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## Moisture conservation practices in enhancing the productivity of rainfed groundnut

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### Abstract

A study was conducted in sandy-loam soils of the Southern Telangana Zone during the rainfed season in 2018. The main objective of the study was to find out the best soil moisture conservation practices during *kharif* under dry spells. The experiment was conducted in a Randomised Block Design with ten treatments and three replications. The treatments include T<sub>1</sub> (control or farmers practice), T<sub>2</sub> (Use of hydrogel 2.5 kg ha<sup>-1</sup>), T<sub>3</sub> (Mulching with agro-waste @ 5 t ha<sup>-1</sup>), T<sub>4</sub> (Intercultural @ 20 and 40 days after sowing), T<sub>5</sub> (Seed treatment with endophytic bacteria) T<sub>6</sub> (One life-saving irrigation through sprinklers from harvested rainwater) and combination of different treatments like T<sub>7</sub> (T<sub>2</sub> + T<sub>3</sub>), T<sub>8</sub> (T<sub>2</sub> + T<sub>5</sub>), T<sub>9</sub> (T<sub>3</sub> + T<sub>5</sub>), T<sub>10</sub> (T<sub>2</sub> + T<sub>3</sub> + T<sub>5</sub>). During the crop growth period, the crop has experienced 4 dry spells. Due to the long dry spells farmer's practice has recorded the lowest yields and negative net returns i.e. loss (Rs. -2,514/- ha<sup>-1</sup>) and the application of hydrogel @ 2.5 kg ha<sup>-1</sup> alone doesn't have any significant advantage over other treatments. T<sub>10</sub> (T<sub>2</sub> + T<sub>3</sub> + T<sub>5</sub>) recorded higher pod yield (1642 kg ha<sup>-1</sup>), gross returns (Rs.66, 665/- ha<sup>-1</sup>), net returns (Rs.27, 218/- ha<sup>-1</sup>) and B: C ratio (1.69) which is on par with T<sub>9</sub> (T<sub>3</sub> + T<sub>5</sub>) (1582 kg ha<sup>-1</sup>, Rs. 64229/- ha<sup>-1</sup>, Rs. 26157/- ha<sup>-1</sup> and 1.69 respectively). Among individual treatments (T<sub>1</sub> to T<sub>6</sub>), seed treatment with endophytic bacteria recorded higher pod yield (1317 kg ha<sup>-1</sup>), gross returns (Rs.53, 470/- ha<sup>-1</sup>), net returns (Rs.18, 398/- ha<sup>-1</sup>) and B: C ratio (1.52). In conclusion, combination treatments having endophytic bacteria performed better over individual treatments.

**Keywords:** Soil moisture conservation, dry spells, hydrogel, mulching, endophytic bacteria, pod yield, rainfed agriculture

### Introduction

Groundnut is one of the most important oilseed crops in India. It is often known as “King of Oilseeds”. Groundnut is a rich source of edible oil (43-55%) and protein (25-28%). The crop is majorly cultivated in *kharif* as a rainfed crop. India ranks first in Groundnut area under cultivation and is the second largest producer in the world after China with 101 lakh tonnes with productivity of 1863 kg per hectare in 2021-22 ([agricoop.nic.in](http://agricoop.nic.in)). China and India are the largest consumers and exporters of peanuts in the world, accounting for more than 36% of global consumption (APEDA, 2024).

