J. Agric. Res. Technol., 49 (2) : 310-314 (2024)

Economics of Soybean Cultivation Underoverhead Sprinkler Irrigation

R. A. Baglane[1], M. S. Mane[2], D. D. Khedkar[3] and K. D. Kale[4]
Inter faculty Dept. of Irrigation Water Management, Mahatma PhulekrishiVidyapeeth, Rahuri - 413 722 (India)
Corresponding author's Email : renukabaglane@gmail.com
(Received : 02.02.2024 Accepted : 04.03.2024)

Abstract

The field experiment on economics of soybean cultivation under overhead sprinkler irrigation was conducted during the year 2021-2022. The study was carried out in randomized block design with ten treatments replicated three times. Soybean crop was planted by hand dibbling at 45 x 10 cm spacing. The experiment comprised of treatments *viz*., T_1 - No N, P and 100% RD of K, T_2 - 100% RD of NPK, T_3 - 75% RD of NPK, T_4 - 50% RD of NPK, T_5 - T_3 + ST + Foliar Spray of Nano DAP @ 2 ml lit^{-1} at 35 DAS, T_6 - T_3 + ST + Foliar Spray of Nano DAP @ 4 ml lit^{-1} at 35 DAS, T_7 - T_4 + ST + Foliar Spray of Nano DAP @ 2 ml lit^{-1} at 35 DAS, T_8 - T_4 + ST + Foliar Spray of Nano DAP @ 4 ml lit^{-1} at 35 DAS, T_9 - T_4 + ST + Foliar Spray of Nano DAP @ 2 ml lit^{-1} at 35 and 55 DAS, T_{10} - T_4 + ST + Foliar Spray of Nano DAP @ 4 ml lit^{-1} at 35 and 55 DAS, (ST- seed treatment with Nano DAP @ 5 ml kg^{-1} of seed, DAS- day after sowing). The overhead sprinkler irrigation was used for irrigation in dry spell. The total consumptive water use in the form of crop evaporation was 293.0 mm. The significantly higher yield of soybean was recorded treatment of T_2 (33.80 q ha^{-1}), however it was at par with the treatment T_6 (32.67 q ha^{-1}) and treatment T_5 (31.19 q ha^{-1}). The data revealed that the maximum value of WUE i.e., 114.58 kg ha-1 mm^{-1} was obtained in treatmentT_2 were applied followed by T_6 (110.61 kg ha^{-1} mm^{-1}) and T_5 (105.69 kg ha^{-1} mm^{-1}).The treatment T_2 resulted into maximum productivity of Rs.570.6 per mm of water used followed by T_6 (Rs. 546.9 per mm). In terms of economics, the treatment T_2 was profitable with higher net seasonal income of Rs. 168335 ha^{-1} followed by T_6 (Rs. 161325 ha^{-1}) and T_5 (Rs. 152130 ha^{-1}). The maximum value of B: C ratio was observed in treatment T_2 (4.28) followedby T_6 (4.18) and T_5 (4.01). On the basis of the results obtained, it can be concluded that over head sprinkler irrigation with 75% RDF Seed Treatment + Foliar Spray of Nano DAP @ 2 ml lit^{-1} at 35 DAP as per growth stages is the best treatment for higher yield, and monetary returns from soybean crop.

Key words : Soybean, foliar spray, yield, economic evaluation and B:C ratio.

Soybean also called as Golden bean, is one of the most ancient crops popularlegume crop in India and cultivated in other tropical and sub-tropical regions of the world.In India, soybean cover 120 million hectares and produce 105 million tonnes. Maharashtra and Madhya Pradesh dominate soybean production in India, accounting for 89 percent of total production. The biggest soybean-growing states in India are Madhya Pradesh, Maharashtra, and Rajasthan is reported to be 111 thousand hectares. In semiarid and arid climatic conditions, increasing agricultural production is mainly dependent on irrigation. As known, the conventional irrigation methods (surface irrigation) use much more water as compared to the pressurized irrigation systems such as sprinkler and drip irrigation. Increasing food demand and decreasing water resources have composed a kind of pressure to find new technologies for efficient use of water and fertilizer for agriculture. In addition, protection of soil and water resources and environmental sustainability are other crucial factors to be considered. Thus, efficient and less water and fertilizer use is significantly important in terms of environmental protection (Oron *et al*., 2003).

