post-harvest Observations

Plant height (cm) was measured from the collar to the base of the highest fully expanded leaf by holding a measuring tape close to the stem. The average height was calculated from five randomly selected plants at 10-day intervals after sowing and recorded as plant height. The number of leaves per plant was determined by counting the fully mature leaves on each plant, and the average of five plants was recorded at the same 10-day intervals. Days to first flowering were recorded through daily observations, noting the number of days from sowing to the appearance of the

first flower.

The average fruit weight (g) was determined by weighing five randomly selected okra fruits from each treatment separately using a weighing balance, and the mean value was recorded. Fruit length (cm) was measured for five sample okra fruits using a measuring tape, and the average of these measurements was noted. Fruit diameter (cm) was determined by cutting each of the five sample fruits at the widest portion and measuring the diameter by placing it on paper, following the traditional method; the average value for each treatment was then recorded. Fruit colour was

assessed using a standard colour chart to determine the characteristic colour of the okra.



**Fig 5:** Installation of Drilled PVC Pipe (0.7 m depth)

#### 2.4 Yield parameters

The number of fruits per plant was recorded at each harvest by counting the total number of okra fruits obtained from five randomly selected plants in each treatment separately. This observation was taken across all pickings, and the

cumulative number of fruits was divided by five to obtain the average number of fruits per plant. This method ensured a reliable estimate by minimizing plant-to-plant variation and accounting for yield over multiple harvests.



**Fig 6:** Initial Growth of Okra Plant

Yield per area ( $\text{kg/m}^2$ ) was determined by harvesting okra at 10-day intervals, with a total of five harvests conducted during the cropping period. The produce from each treatment was collected and weighed separately using a weighing balance. The total yield obtained from each treatment was then converted into yield per unit area by considering the plot size. Finally, the average yield across all harvests was calculated for both drip irrigation and deep root irrigation treatments, providing a comparative assessment of productivity under different irrigation methods.

### 3. Results and Discussion

#### 3.1 Physical Attributes

The results of the present study entitled "Performance evaluation of deep root irrigation for okra (*Abelmoschus esculentus*) crop" is presented in this chapter under different headings with tables, figures at appropriate places. These results are based upon enormous kind of observations collected under real ground scenarios, which resembles with farmer's conditions. The results describe in below given segments are indeed reflects, ranges as well as trends whatever could be generated from above mentioned field

observations, spared over a period of 3 months and accomdating a full growing period of okra in the study area

as shown in Fig. 7.



**Fig 7:** Harvesting Stage of Okra Crop

The maximum height (i.e, 152 cm) of the plant was recorded in treatment-3(Deep root irrigation) than that in the treatment-2(Drip irrigation). This might be because of direct

application of water to the rootzone of the plant by avoiding runoff and evaporation resulting in better root development and improvement in plant growth.