In *kharif* 2022-23, groundnut production was 83.69 lakh tonnes in an area of 45.53 lakh hectares ([agricoop.nic](http://agricoop.nic.in)). Although the crop can be grown in all seasons, *kharif* season production accounts for about 80 % of the total production. More than 90 % of the groundnut area is grown under rainfed conditions. *Kharif* crop is grown during the June-September period in the majority of Gujarat and Maharashtra (APEDA, 2024). Groundnut Productivity in rainfed season is meagre (1498 kg ha<sup>-1</sup>) (APEDA, 2022) when compared to the *rabi* (2500 kg ha<sup>-1</sup>) productivity. One of the main reasons behind the fall in the productivity of the crop is drought. Rainfed groundnut often faces frequent dry spells, erratic, uneven distribution of rainfall cultivation of the crop in marginal and sub-marginal lands, low input management, High insect pest, disease and weed load on the crop. As *kharif* Groundnut is a rain-fed crop, distribution and amount of rainfall play a major role in the crop development at different growth stages. The study aims to identify the best moisture conservation practices in rainfed groundnut to enhance productivity under drought conditions. Soil moisture conservation practices will improve the groundnut quality and productivity of the groundnut crop Varsi *et al* (2024) [2]. According to Danish *et al.*, (2020) [7] and Yasmin *et al.*, (2020) [8]

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organic manures like sugarcane trash and paddy straw has increased soil moisture in the root zone up to 20.1-26.9% on a dry basis. Gajera, J.B et al., (2023) <sup>[4]</sup> revealed that the application of 2.5 kg hydrogel per hectare did not enhance moisture levels and yield of the groundnut crop. Intercultivation will create a dust mulch blocking the capillary movement of water into the atmosphere. Research study by Mallareddy et al (2016) reported that inter-cultivation was resulted in increased soil moisture content in the plant root zone. Wattenbarger et al., (2023) <sup>[16]</sup> and Shree et al (2024) <sup>[1]</sup> revealed the importance of drought tolerance mechanism of endophytic bacteria in groundnut and other crops. A case study on north Eastern Ghats of odhisha revealed the importance of supplemental irrigation in enhancing the crop productivity under rainfed conditions Behara et al (2024) <sup>[3]</sup>.

Research methodology

The trial was conducted at the Regional Agricultural Research Station, Palem during kharif 2018 to assess the performance of different moisture conservation practices. The experiment was conducted in statistical design Randomised Block Design with 10 treatments and 3 replications. The experimental location is sandy loam soil with neutral p H. It had low organic carbon, a low level of available nitrogen (kg ha<sup>-1</sup>), medium levels of

available Phosphorus (kg ha<sup>-1</sup>) and a high level of available Potassium (kg ha<sup>-1</sup>). Groundnut variety kadiri-6 was utilized to conduct this experiment. The study evaluated 6 individual treatments T<sub>1</sub>: control or farmers practice), T<sub>2</sub>: Use of Hydrogel 2.5 kg ha<sup>-1</sup>), T<sub>3</sub>: Mulching with agro-waste @ 5 t ha<sup>-1</sup>, T<sub>4</sub>: Intercultural @ 20 and 40 DAE, T<sub>5</sub>: Seed treatment with endophytic bacteria, T<sub>6</sub>: One life-saving irrigation through sprinklers from harvested rainwater) and 4 combinations of treatments i.e., T<sub>7</sub>(T<sub>2</sub> + T<sub>3</sub>), T<sub>8</sub> (T<sub>2</sub> + T<sub>5</sub>), T<sub>9</sub> (T<sub>3</sub> + T<sub>5</sub>), T<sub>10</sub> (T<sub>2</sub> + T<sub>3</sub>+ T<sub>5</sub>). T<sub>1</sub> farmer's practice is the data collected from the groundnut-growing farmers, T<sub>2</sub> the hydrogel was applied at the time of sowing in line placement to conserve soil moisture, T<sub>3</sub> Paddy straw and groundnut shells were applied a mulch in between the groundnut rows to reduce the evaporation. T<sub>4</sub> intercultural operations were carried out at 20 DAS and 40 DAS to create a dust mulch, T<sub>5</sub> the groundnut seed was treated with endophytic bacteria @ 200 grams/acre. T<sub>6</sub> one life-saving irrigation was given in June 21<sup>st</sup>. Rainfall data was collected daily from the weather station, RARS, Palem to notice dry spells. The crop has received an amount of 381.4 mm rainfall in 29 rainy days as against 464.6 mm of normal rainfall. The crop had experienced 4 long dry spells during the crop growth period. Soil moisture data was recorded at regular intervals at different depths by the gravimetric method of soil moisture estimation.

