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# Yield and economics of soybean (*Glycine max* L.) as influenced by moisture stress management practices under rainfed condition

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**Abstract**
During the *Kharif*, 2022-23, an agronomical study was carried out at the Agronomy Experimental Farm, College of Agriculture, Latur, to assess the yield and economics of soybean (*Glycine max* L.) as affected by moisture stress management practices under rainfed conditions. The experimental layout used a randomized block design (RBD) with eight treatments and three replications. The treatments were: $T_1$ - Control, $T_2$ - Straw mulching at 2.5 tons $ha^{-1}$, $T_3$ - Straw mulching at 5.0 tons $ha^{-1}$, $T_4$ - Hydrogel at 2.5 kg $ha^{-1}$, $T_5$ - Potassium nitrate at 2% during the pre-flowering stage, $T_6$ - Potassium nitrate at 2% during both the pre- flowering and pod development stages, $T_7$ - Kaolin at 5% during the pre- flowering stage, and $T_8$ - Hoeing at 20 days post-sowing. The gross plot area was 5.4 m x 4.5 m, whereas the net plot size was 4.5 m x 3.9m. On July 9, 2022, soybeans were seeded using the dibbling method at a seed rate of 65 kg/ha. The crop's recommended fertilizer dose (RDF) was 30:60:30 kg NPK per hectare. $T_4$-hydrogel treatment at 2.5 kg $ha^{-1}$ significantly improved yield characteristics, including number of seed plants (81.76), seed yield (2805 kg $ha^{-1}$), straw yield (3381 kg $ha^{-1}$), biological yield (6186 kg $ha^{-1}$), and cost-effectiveness in terms of GMR (110811), NMR (73977), and B:C ratio (3.01).

**Keywords:** Soybean, *Glycine max* L., moisture stress management, rainfed conditions

## Introduction

Soybean (*Glycine max* L.) is unquestionably the most widely grown species in the Fabaceae family. It is a significant legume crop that produces essential oils and proteins for human and animal consumption. Soybean seeds contain about 18-22% cholesterol-free oil, with 85% unsaturated fatty acids, 40-45% protein, 24-26% carbs, and a variety of micronutrients. As the world's leading oilseed crop, soybeans serve an important role in meeting the nutritional needs of both humans and cattle (Abd El-Aal *et al*., 2017) [1].

Straw mulching has been proven to reduce maximum soil temperature while raising minimum soil temperature in the seed zone, hence retaining soil moisture and boosting the rate and final count of seedling emergence (Kitoh and Yoshida, 1996) [5]. Potassium, as found in potassium nitrate, plays an important role in avoiding water loss by regulating stomatal activity, which controls plant transpiration. This mechanism reduces the plant's water requirement while increasing its resistance to water stress. Furthermore, potassium boosts plant resilience to a variety of abiotic stimuli, including heat, frost, and biotic challenges, such as mold and mildew in soybeans. It also aids in the efficient use of phosphorus and other important elements. Kaolin, a chemically inert, non-abrasive, and non-toxic white mineral, readily dissolves in water. When applied as a suspension to leaf surfaces, the water evaporates, leaving a protective particle coating (Cantore *et al*., 2009) [3]. This use can reduce reactive oxygen species (ROS) and limit hydroxyl radical formation by enhancing the production of antioxidant substances such phenolics, flavonoids, and anthocyanins (Dinis *et al*., 2016) [4]. Water stress at critical growth stages like as germination, flowering, and pod development can significantly reduce the plant's ability to absorb nutrients, perform photosynthesis, and produce biomass. Even brief durations of water deficit in soybean can result in considerable losses in seed size, pod number, and overall output.

Thus, regulating water stress is crucial for achieving optimal growth and yield potential. In view of the aforementioned factors, attempts were made to conduct a field experiment titled "Yield and economics of soybean (*Glycine max* L.) as influenced by moisture stress management practices under rainfed condition".