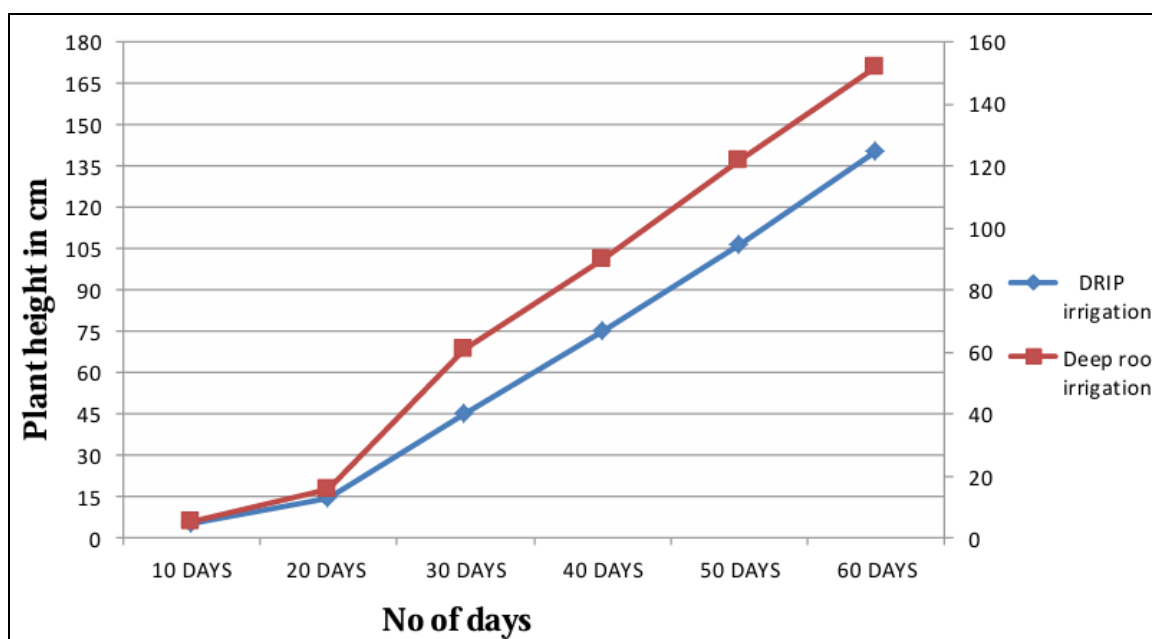


**Fig 8:** Plant height (cm) of okra at different irrigation treatments

With 10 days interval from sowing, the no. of leaves counted for five observational plants separately for two treatments and average was recorded. The maximum no. of leaves per plant (27) was recorded in treatment-3(Deep root

irrigation) than that in the treatment-2(Drip irrigation). This might be because of efficient utilization of irrigation water for better growth of plant.

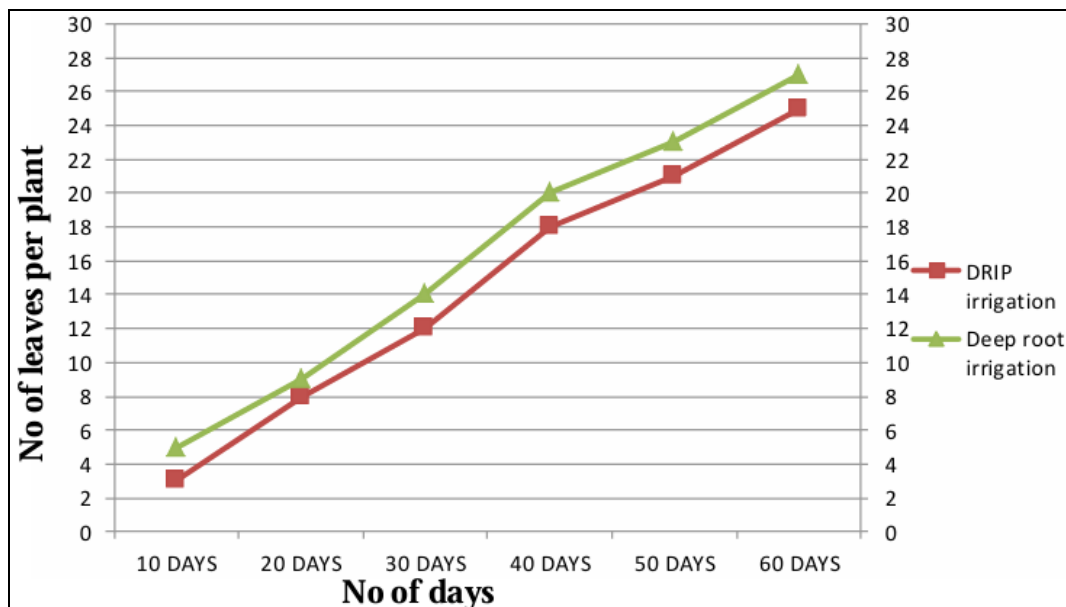


**Fig 9:** No. of leaves per plant at different irrigation treatments

The sowing is done on 23rd April and the plant begins the flowering from 13th May that means 21 days required for flowering from the date of sowing as shown in Fig. 9