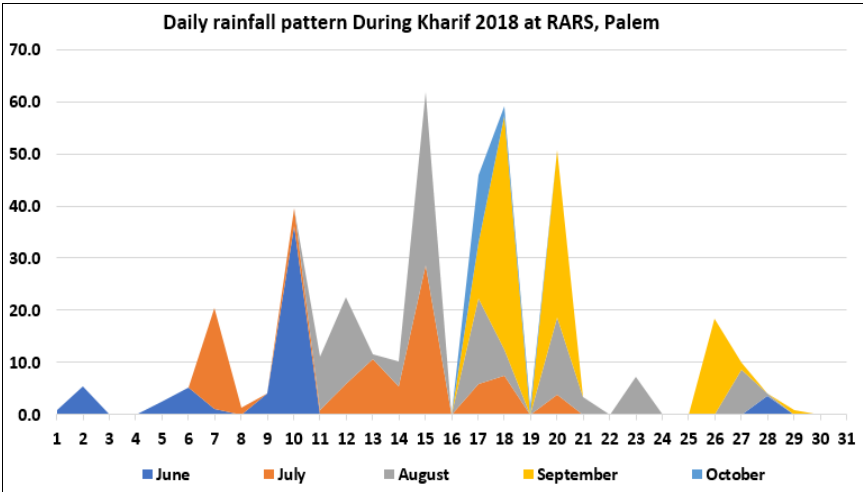


Fig 1: Daily rainfall (mm) recorded during kharif season at RARS, Palem

Results & Discussion  
Plant Growth Parameters

Combined application of hydrogel @ 2.5kg ha<sup>-1</sup>+ mulching with agro-waste @ 5 t ha<sup>-1</sup> and seed treatment with endophytic bacteria recorded higher no. of branches (10.8) over control (6.1) and application of hydrogel @ 2.5kg ha<sup>-1</sup> (7.5) and on par with all other treatments. Number of pods per plant are

significantly higher in Combined application of hydrogel @ 2.5 kg ha<sup>-1</sup>+ mulching with agro-waste @ 5 t ha<sup>-1</sup> and seed treatment with endophytic bacteria (28.4) followed by mulching with agro-waste @ 5 t ha<sup>-1</sup> and seed treatment with endophytic bacteria (26.13) over other treatments. The results are in line with Varsi et al (2024) <sup>[2]</sup>, Danish et al., (2020) <sup>[7]</sup> and Yasmin et al., (2020) <sup>[8]</sup>, Wattenbarger et al., (2023) <sup>[16]</sup> and Shree et al (2024) <sup>[1]</sup>.

Table 1: Effect of different treatments on growth and yield parameters of groundnut harvest