## Materials and Methods

The field experiment was carried out in *kharif* 2022 on medium to deep black soil at the College of Agriculture in Latur. The experimental design was RBD with three replications and eight treatments, which were assigned at random in each replication. The experimental site had a clay-like texture and a slightly alkaline pH. The soil in the experimental plot had a clayey texture, low available nitrogen (231 kg $ha^{-1}$), medium available phosphorus (16.90 kg $ha^{-1}$), and extremely high accessible potassium (434 kg $ha^{-1}$). The soil was well-drained and capable of retaining water. Sowing occurred on July 9, 2022, with harvesting taking place on October 18, 2022.

The treatments were: $T_1$ - Control, $T_2$ - Straw mulching at 2.5 tons $ha^{-1}$, $T_3$ - Straw mulching at 5.0 tons $ha^{-1}$, $T_4$ - Hydrogel at 2.5 kg $ha^{-1}$, $T_5$ - Potassium nitrate at 2% during the pre-flowering stage, $T_6$ - Potassium nitrate at 2% during both the pre-flowering and pod development stages, $T_7$ - Kaolin at 5% during the pre-flowering stage, and $T_8$ - Hoeing at 20 days post-sowing. Dibbling method was used for sowing of soybean variety MAUS-158 with the seed rate of 65 kg $ha^{-1}$ & 30:60:30 NPK kg $ha^{-1}$ RDF. The gross & net plot size of experiment was 5.4 m × 4.5 m, 4.5 m × 4.2 m respectively.

## Results and Discussion Yield studies

The yield parameters of soybean, such as the number of seeds pod-1, the number of seeds plant-1, the pod weight plant-1, the seed weight plant-1, the seed yield, the straw yield, and the biological yield, were significantly affected by various treatments (Table 1). When hydrogel was applied at 2.5 kg $ha^{-1}$ ($T_4$), the highest values were recorded for the number of seeds pod-1 (2.80), number of seeds plant-1 (81.76), pod weight plant-1 (12.21 g), seed weight plant-1 (9.20 g), seed yield (2805 kg $ha^{-1}$), straw yield (3381 kg $ha^{-1}$), and biological yield (6186 kg $ha^{-1}$). This treatment beat the other treatments by a large margin and was statistically comparable to the application of straw mulching at 5.0 tons $ha^{-1}$ ($T_3$) and potassium nitrate at 2% during the pre- flowering and pod development stages ($T_6$). Furthermore, at crucial growth phases, the application of Hydrogel at 2.5 kg $ha^{-1}$ ($T_4$) produced the highest harvest index (45.35%) and test weight (115.47 g), which was followed by the application of potassium nitrate at 2% ($T_6$) and straw mulching at 5.0 tons $ha^{-1}$ ($T_3$). These results align with the conclusions published by Rajanna *et al.* (2022) [6], Fidelis *et al.* (2018), and Ali and Abdel-Aal (2021) [2].

## Economics

The results from table 2 demonstrated that soybean economics, comprising gross and net monetary returns, as well as the Benefit-Cost (B:C) ratio, were considerably altered by different treatments. The mean gross return was ₹ 95,228 $ha^{-1}$, the highest return observed in the ($T_4$) Hydrogel @ 2.5 kg $ha^{-1}$ treatment (₹ 1,10,811 $ha^{-1}$), which was at par with $T_3$ (Straw mulching at 5.0 tons $ha^{-1}$) and $T_6$ (Potassium nitrate at 2% during both the pre-flowering and pod development stages) but significantly superior to the other treatments. The mean net monetary return was ₹ 58,853 $ha^{-1}$, treatment ($T_4$) Hydrogel @ 2.5 kg $ha^{-1}$ likewise showed the highest net return of ₹ 73,977 $ha^{-1}$, again at par with $T_3$ and $T_6$. The mean B:C ratio was 2.62, with ($T_4$) Hydrogel @ 2.5 kg $ha^{-1}$ producing the greatest ratio (3.01), while the control ($T_1$) recorded the lowest (2.49). These findings are congruent with the results reported by Rajanna *et al.* (2022) [16].

