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RESPONSE OF DAP AND NANO DAP FOLIAR SPRAYS ON YIELD AND ECONOMICS OF *KHARIF* SOYBEAN (*Glycine max* L. Merrill) IN SUB-MONTANE ZONE OF MAHARASHTRA INDIA

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The field experiment was conducted at Research farm, Agronomy section, Rajarshree Chhatrapati Shahu Maharaj college of Agriculture, Kolhapur (Maharashtra), India during the *kharif* season of 2023. The experiment was laid out in randomized block design with eleven treatments replicated three times and conducted with aim of studying the "Response of DAP and Nano DAP Foliar Sprays on Yield and Economics of *kharif* Soybean (*Glycine max* (L.) Merrill) in Sub-Montane Zone of Maharashtra." The soybean variety *Phule Sangam* (KDS 726) was sown by the method of dibbling.

The maximum value of yield attributes was observed in 100% RDF with foliar spray of 4% DAP at 35 and 55 DAS which was No. of Pods (49.75 plant⁻¹), Weight of pods (23.92 g Plant⁻¹), No. of Seeds (2.72 Pod⁻¹), No. of Seeds (121.50 plant⁻¹), Seed Weight (16.66 g Plant⁻¹), 100 Seed Weight (13.99 g). 100% RDF along with foliar spray of 4% Nano DAP and 100% RDF along with foliar spray of 2% DAP shows at par result with it.

Seed yield, straw yield and harvest index observation taken after harvesting. Significantly superior seed yield (35.52 q ha⁻¹) and straw yield (43.14 q ha⁻¹) observed in the treatment 100% RDF with foliar spray of 4% DAP which was followed by 100% RDF along with foliar spray of 4% Nano DAP and 100% RDF along with foliar spray of 2% DAP at 35 and 55 DAS. Highest harvesting index observe in 100% RDF along with foliar spray of 2% DAP at 35 and 55 DAS.

The treatment with GRDF, which includes FYM application, incurred the highest cultivation cost of Rs 86,215/- ha⁻¹. The highest gross monetary return of Rs 1,72,025/- ha⁻¹ was achieved with the 4% DAP foliar spray combined with 100% RDF, with similar returns observed for treatments using 4% Nano DAP and 2% DAP alongside 100% RDF. The 4% DAP foliar spray with 100% RDF also yielded the highest net monetary return of Rs 1,00,778 ha⁻¹/. The Benefit: Cost (B:C) ratio was highest for the 100% RDF with 2% DAP foliar spray at 35 and 55 DAS, was 2.42, due to the lower cost of 2% DAP. Conversely, the Absolute Control had the lowest B:C ratio of 1.34, primarily due to its lower yield.

Key word: soybean, foliar spray, growth, yield.

ABSTRACT

Introduction

Soybean, rightly called as Golden Bean is a most happening crop of twenty first century, occupying premier

position among oilseed crops of the country since 2006. It is also the most important oil-bearing leguminous crop of the world. The productivity potential of soybean is

higher than that of other legumes. It is a richest source of quality protein which can be used for alleviating protein calorie malnutrition. Soybean contains around 40% protein with all the essential amino acids beside 18-20% oil. The necessity of integrating soy in Indian diet is more, considering presence of vitamins and other minerals like calcium, iron and other nutraceutical and health benefitting compounds. Soybean till now has been an export commodity of valuable foreign exchange mainly for its de-oiled cake (DOC), which contributed greatly to the economy of India. Extension Bulletin 18 (2023).

Foliar feeding is a technique of feeding plants by applying fertilizer directly to their leaves. Plants are able to absorb essential elements through their leaves. The absorption takes place through their stomata and also through their epidermis. Transport is usually faster through the stomata, but total absorption may be as great through the epidermis. Plants are also able to absorb nutrients through their bark. Efficiency of fertilizers applied to soil is generally low due to various losses and due to fixation. Foliar application of nutrients eliminates the problems of fixation and immobilization. Hence, foliar nutrition is recognized as an important method of fertilization in modern agriculture. Keeping this point in view, a study was undertaken to study the effect of water-soluble fertilizers sprays on growth and yield of soybean and find out the suitable water-soluble fertilizers for spraying on soybean crop (Dikey *et al.*, 2020).