| Treatments      | Treatment Details                                | Plant height (cm) | No. of Branches plant <sup>-1</sup> | No. of pods plant <sup>-1</sup> |
|-----------------|--------------------------------------------------|-------------------|-------------------------------------|---------------------------------|
| T <sub>1</sub>  | Farmers practice                                 | 34.9              | 6.1                                 | 9.40                            |
| T <sub>2</sub>  | Use of Hydrogel 2.5 kg ha <sup>-1</sup>          | 30.5              | 7.5                                 | 10.20                           |
| T <sub>3</sub>  | Mulching with agro-waste @ 5 t ha <sup>-1</sup>  | 33.1              | 8.9                                 | 14.93                           |
| T <sub>4</sub>  | Intercultural @ 20 and 40 DAE                    | 36.8              | 8.3                                 | 14.80                           |
| T <sub>5</sub>  | Seed treatment with endophytic bacteria          | 32.7              | 10.4                                | 23.20                           |
| T <sub>6</sub>  | One life-saving irrigation under dry spells      | 37.7              | 8.1                                 | 17.73                           |
| T <sub>7</sub>  | T <sub>2</sub> + T <sub>3</sub>                  | 31.7              | 9.7                                 | 19.00                           |
| T <sub>8</sub>  | T <sub>2</sub> + T <sub>5</sub>                  | 32.2              | 10.6                                | 23.43                           |
| T <sub>9</sub>  | T <sub>3</sub> + T <sub>5</sub>                  | 30.9              | 9.5                                 | 26.13                           |
| T <sub>10</sub> | T <sub>2</sub> + T <sub>3</sub> + T <sub>5</sub> | 30.8              | 10.8                                | 28.40                           |
| SEm±            |                                                  | 1.79              | 1.06                                | 1.40                            |
| CD at 5%        |                                                  | 5.52              | 3.26                                | 4.31                            |

Yield Parameters and Yield

Regarding pod yield mulching with agro-waste @ 5 t ha<sup>-1</sup> and seed treatment with endophytic bacteria(1582 kg ha<sup>-1</sup>) and Combined application of hydrogel @ 2.5 kg ha<sup>-1</sup>+ mulching with agro-waste @ 5 t ha<sup>-1</sup> and seed treatment with endophytic bacteria(1642kg ha<sup>-1</sup>) are on par with each other and significant over all other treatments where as haulm yield was significantly higher in mulching with agro-waste @ 5 t ha<sup>-1</sup> and seed treatment with endophytic bacteria treatment over other

treatments. With respect to Shelling Percentage application of hydrogel @ 2.5kg ha<sup>-1</sup>+ mulching with agro-waste @ 5 t ha<sup>-1</sup>, application of hydrogel @ 2.5kg ha<sup>-1</sup> and seed treatment with endophytic bacteria, mulching with agro-waste @ 5 t ha<sup>-1</sup> and seed treatment with endophytic bacteria and Combined application of hydrogel @ 2.5 kg ha<sup>-1</sup>+ mulching with agro-waste @ 5 t ha<sup>-1</sup> and seed treatment with endophytic bacteria are on par with each other. Shree et al., (2024)<sup>[1]</sup> and Sounda et al., (2006)<sup>[15]</sup>.

Table 2: Effect of Different treatments on yield and yield parameters of groundnut at Harvest

| Treatments      | Pod Yield (kg ha <sup>-1</sup> ) | Haulm yield (kg ha <sup>-1</sup> ) | Shelling (%) | Test weight (g) |
|-----------------|----------------------------------|------------------------------------|--------------|-----------------|
| T <sub>1</sub>  | 797                              | 1827                               | 57.9         | 32.7            |
| T <sub>2</sub>  | 873                              | 1841                               | 58.5         | 33.1            |
| T <sub>3</sub>  | 1153                             | 2725                               | 61.3         | 34.0            |
| T <sub>4</sub>  | 982                              | 1966                               | 58.9         | 31.1            |
| T <sub>5</sub>  | 1317                             | 3033                               | 62.9         | 35.5            |
| T <sub>6</sub>  | 1114                             | 2489                               | 60.8         | 33.1            |
| T <sub>7</sub>  | 1168                             | 2685                               | 59.2         | 34.2            |
| T <sub>8</sub>  | 1379                             | 2914                               | 63.2         | 33.6            |
| T <sub>9</sub>  | 1582                             | 3147                               | 63.9         | 34.7            |
| T <sub>10</sub> | 1642                             | 3529                               | 65.4         | 36.0            |
| SEm±            | 30.9                             | 28.7                               | 0.6          | 0.9             |
| CD at 5%        | 95.4                             | 88.6                               | 1.9          | 2.8             |