1. Student (M.Sc (Agri.), 2. Head, 3. and 4. Assistant Professor.

Foliar treatment is more effective than traditional fertilizersbecause it comes into direct touch with the leaves and is taken up by the target organs, resulting in a more targeted and immediate response. Nano fertilizers are more reactive and may pierce the cuticle, allowing for regulated release and delivery. Foliar feeding has been shown to be the most efficient way of correcting nutrient deficiencies and increasing crop yield and quality. It also reduces pollution and improves nutrient utilization by reducing the amount of fertilizers applied to the soil. Even though leaves allow for gas exchange, their cuticle prevents things from penetrating (Schwab *et al*. 2015)

Nano fertilizers are products that help to boost nutrient efficiency on a nanometer scale in the form of nano particles. In comparison to conventional granular fertilizer, the particle size of liquid nano fertilizer is smaller than 30 nanometers. Due to its super tiny size and surface qualities, it has around 10000 times more surface area to volume size, allowing for easier penetration in leaves. Nano fertilizers are smaller than plant cells (10,000 to 30,000 nm), allowing for easier absorption and increased efficiency. It cuts the amount of conventional fertilizer needed by half or more (Al- jutheryet *al*.,2018). It takes less time and generates more. Environmentally friendly products can assist solve global warming concerns by improving soil, air, and water quality. Traditional fertilizers are more expensive. Cut your input costs. Traditional fertilizers are more expensive. Farmers' input costs are reduced, resulting in increased income. Increases crop yield, soil health, and produce nutritional quality. Traditional fertilizers are more expensive. Farmers' input costs are reduced, resulting in increased income. Increases crop yield, soil health, and produce nutritional quality.

Overhead sprinkler irrigation is a method of pressurized irrigation in which releases water similar to rainfall through a small diameter nozzle placed in pipes. water is distributed through a system of pipes, sprayed into air and irrigate in most of the soil type due to wide range of discharge capacity (Zakari *et al*., 2012). High water distribution uniformity with a low precipitation rate, low operating pressure. Flow rate is 60-70% lower than that conventional sprinklers. Hence the study was planned to study the yield and economics of soybean as influenced by nano DAP.

Materials and Methods

Experimental Site : A field experiment conducted at the Research Farm of Interfaculty Department of Irrigation water Management, Post Graduate Institute, Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist. Ahmednagar, Maharashtra, India, during summer season of 2021-2022 Geographically, the central campus of Mahatma PhuleKrishiVidyapeeth, Rahuri situated between 19°00' and 19° 57' N latitude and between 74° 19' and 74° 32' E longitude. The altitude is 495 to 555 m above the mean sea level.

Soil and climate : Climatologically, the area falls under semi-arid and subtropical zone. The topography of experimental field was uniform and leveled. The soil of experimental field was well drained with 45 cm soil depth. Representative and composite soil sample was collected from experimental site for assessing the initial soil fertility status of the soil. The infiltration rate of the soil was 3.15 cm hr^{-1}.The soil was slightly alkaline in reaction (pH 7.9). The soil was low in available nitrogen (168 kg ha^{-1}), medium in available phosphorus (18 kg ha^{-1}) and high in available potassium (334.00 kg ha^{-1}). The mean values of moisture constants *viz*., field capacity and permanent wilting point were 30.4% and 16.7%, respectively. The bulk density of soil was 1.21 Mg m^{-3}.

Treatment details : The experiment comprised of ten treatments, T_1 - no N,P and 100% RD of K, T_2 - 100% RD of NPK, T_3 - 75% RD of NPK, T_4 - 50% RD of NPK, T_5 - T_3 + ST + Foliar Spray of Nano DAP @ 2 ml lit^{-1} at 35 DAS, T_6 - T_3 + ST + Foliar Spray of Nano DAP @ 4 ml lit^{-1} at 35 DAS, T_7 - T_4 + ST + Foliar Spray of Nano DAP @ 2 ml lit^{-1} at 35 DAS, T_8 - T_4 + ST + Foliar Spray of Nano DAP @ 4 ml lit^{-1} at 35 DAS, T_9 - T_4 + ST + Foliar Spray of Nano DAP @ 2 ml lit^{-1} at 35 and 55 DAS, T_{10} - T_4 + ST + Foliar Spray of Nano DAP @ 4 ml lit^{-1} at 35 and 55 DAS, (ST- seed treatment with Nano DAP @ 5 ml kg^{-1} of seed, DAS- day after sowing).