Research by (Kumar *et al.*, 2013) found that foliar application of 2% diammonium phosphate (DAP) significantly increased the number of pods per plant, number of seeds per pod, seed index, and overall soybean yield. With these considerations in mind, the current study aimed to investigate effect of foliar spray of DAP on soybean. Whereas Nano fertilizers, developed through nanotechnology, enhance soil fertility, agricultural productivity, and crop quality by modifying traditional fertilizers or extracting plant components using various physical, chemical, or biological techniques (Singh M.D., 2017).

Materials and Methods

A field experiment was carried out at, Research Farm, Agronomy Section, RSCM College of Agriculture, Kolhapur, Maharashtra (India) during *kharif* season of the year 2023. The soil of experimental field was sandy clay loam with pH of 7.63, organic carbon 0.61 g/kg, total nitrogen 199.12kg/ha, available phosphorus 15.25kg/ha and 216.56 kg/ha available potassium content. The crop (Variety *Phule Sangam* (KDS 726)) was raised using RDF @ 50 kg N, 75 kg P₂O₅ and 45 kg K₂O per

hectare at the time of sowing. Seeds were sown at the rate of 75 kg ha⁻¹ by dibbling method at a spacing of 45 cm × 05 cm. The gross and net plot sizes were 5.00 × 4.50 m² and 4.50 × 3.60 m² respectively. The experiment was laid out in Randomized Block Design with eleven treatments which replicated thrice. The treatments were allotted in field follow the random methods. The treatment comprises Absolute Control, GRDF (50:75:45 N, P₂O₅, K₂O kg ha⁻¹ + FYM @12 t ha⁻¹), 100% RDF (50:75:45 N, P₂O₅, K₂O kg ha⁻¹), 100% RDF +Foliar Spray of Nano DAP @ 2% at 35 and 55 DAS, 100% RDF +Foliar Spray of Nano DAP @ 4% at 35 and 55 DAS, 100% RDF+ Foliar Spray of DAP @ 2% at 35 and 55 DAS, 100%RDF +Foliar Spray of DAP @ 4% at 35 and 55 DAS, 75% RDF +Foliar Spray of Nano DAP @ 2% at 35 and 55 DAS, 75% RDF +Foliar Spray of Nano DAP @ 4% at 35 and 55 DAS, 75% RDF +Foliar Spray of DAP @ 2% at 35 and 55 DAS and 75% RDF +Foliar Spray of DAP @ 4% at 35 and 55 DAS. The application of foliar sprays was carried out in accordance with specific treatments using a knapsack sprayer equipped with a flat fan nozzle, delivering a spray volume of 500 L ha⁻¹.

Post harvest studies on soybean

Number of pods per plant:

At the time of harvest, total number of pods from each observational plant were separated and counted individually to determine total number of pods per plant.

Weight of pods per plant:

Weight of pods obtained from each observational plant was recorded separately.

Number of seeds per pod:

The pods were collected from randomly selected plants then they were threshed, cleaned and total number of seeds were counted and the average number of seeds per pod was estimated.

Number of seeds per plant:

The total pods obtained from each plant were threshed separately and total number of seeds obtained from each observational plant were determined as a number of seeds per plant.

Weight of seeds per plant:

Weight of seeds obtained from each observational plant was recorded separately.

Test Weight:

Seed sample from each observational plot was taken randomly after harvest. Hundred seeds were counted and their weight was recorded.

Seed yield per plot:

The plants from each observational plot were harvested separately, threshed, winnowed and weighed separately. The seed yield per net plot was expressed in kilograms. The data was converted into seed yield (q ha^{-1}) and reported.

Straw yield per plot:

The weight of whole bundle of plants from each net plot was taken separately. The seed yield was subtracted from the biological yield and straw yield (kg/plot), thus obtained was recorded. The data was converted to q/ha and reported.

Harvest index:

It is the ratio of economic yield (seed yield) to the biological yield, which was worked out by following formula (Donald and Hamblin, 1976) and expressed in percent.

$$\text{Harvest Index} = \frac{\text{Seed yield (kg ha}^{-1}\text{)}}{\text{Biological yield (kg ha}^{-1}\text{)}} \times 100$$

Economic studies:

Based on the results obtained, the economics of various treatments was worked out. The cost of cultivation under individual treated plot was carried out. The gross income per hectare was calculated on the basis of grain and straw yield from each respective treatment. The prevailing market price for grain and straw were procured. Net monetary return and B:C ratio was worked out.