Soil Moisture

Soil Moisture at 30 DAE

Combined application of hydrogel @ 2.5kg ha<sup>-1</sup>+ mulching with agro-waste @ 5 t ha<sup>-1</sup> and seed treatment with endophytic bacteria holding significantly higher soil moisture percent over other treatment at 0-15 cm depth and it is on par with mulching with agro-waste @ 5 t ha<sup>-1</sup> and seed treatment with endophytic bacteria, application of hydrogel @ 2.5 kg ha<sup>-1</sup>+ mulching with agro-waste @ 5 t ha<sup>-1</sup> and seed treatment with endophytic bacteria at 15-30cm and 30-45 cm depth.

agro-waste @ 5 t ha<sup>-1</sup> and seed treatment with endophytic bacteria and application of hydrogel @ 2.5 kg ha<sup>-1</sup>+ mulching with agro-waste @ 5 t ha<sup>-1</sup> are at par with each other and Combined application of hydrogel @ 2.5 kg ha<sup>-1</sup>+ mulching with agro-waste @ 5 t ha<sup>-1</sup> and seed treatment with endophytic bacteria significantly superior over all other treatments.

Soil Moisture at 60 DAE

Combined application of hydrogel @ 2.5 kg ha<sup>-1</sup>+ mulching with agro-waste @ 5 t ha<sup>-1</sup> and seed treatment with endophytic bacteria was on par with other treatments at 0-15 cm, 15-30 cm and 30-45 cm depth. Total soil moisture of the profile 0-45 cm, Combined application of hydrogel @ 2.5 kg ha<sup>-1</sup>+ mulching with

Soil Moisture at 90 DAE & Final Soil Moisture

Soil moisture at different depths shows the trend that Combined application of hydrogel @ 2.5kg ha<sup>-1</sup>+ mulching with agro-waste @ 5 t ha<sup>-1</sup> and seed treatment with endophytic bacteria is holding high soil moisture over other treatments and it is at par with mulching with agro-waste @ 5 t ha<sup>-1</sup> and seed treatment with endophytic bacteria, application of hydrogel @ 2.5 kg ha<sup>-1</sup>+ mulching with agro-waste @ 5 t ha<sup>-1</sup> and mulching with agro-waste @ 5 t ha<sup>-1</sup>. The results are in line with Danish et al., (2020)<sup>[7]</sup> and Yasmin et al., (2020)<sup>[8]</sup>.

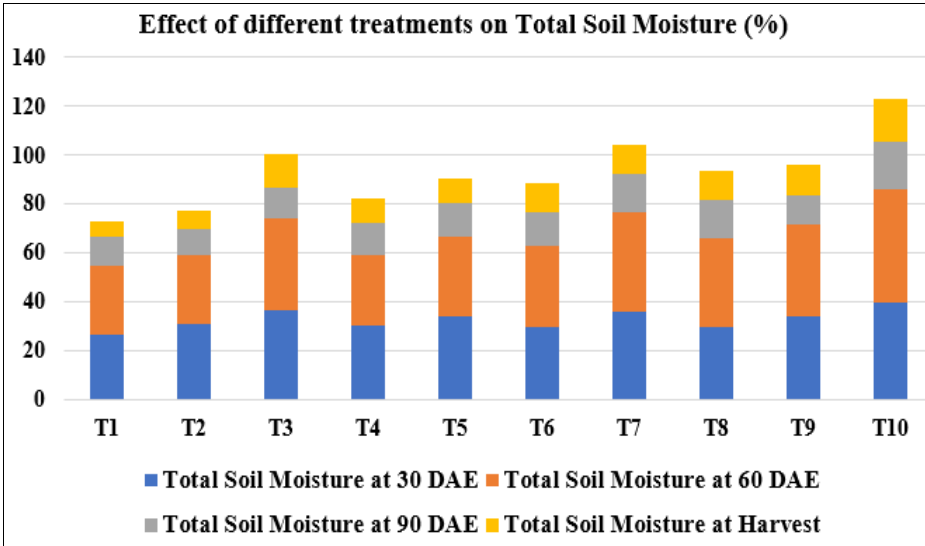


Fig 2: Soil Moisture at 30 DAS, 60 DAS, 90 DAS & at harvest (%) recorded during *kharif* season at RARS, Palem