**Table 1:** Effect of different treatments on yield and yield attributing characters of soybean

| Treatments | No. of seeds $plant^{-1}$ | Pod yield $plant^{-1}$ (g) | Seed yield $plant^{-1}$ (g) | Seed yield (Kg $ha^{-1}$) | Straw yield (Kg $ha^{-1}$) | Biological yield (Kg $ha^{-1}$) | Harvest index (%) |
|---|---|---|---|---|---|---|---|
| $T_1$: Control | 72.82 | 9.84 | 6.20 | 1752 | 2841 | 4593 | 38.15 |
| $T_2$: Straw mulching @2.5 ton $ha^{-1}$ | 74.00 | 11.41 | 6.63 | 2350 | 3202 | 5590 | 42.04 |
| $T_3$: Straw mulching @5.0 ton $ha^{-1}$ | 79.76 | 11.78 | 8.01 | 2663 | 3375 | 6038 | 42.54 |
| $T_4$: Hydrogel @2.5 kg $ha^{-1}$ | 81.76 | 12.21 | 9.20 | 2805 | 3381 | 6186 | 45.35 |
| $T_5$: Potassium nitrate @ 2% at pre flowering stage | 75.81 | 11.56 | 7.12 | 2433 | 3279 | 5712 | 42.59 |
| $T_6$: Potassium nitrate @ 2% at pre flowering stage and pod development stage | 77.08 | 7.33 | 24.89 | 2568 | 3334 | 5902 | 45.12 |
| $T_7$: Kaolin @ 5% at pre flowering stage | 73.47 | 6.44 | 17.13 | 2280 | 3200 | 5480 | 41.61 |
| $T_8$: Hoeing at 20 days after sowing | 74.94 | 6.94 | 19.88 | 2400 | 3255 | 5655 | 42.44 |
| S.E. (m) ± | 1.72 | 0.67 | 1.19 | 115 | 120 | 195 | - |
| C.D. at 5% | 5.02 | 1.97 | 3.47 | 337 | 353 | 594 | - |
| General Mean | 76.20 | 7.23 | 21.72 | 2410 | 3233 | 5780 | 42.48 |

**Table 2:** Effect of different treatments on economics of soybean

| Treatments | Economics (₹ $ha^{-1}$) | | | | |
|---|---|---|---|---|---|
| | Seed yield (Kg $ha^{-1}$) | GMR | CC | NMR | B:C ratio |
| $T_1$: Control | 1752 | 69204 | 27752 | 41452 | 2.49 |
| $T_2$: Straw mulching @2.5 ton $ha^{-1}$ | 2350 | 92825 | 36575 | 56250 | 2.54 |
| $T_3$: Straw mulching @5.0 ton $ha^{-1}$ | 2663 | 105189 | 39075 | 66114 | 2.69 |
| $T_4$: Hydrogel @2.5 kg $ha^{-1}$ | 2805 | 110811 | 36834 | 73977 | 3.01 |
| $T_5$: Potassium nitrate @ 2% at pre flowering stage | 2433 | 96104 | 36360 | 59744 | 2.64 |
| $T_6$: Potassium nitrate @ 2% at pre flowering stage and pod development stage | 2568 | 101449 | 38160 | 63289 | 2.66 |
| $T_7$: Kaolin @ 5% at pre flowering stage | 2280 | 90060 | 39588 | 50472 | 2.27 |
| $T_8$: Hoeing at 20 days after sowing | 2400 | 94800 | 35270 | 59530 | 2.69 |
| SE ± | 115 | 4312 | - | 4734 | - |
| CD @ 5% | 337 | 12615 | - | 13848 | - |
| Grand mean | 2406 | 95228 | 36202 | 58853 | 2.62 |

## Conclusion

In conclusion, the application of Hydrogel @ 2.5 kg ha⁻¹ ($T_4$) greatly improved soybean yield parameters, including the number of seeds per pod, number of seeds per plant, pod and seed weight, as well as overall seed, straw, and biological yield. This treatment was comparable to straw mulching at 5.0 tons ha⁻¹ ($T_3$) and Potassium nitrate at 2% ($T_6$) applied at key growth stages but was significantly superior to other treatments. Additionally, the Hydrogel treatment ($T_4$) offered the highest gross and net monetary returns, along with the best Benefit-Cost (B:C) ratio, demonstrating its economic viability. These results are corroborated by earlier studies, reinforcing the effectiveness of Hydrogel in enhancing soybean yield and profitability.

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