Nature of season during experimental period : The sowing of the crop was done in kharif season with a spacing of 45 x 10 cm. The mean maximum temperatures during experimentation ranged between 30 to 40.6 0C, while mean minimum temperatures ranged between 14.7 to 26.9°C.

Method of Irrigation : Overhead irrigation includes all the systems that provide water to the plants in the form of sprays or bucket system. This category is the most used system in the field where there is a lot of plants to be irrigated. It also holds a unique advantage of washing off the dust and fungal debris that may be attached to the foliar plant parts. The spray irrigation system is restricted by the need of power to pump the water in a high-pressure pipe that will deliver the showers to the crops. Overhead irrigation also reduces the temperatures that the irrigated crops are exposed to, which is beneficial in areas where temperatures may exceed the survival threshold of certain crops. There are many varieties of the overhead irrigation methods. Farmers usually have their own design that are based on their objective or circumstances that they face on the farm.The overhead sprinkler irrigation is applied according to amount of water required is calculated with the help of reference evapotranspiration and crop coefficient.

Economic analysis

Cost of Cultivation : The total cost of cultivation was worked out by adding the system cost and operational cost of the respective treatment. The system cost and operating cost of each treatment were added to determine the overall cost of cultivation. The different farm assets, including machinery, land, and implements, are assessed based on going market prices. The primary crop product and the crop's byproduct, valued at market prices, are both

Table 1. Yield of soybean

Treatments	Water applied (mm)	Water use efficiency (Kg ha^{-1} mm)	Yield of soybean (q ha^{-1})
T_1 - Control (No N and P; 100% RD of K)	293	69.49	20.50
T_2 - 100% RDF of NPK	293	114.54	33.80
T_3 - 75% RDF of NPK	293	94.58	27.90
T_4 - 50% RDF of NPK	293	78.51	23.67
T_5 - T_3 + ST + Foliar spray of Nano DAP @ 2 ml lit^{-1} at 35 DAS	293	105.69	31.19
T_6 - T_3 + ST + Foliar spray of Nano DAP @ 4 ml lit^{-1} at 35 DAS	293	110.61	32.67
T_7 - T_4 + ST + Foliar spray of Nano DAP @ 2 ml lit^{-1} at 35 DAS	293	85.76	25.27
T_8 - T_4 + ST + Foliar spray of Nano DAP @ 4 ml lit^{-1} at 35 DAS	293	87.80	25.80
T_9 - T_4 + ST +Two foliar sprays of Nano DAP @ 2 ml lit^{-1} at 35 and 55 DAS	293	91.69	27.43
T_{10} - T_4 + ST +Two foliar sprays of Nano DAP @ 4 ml lit^{-1} at 35 and 55 DAS	293	93.56	27.80

included in the assessment of farm output. During the growth season, the farm inputhuman labour, family labour, and bullock labor-are assessed based on market rates. The actual cost of the rental machine is included in the prices. However, the cost of equipment maintenance which includes fuel costs, electricity bills, and repair costsis taken into account for owned machinery. To determine the entire cost, divide it by the machine's productive working hours.Real rates are used to analyse the costs associated with seeds, manure, fertilisers, pesticides, and field operations expenses.

Net Seasonal Income : Net seasonal income was worked out by subtracting the cost of production from the gross returns for each treatment.

Benefit-cost ratio

Benefit : cost ratio was calculated for each treatment by using following equation.

$$\text{Benefit:cost ratio} = \frac{\text{Gross income (Rs. Ha}^{-1})}{\text{Total cost of cultivation (Rs. ha}^{-1})}$$

Results and Discussion

Yield of crop : The soybean grain yield details are revealed that the treatment T_2 (100% RD of NPK) recorded significantly maximum grain yield (33.80 q ha^{-1}) over all other treatments. However it was at par with T_6 (T_3 + ST + Foliar Spray of Nano DAP @ 4 ml lit^{-1} at 35 DAS) i.e (32.63 q ha^{-1}) and T_5 (T_3 + ST + Foliar Spray of Nano DAP @ 2 ml lit^{-1} at 35 DAS) i.e. (31.18 q ha^{-1}). The minimum grain yield 20.50 q ha^{-1}, was observed in T1 (no NP and 100%). These results are in agreement with Fageria *et al*., (2009) reported that yield response of soybean to foliar application of macro and micronutrients.

Water applied : The overhead sprinkler was used for irrigation in dry spell. The total consumptive water use in the form of crop evaporation was 293.0 mm.