Cost of cultivation (Rs ha^{-1}):

The cost of cultivation was calculated on per hectare basis by considering the hire charges of labour and market value of other inputs like fertilizers, herbicides, pesticides etc.

Gross monetary returns (Rs ha^{-1}):

Gross monetary return (GMR) was computed on per hectare basis from the final seed yield of soybean and its prevailing market price.

Net monetary returns (Rs ha^{-1}):

Net monetary returns were calculated by deducting the cost of cultivation from gross monetary returns for all the treatment combination.

Net monetary returns are calculated by using following formula:

Net monetary returns (NMR) = Gross monetary returns (GMR) - Cost of cultivation (COC).

Benefit: Cost ratio:

B:C ratio was calculated by using following formula,

$$\text{B:C ratio} = \frac{\text{Gross returns (Rs. ha}^{-1}\text{)}}{\text{Total cost of cultivation (Rs. ha}^{-1}\text{)}}$$

Results and Discussions**Effect of foliar spray of DAP and Nano DAP on yield attributing characters of soybean****Mean number of pods per plant as affected by foliar spray:**

The mean number of pods on soybean plants plays a crucial role in determining their growth and yield. A higher pod count generally correlates with increased seed production, directly enhancing the overall yield. This matrix reflects the plant's health and its ability to effectively utilize nutrients and water.

The higher number of pods was observed in 100% RDF +Foliar Spray of DAP @ 4% at 35 and 55 DAS (T_7), which involved the foliar spray of DAP. This treatment produced an impressive average of 49.75 pods per plant, a figure that was notably at par to the results seen in 100% RDF +Foliar Spray of Nano DAP @ 4% at 35 and 55 DAS (T_5) and 100% RDF+ Foliar Spray of DAP @2% at 35 and 55 DAS (T_6). Specifically, 100% RDF +Foliar Spray of Nano DAP @ 4% at 35 and 55 DAS(T_5) yielded an average of 47.47 pods per plant, while 100% RDF+ Foliar Spray of DAP @ 2% at 35 and 55 DAS (T_6) produced 46.52 pods per plant. In comparison, Absolute Control (T_1) demonstrated a significantly lower pod count per plant, highlighting a marked difference in pod production efficiency.

Concordant result was reported by Ghosh and Joseph (2008).

Mean pod weight per plant as affected by foliar spray:

Pod weight in soybeans is a vital factor influencing overall yield and crop quality. Heavier pods generally indicate a higher potential for seed weight and yield, contributing to greater profitability for growers. This measure reflects the plant's ability to accumulate resources effectively and can impact the plant's overall health and productivity. By monitoring and optimizing pod weight, farmers can enhance their crop management strategies and achieve better results in both yield and economic returns.

The pod weight was observed to be the higher in 100% RDF +Foliar Spray of DAP @ 4% at 35 and 55 DAS (T_7), which averaged 23.92 grams. This was notably greater than the pod weights recorded for 100% RDF +Foliar Spray of Nano DAP @ 4% at 35 and 55 DAS (T_5) and 100% RDF+ Foliar Spray of DAP @ 2% at 35

Table 1: No. of Pods Plant⁻¹, Weight of Pods (g Plant⁻¹), No. of Seeds Pod⁻¹, No. of Seeds per plant, Seed Weight g Plant⁻¹, 100 Seed Weight (g) influenced by Foliar spray of DAP and Nano DAP.