### 3.2 Pre and Post-Harvest Observations

The physical and yield parameters of okra were analyzed and presented based on observations from two treatments, namely drip irrigation (T-2) and deep root irrigation (T-3). The average weight of individual fruits, as shown in Table 5, was determined by weighing five randomly selected okra fruits from each treatment separately. It was observed that the average fruit weight was higher in T-3 (28 g) compared to T-2 (22 g), which may be attributed to the direct supply of water to the root zone, promoting stronger root

development and improved nutrient uptake, ultimately enhancing fruit quality and yield. Similarly, fruit length was measured using a measuring tape for five sample fruits, and the average values indicated that fruits from T-3 (15.24 cm) were longer than those from T-2 (12.7 cm). Fruit diameter was also recorded by measuring the widest portion of the fruit, and the results showed a maximum diameter of 1.7 cm in T-3, while T-2 recorded a smaller diameter of 1.4 cm. The increased fruit size in deep root irrigation could be due to better water availability and enhanced metabolic activities, leading to higher cell division and accumulation of carbohydrates and proteins. Fruit colour in both treatments was assessed using a standard colour chart and was found to be bright green.

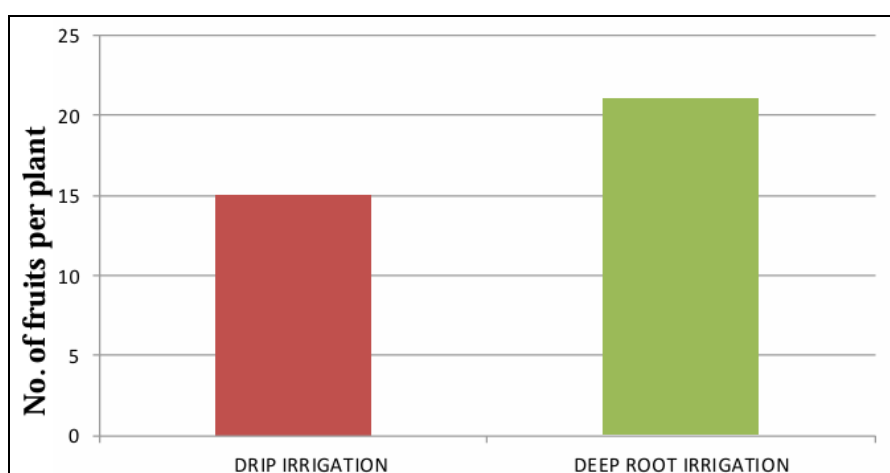


**Fig 10:** Fruits per plant under varying irrigation treatments

In terms of yield parameters, the number of fruits per plant and yield per unit area were evaluated and summarized in Table 6. Harvesting was carried out five times at 10-day intervals after fruit maturity, and the number of fruits from five selected plants was recorded at each picking. The average number of fruits per plant was higher in T-3 (21 fruits) compared to T-2 (16 fruits), indicating better performance under deep root irrigation. Yield per area was calculated by weighing the total produce from each

treatment across all harvests and converting it to kg/m<sup>2</sup>. The results revealed that T-3 produced a higher yield (0.94 kg/m<sup>2</sup>) than T-2 (0.81 kg/m<sup>2</sup>). Overall, the findings suggest that deep root irrigation significantly improved both physical characteristics and yield of okra compared to drip irrigation.

The okra harvested from the two different irrigation treatments i.e., drip irrigation (T-2) and deep root irrigation (T-3) the okra harvested 5 times within the 10 days of

interval. The yields from each area are calculated separately. The yield per area was calculated by taking average of no. of. Harvestings which was highest (0.94 kg/m<sup>2</sup>) in the treatment-3 and it is recorded in the treatment-2 was (0.81

kg/m<sup>2</sup>). This might be because of direct application of water to the healthy root zone of okra crop without any water losses due to evaporation and runoff which affects the growth of fruits.