Water use efficiency : The drip irrigation method of irrigation used 293 mm of water. The maximum water use efficiency of 114.58 kg ha^{-1} mm^{-1} was recorded in treatment T_2 followed by the treatment T_6 (110.61 kg ha^{-1} mm^{-1}) and T_5 (105.69 kg ha^{-1} mm^{-1}). The maximum water use efficiency is found to be maximum in treatment T_2 is might be due to the yield of the crop. Because it recorded the higher yield than any other treatments.Gawade*et*

Table 2. Economics of soybean as influenced by different treatments

Treatments	Seasonal cost of cultivation (Rs. ha^{-1})	Net seasonal income (Rs.ha^{-1})	B:C	Water productivity (Rs. mm^{-1})
T_1 - Control (No N and P; 100% RD of K)	45951	87299	2.90	295.9
T_2 - 100% RDF of NPK	51365	168335	4.28	570.6
T_3 - 75% RDF of NPK	49644	131706	3.65	446.5
T_4 - 50% RDF of NPK	47935	102215	3.13	346.5
T_5 - T_3 + ST + Foliar spray of Nano DAP @ 2 ml lit-1 at 35 DAS	50540	152130	4.01	515.7
T_6 - T_3 + ST + Foliar spray of Nano DAP @ 4 ml lit-1 at 35 DAS	50770	161325	4.18	546.9
T_7 - T_4 + ST + Foliar spray of Nano DAP @ 2 ml lit-1 at 35 DAS	48831	115619	3.37	391.9
T_8 - T_4 + ST + Foliar spray of Nano DAP @ 4 ml lit-1 at 35 DAS	49727	118623	3.39	402.1
T_9 - T_4 + ST +Two foliar sprays of Nano DAP @ 2 ml lit-1 at 35 and 55 DAS	49727	126098	3.54	427.5
T_{10} - T_4 + ST +Two foliar sprays of Nano DAP @ 4 ml lit-1 at 35 and 55 DAS	51519	127881	3.48	433.2

al.,(1998) reported results which are close to these observations.

Cost economics : The data regarding the economics of the soybean is presented in the Table 2. The cost of cultivation is found maximum in the treatment T_{10} (Rs. 51519 ha^{-1}) followed by treatment T_2 (Rs. 51365 ha^{-1}). The lowest cost of cultivation is recorded in the treatment T_1 (Rs. 45951 ha^{-1}).

B:C ratio : When the B:C ratio is greater than the treatment is said to be profitable and if it is less than 1, then treatment shows more expenditure than income i.e. not profitable and if its valueis 1 then there is no loss or profit. The B:C ratio was improved under different treatments with foliar sprays of Nano fertilizers. The maximum value of B: C ratio was observed in treatment T_2 (100% RDF of NPK) followed by T_6 (T_3 + ST + Foliar spray of Nano DAP @ 4 ml lit^{-1} at 35 DAS) i.e., 4.18. the lowest B:C ratio was observed in control treatment.

Water productivity : The treatment T_2 resulted into maximum productivity of Rs.570.6 per cm of water used followed by T6(75% RDF of NPK + ST + Foliar spray of Nano DAP @ 4 ml lit^{-1} at 35 DAS) resulted into maximum water productivity of Rs. 546.9per cm whereas the treatment T_1 (No N &P and 100% RD of K) resulted into lowest water productivity of Rs. 295.9 per cm of water.

Conclusions

The significantly maximum yield (33.80 q ha^{-1}) of soybean was obtained in treatment T_2 (100% RDF of NPK) over all other treatments, however, it was at par with T_6 (T_3 + ST + Foliar Spray of Nano DAP @ 4 ml lit^{-1} at 35 DAS)i.e 32.67 q ha^{-1}, T_5 (T_3 + ST + Foliar Spray of Nano DAP @ 2 ml lit^{-1} at 35 DAS) i.e 31.19 q ha^{-1}. The treatment T_2 (100% RDF of NPK) resulted into higher net seasonal income (Rs.168335 ha^{-1}), B:C ratio (4.28), and water productivity (Rs. 570.6 mm^{-1}) as compared to other treatments.

On the basis of the results obtained, it can be concluded that overhead sprinkler irrigation with 75% RDF and foliar spray of nano DAP@ 2 ml lit^{-1} at 35 DAS is the best treatment for higher yield, optimum water use, B:C ratioand net seasonal income from soybean crop.

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