Treatments	NPP	WPP	NP	NSP	SWP	SW
T ₁ : Absolute Control	33.79	15.56	2.30	95.17	9.27	9.34
T ₂ : GRDF (50:75:45 N, P ₂ O ₅ , K ₂ O kg ha ⁻¹ + 12 t FYM ha ⁻¹)	40.42	19.71	2.34	107.91	13.48	12.79
T ₃ : 100% RDF (50:75:45 N, P ₂ O ₅ , K ₂ O kg ha ⁻¹)	40.02	19.64	2.31	104.72	12.98	12.73
T ₄ : 100% RDF +Foliar Spray of Nano DAP @ 2% at 35 and 55 DAS	43.91	21.14	2.48	111.67	14.65	13.12
T ₅ : 100% RDF +Foliar Spray of Nano DAP @ 4% at 35 and 55 DAS	47.47	22.34	2.68	117.93	15.76	13.89
T ₆ : 100% RDF+ Foliar Spray of DAP @2% at 35 and 55 DAS	46.52	22.02	2.54	116.97	15.38	13.35
T ₇ : 100%RDF +Foliar Spray of DAP @ 4% at 35 and 55 DAS	49.75	23.92	2.72	121.50	16.66	13.99
T ₈ : 75% RDF +Foliar Spray of Nano DAP @ 2% at 35 and 55 DAS	40.90	20.00	2.35	108.57	13.98	12.91
T ₉ : 75% RDF +Foliar Spray of Nano DAP @ 4% at 35 and 55 DAS	42.42	20.31	2.37	110.85	14.34	12.87
T ₁₀ : 75% RDF +Foliar Spray of DAP @2% at 35and 55 DAS	41.37	20.13	2.35	109.18	14.22	13.44
T ₁₁ : 75% RDF +Foliar Spray of DAP @ 4% at 35 and 55 DAS	43.58	20.63	2.41	111.15	14.38	13.24
SEm±	1.92	0.66	0.09	3.21	0.65	0.63
CD @ 5%	5.66	1.95	NS	9.47	1.92	1.86
General Mean	42.74	20.49	2.40	110.51	14.10	12.88
NPP: No. of Pods Plant ⁻¹ ; WPP: Weight of Pods Plant ⁻¹ ; NP: No. of Seeds Pod ⁻¹ ; NSP: No. of SeedsPlant ⁻¹ ; SWP: Seed Weight g Plant ⁻¹ ; SW: 100 Seed Weight(g)						

and 55 DAS (T₆), which were 22.34 grams and 22.02 grams per plant, respectively, with both being statistically at par to 100% RDF +Foliar Spray of DAP @ 4% at 35 and 55 DAS (T₇). The superior pod weight in 100% RDF +Foliar Spray of DAP @ 4% at 35 and 55 DAS (T₇) was largely due to its capacity to bear the maximum number of pods. On the other hand, Absolute Control(T₁) displayed the lowest pod weight when compared to all other treatments, highlighting a significant difference in pod development.

Concordant result was reported by Ghosh and Joseph (2008), Venkatesh and Basu (2011).

Mean number of seeds per pod as affected by foliar spray:

The number of seeds per plant is a crucial factor in determining soybean yield and overall crop performance. This matrix directly influences the total seed production, as a higher seed count per plant generally leads to increased overall yield. It reflects the plant's ability to successfully produce and mature seeds, which is often a result of optimal growth conditions and effective nutrient uptake. A greater number of seeds per plant can also indicate better plant health and vitality.

The average number of seeds per soybean plant was observed to be between 2 and 3. Analysis showed that there were no significant differences in the number of seeds per pod across the various treatments. Among the treatments, the higher seed count per pod was found in 100% RDF +Foliar Spray of DAP @ 4% at 35 and 55 DAS (T₇), which had an average of 2.72 seeds per pod. In contrast, Absolute Control (T₁) recorded the lowest

number of seeds per pod, averaging 2.3. The seed counts per pod for the remaining treatments were comparable and did not show significant variation from one another.

Concordant result was reported by Venkatesh and Basu (2011), Basavarajappa *et al.*, (2013).

Mean number of seeds per plant as affected by foliar spray:

In soybeans, the number of seeds per plant is a key determinant of yield and overall productivity. A higher seed count per plant generally leads to increased total seed production, which directly boosts the crop's yield. This matrix reflects the plant's capacity to develop and mature seeds successfully, often indicating good plant health and optimal growing conditions. Enhancing the number of seeds per plant can therefore improve yield efficiency and contribute to more profitable soybean production.