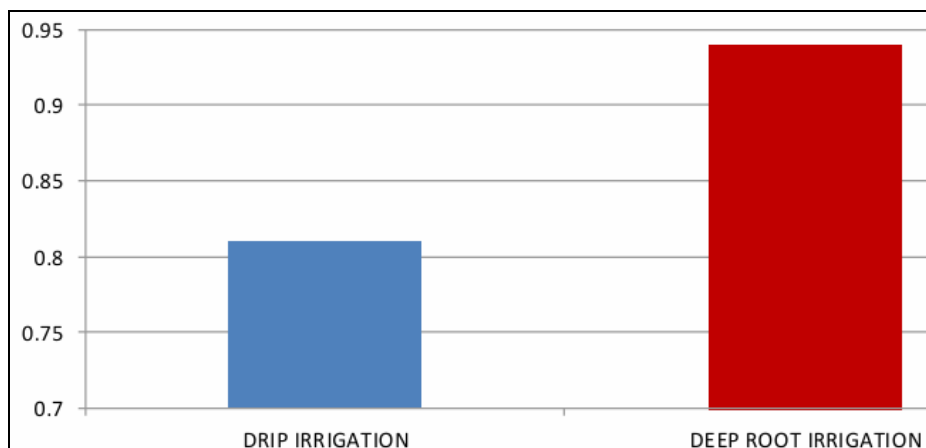


**Fig 11:** Yield per area as influenced by two different irrigation treatments.

#### 4. Conclusion

The present investigation entitled “Performance Evaluation of Deep Root Irrigation for Okra (*Abelmoschus esculentus*) Crop” was conducted during the zaid season at the Research Farm of the Department of Agricultural Engineering, Aditya Engineering College, Surampalem. The study was designed to evaluate the effect of two irrigation methods, namely drip irrigation (T-2) and deep root irrigation (T-3), on the growth and yield parameters of okra. The experimental data were statistically analyzed, and the major findings are summarized as follows.

The results revealed that irrigation methods significantly influenced the growth parameters of okra. The maximum plant height (152 cm) and number of leaves per plant (27) were recorded under deep root irrigation (T-3), whereas the minimum plant height (140.2 cm) and number of leaves per plant (24) were observed under drip irrigation (T-2). Similarly, fruit weight was notably higher under deep root irrigation (28 g) compared to drip irrigation (22 g).

Significant differences were also observed in the physical characteristics of the fruits. The maximum fruit length (15.2 cm) and diameter (1.7 cm) were recorded in T-3, while the minimum fruit length (12.7 cm) and diameter (1.4 cm) were observed in T-2. These improvements in fruit size under deep root irrigation may be attributed to better water availability at the root zone, which enhances nutrient uptake and metabolic activity.

Yield parameters further indicated the superiority of deep root irrigation over drip irrigation. The maximum number of fruits per plant (21) and higher yield per area (0.94 kg/m<sup>2</sup>) were obtained under T-3, whereas drip irrigation (T-2) recorded a lower number of fruits per plant (16) and yield (0.81 kg/m<sup>2</sup>).

Overall, the findings of the study demonstrate that deep root irrigation performed better than drip irrigation in terms of growth, yield, and fruit quality parameters of okra. This improvement can be attributed to the direct and efficient delivery of water to the root zone, which promotes stronger root development, enhances water and nutrient use efficiency, and supports better plant growth. Additionally, the deep root irrigation system facilitates the formation of localized moisture zones (micro-aquifers) around the root

region, ensuring sustained water availability to the crop. Therefore, deep root irrigation can be considered a more effective irrigation method for improving okra productivity under similar agro-climatic conditions.

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