Economics

Seed treatment with endophytic bacteria being a low-cost input resulted in higher net returns over six treatments. Regarding economics mulching with agro-waste @ 5 t ha<sup>-1</sup> and seed treatment with endophytic bacteria and combined application of

hydrogel @ 2.5 kg ha<sup>-1</sup>+ mulching with agro-waste @ 5 t ha<sup>-1</sup> and seed treatment with endophytic bacteria have recorded higher net returns (27,218 and 26,157 respectively) and B:C ratio (1.69 and 1.69 respectively) over other treatments. Similar results were reported by Gajera et al., (2023)<sup>[4]</sup>.

Table 3: Effect of Different treatments on the economics of groundnut at Harvest

| Treatments      | COC (Rs.) | Gross Returns (Rs.) | Net Returns (Rs.) | B: C ratio |
|-----------------|-----------|---------------------|-------------------|------------|
| T <sub>1</sub>  | 34873     | 32358               | -2514             | 0.93       |
| T <sub>2</sub>  | 36248     | 35444               | -804              | 0.98       |
| T <sub>3</sub>  | 37873     | 46812               | 8939              | 1.24       |
| T <sub>4</sub>  | 36873     | 39869               | 2997              | 1.08       |
| T <sub>5</sub>  | 35073     | 53470               | 18398             | 1.52       |
| T <sub>6</sub>  | 35283     | 45228               | 9946              | 1.28       |
| T <sub>7</sub>  | 39248     | 47421               | 8173              | 1.21       |
| T <sub>8</sub>  | 36448     | 55987               | 19540             | 1.54       |
| T <sub>9</sub>  | 38073     | 64229               | 26157             | 1.69       |
| T <sub>10</sub> | 39448     | 66665               | 27218             | 1.69       |

Conclusion

Dry spells are a very common phenomenon under kharif or rainfed farming. The present study observed that, under rainfed conditions, soil moisture conservation practices can help to increase the productivity of the groundnut crop. Hydrogel @ 2.5 kg ha<sup>-1</sup> was not an effective practice as the cost incurred towards the hydrogel was higher over other treatments. Seed treatment with endophytic bacteria helped to overcome drought as endophytic bacteria will release phytohormones under drought conditions to reduce the negative impact of drought on groundnut crop productivity. One life-saving irrigation couldn't save the crop from drought as the crop has experienced severe water stress throughout the crop growth period. T<sub>10</sub> (T<sub>2</sub> + T<sub>3</sub>+ T<sub>5</sub>) combined application of hydrogel @ 2.5kg ha<sup>-1</sup>+ mulching with agro-waste @ 5 t ha<sup>-1</sup> and seed treatment with endophytic bacteria recorded higher pod yield (1642 kg ha<sup>-1</sup>), gross returns (Rs.66,665/- ha<sup>-1</sup>), net returns (Rs.27,218/- ha<sup>-1</sup>) and B: C ratio (1.69) which is on par with T<sub>9</sub> (T<sub>3</sub> + T<sub>5</sub>) (1582 kg ha<sup>-1</sup>, Rs. 64229/- ha<sup>-1</sup>, Rs. 26157/- ha<sup>-1</sup> and 1.69 respectively).

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Authors Contribution

Authors K. Mamatha conducted the trial. Authors G. Seshu provided his valuable suggestions in providing need-based inputs to the farmers. Authors M. Venkata Ramana and K. Avil Kumar monitored the trial and provided support as senior members.

Disclaimer

I declare that NO generative AI technologies such as large language models and text-to-image generators have been used during the writing or editing of this manuscript.

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