The greatest number of seeds per plant was recorded in 100% RDF +Foliar Spray of DAP @ 4% at 35 and 55 DAS (T₇), which involved a 4% foliar spray of DAP, yielding an average of 121.50 seeds per plant. This result was notably higher compared to 100% RDF +Foliar Spray of Nano DAP @ 4% at 35 and 55 DAS (T₅) and 100% RDF+ Foliar Spray of DAP @ 2% at 35 and 55 DAS (T₆), which displayed similar outcomes with average seed counts of 117.93 and 116.97 per plant respectively. In comparison, Absolute Control (T₁) exhibited the lowest number of seeds per plant among all the treatments, indicating a significant difference in seed production efficiency.

Concordant result was reported by Sarkar and Pal

Table 2: Mean seed yield, mean straw yield and harvest index of soybean influenced by Foliar spray of DAP and Nano DAP.

Treatments	Seed Yield (q ha ⁻¹)	Straw Yield (q ha ⁻¹)	Harvest Index (%)
T ₁ : Absolute Control	17.74	27.15	39.44
T ₂ : GRDF (50:75:45 N, P ₂ O ₅ , K ₂ O kg ha ⁻¹ + 12 t FYM ha ⁻¹)	24.80	33.99	42.17
T ₃ : 100% RDF (50:75:45 N, P ₂ O ₅ , K ₂ O kg ha ⁻¹)	24.11	32.46	42.67
T ₄ : 100% RDF +Foliar Spray of Nano DAP@2% at 35 and 55 DAS	29.77	37.02	44.55
T ₅ : 100% RDF +Foliar Spray of Nano DAP @ 4% at 35 and 55 DAS	35.19	42.35	45.38
T ₆ : 100% RDF+ Foliar Spray of DAP @ 2% at 35 and 55 DAS	35.01	42.08	45.40
T ₇ : 100%RDF +Foliar Spray of DAP @ 4% at 35 and 55 DAS	35.52	43.14	45.07
T ₈ : 75% RDF +Foliar Spray of Nano DAP @ 2% at 35 and 55 DAS	26.88	33.36	44.51
T ₉ : 75% RDF +Foliar Spray of Nano DAP @ 4% at 35 and 55 DAS	28.97	35.85	44.18
T ₁₀ : 75% RDF +Foliar Spray of DAP @2% at 35and 55 DAS	28.10	35.33	44.32
T ₁₁ : 75% RDF +Foliar Spray of DAP @ 4% at 35 and 55 DAS	29.24	36.58	44.42
SEm±	1.83	1.43	-
CD @ 5%	5.40	4.22	-
General Mean	28.67	36.30	43.83

(2006), Shashikumar *et al.*, (2013), Dikey *et al.*, (2020).

Mean seed weight per plant as affected by foliar spray:

The average seed weight per plant is a key matrix in evaluating soybean crop quality and yield. This value represents the typical weight of seeds produced by each plant and directly impacts the total harvestable yield and its market value. Larger seed weights often indicate healthier plants and more effective use of nutrients throughout the growing period. By improving the mean seed weight per plant, growers can boost both the overall productivity and profitability of their soybean crops, leading to enhanced economic returns and superior product quality.

For details on seed weight per plant, refer to Table 4.7; Fig. 4.6 provides a graphical view of the same information. The higher seed weight per plant in soybeans was observed in 100% RDF +Foliar Spray of DAP @ 4% at 35 and 55 DAS (T₇), which received a foliar spray of DAP, resulting in an average of 16.66 grams per plant. 100% RDF +Foliar Spray of Nano DAP @ 4% at 35 and 55 DAS (T₅) and 100% RDF+ Foliar Spray of DAP @ 2% at 35 and 55 DAS (T₆) shows at par result with it, which recorded average seed weights of 15.76 grams and 15.38 grams per plant, respectively, and were statistically comparable to each other. In contrast, Absolute Control (T₁) displayed a significantly lower seed weight per plant compared to all other treatments, highlighting a marked difference in seed development efficiency.

Concordant result was reported by Sarkar and Pal (2006), Basavarajappa *et al.*, (2013), Sharifi *et al.*, (2018).

Mean 100 seed weight of soybean as affected by foliar spray:

Test weight, is an important measure for assessing soybean quality and potential yield. It quantifies the weight of a specific volume of seeds, providing insights into seed size, density, and overall quality. Generally, a higher test weight indicates larger, denser seeds, which are often linked to better seed health and vitality. This matrix is crucial for determining the commercial value of the soybean crop, influencing aspects such as storage and processing efficiency.

The dry matter statistics are available in Table 4.7, with Fig. 4.6 offering a visual representation. The higher mean weight for 100 seeds was observed in 100% RDF +Foliar Spray of DAP @ 4% at 35 and 55 DAS (T₇), which recorded an average of 13.99 grams. This result was notably higher compared to all other treatments, which displayed comparable weights. In contrast, Absolute Control (T₁) demonstrated a significantly lower mean weight for 100 seeds, averaging only 9.34 grams. This marked difference highlights the impact of the treatments on seed weight, with 100% RDF +Foliar Spray of DAP

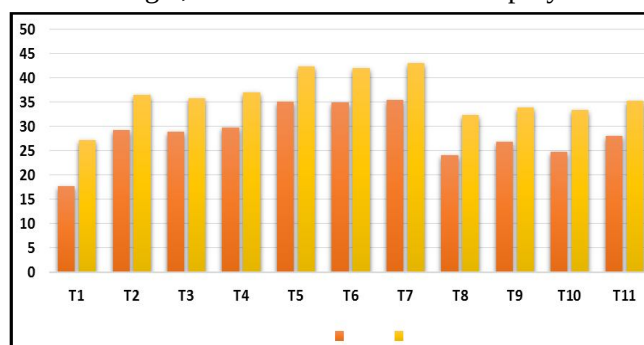


Fig. 1: Mean seed yield and mean straw yield (q/ha) of soybean influenced by Foliar Spray of DAP and Nano DAP.

Table 3: Economics of soybean as influenced by Foliar spray of DAP and Nano DAP.

Treatments	CC	GMR	NMR	B:C ratio
T ₁ : Absolute Control	64820	87033	22213	1.34
T ₂ : GRDF (50:75:45 N, P ₂ O ₅ , K ₂ O kg ha ⁻¹ + 12 t FYM ha ⁻¹)	86215	120885	34670	1.40
T ₃ : 100% RDF (50:75:45 N, P ₂ O ₅ , K ₂ O kg ha ⁻¹)	66215	117418	51203	1.77
T ₄ : 100% RDF +Foliar Spray of Nano DAP@2% at 35 and 55 DAS	74215	144346	70131	1.94
T ₅ : 100% RDF +Foliar Spray of Nano DAP @ 4% at 35 and 55 DAS	82215	170345	88130	2.07
T ₆ : 100% RDF+ Foliar Spray of DAP @ 2% at 35 and 55 DAS	70031	169459	99428	2.42
T ₇ : 100%RDF +Foliar Spray of DAP @ 4% at 35 and 55 DAS	71247	172025	100778	2.41
T ₈ : 75% RDF +Foliar Spray of Nano DAP @ 2% at 35 and 55 DAS	72395	130304	57909	1.80
T ₉ : 75% RDF +Foliar Spray of Nano DAP @ 4% at 35 and 55 DAS	80395	140425	60030	1.75
T ₁₀ : 75% RDF +Foliar Spray of DAP @2% at 35and 55 DAS	66211	136328	70117	2.06
T ₁₁ : 75% RDF +Foliar Spray of DAP @ 4% at 35 and 55 DAS	67427	141819	74392	2.10
General Mean	72853	139126	66273	1.92
CC: Cost of Cultivation(Rs. Ha ⁻¹); GMR: Gross Monetary Return (Rs. Ha ⁻¹); NMR: Net monetary Return (Rs. Ha ⁻¹)				

@ 4% at 35 and 55 DAS (T₇) achieving significantly superior results in seed density and size.

Concordant result was reported by Sharifi *et al.*, (2018), Sruthi *et al.*, (2020), Warpe *et al.*, (2022).

Effect of foliar spray of DAP and Nano DAP on yield of soybean

Seed yield of soybean influenced by Foliar spray of DAP and Nano DAP:

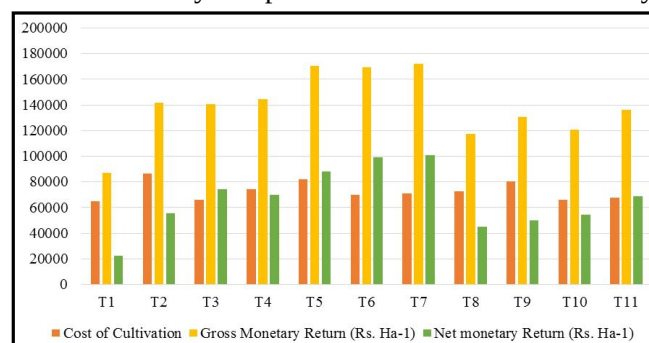
Seed yield in soybeans is essential because it directly influences the crop's overall productivity and economic return. A higher seed yield signifies a more successful harvest, translating to greater revenue for growers. This measure reflects not only the quantity of seeds produced but also the effectiveness of cultivation practices, seed quality, and plant health. By optimizing seed yield, farmers can enhance their profitability and ensure a more robust and successful crop.

The higher seed yield was recorded in 100% RDF +Foliar Spray of DAP @ 4% at 35 and 55 DAS (T₇), which achieved an impressive 35.52 quintals per hectare, a result that was comparable to the yields observed in 100% RDF +Foliar Spray of Nano DAP @ 4% at 35 and 55 DAS (T₅) and 100% RDF+ Foliar Spray of DAP @ 2% at 35 and 55 DAS (T₆). This outcome was attributed to the application of a 4% DAP foliar spray. Specifically, 100% RDF +Foliar Spray of Nano DAP @ 4% at 35 and 55 DAS (T₅) and 100% RDF+ Foliar Spray of DAP @ 2% at 35 and 55 DAS (T₆), produced yields of 35.19 and 35.01 quintals per hectare, respectively. This indicates that the foliar spray of DAP at 4% significantly influenced the seed yield, although 100% RDF +Foliar Spray of DAP @ 4% at 35 and 55 DAS (T₇) results were on par with the higher yields of 100% RDF +Foliar Spray of Nano DAP @ 4% at 35 and 55 DAS (T₅) and 100% RDF+ Foliar Spray of DAP @ 2% at 35 and 55

DAS (T₆). Absolute Control (T₁) exhibits result that were markedly lower compared to the outcomes observed with all other treatments. This discrepancy highlights a significant difference in effectiveness, with Absolute Control (T₁) showing a notably diminished performance relative to the other methods tested. Concordant result was reported by Sruthi *et al.*, (2020), Sharifi *et al.*, (2018).

Straw yield of soybean influenced by Foliar spray of DAP and Nano DAP:

In the study, it was observed that the treatment incorporating a 4% DAP foliar spray along with 100% Recommended Dose of Fertilizer (RDF) yielded the maximum straw production. Specifically, 100% RDF +Foliar Spray of DAP @ 4% at 35 and 55 DAS (T₇), which involved this combination, produced a straw yield of 43.14 quintals per hectare. In comparison, 100% RDF +Foliar Spray of Nano DAP @ 4% at 35 and 55 DAS (T₅) and 100% RDF+ Foliar Spray of DAP @2% at 35 and 55 DAS (T₆), which also employed similar strategies but with slight variations and shown at par result with 100%RDF +Foliar Spray of DAP @ 4% at 35 and 55 DAS (T₇), achieved straw yields of 42.35 and 42.08 quintals per hectare, respectively, showing results that were statistically comparable to each other. Conversely,

**Fig. 2:** Economics of soybean as influenced by foliar spray of DAP and Nano DAP.

the control treatment, labelled as T_1 , which did not receive any additional treatment beyond the standard practices, resulted in a significantly lower straw yield of 27.15 quintals per hectare.

Concordant result was reported by Sruthi *et al.*, (2020), Warpe *et al.*, (2022).

Harvest index as affected by foliar spray of DAP and Nano DAP:

The harvest index (HI) is crucial for soybean production as it measures the proportion of a plant's biomass allocated to harvestable seeds, reflecting its efficiency in seed production. A higher HI indicates that a greater share of the plant's total biomass is converted into economic yield, which is desirable for maximizing productivity and profitability. Understanding and optimizing the HI helps farmers and breeders improve crop management, resource allocation, and variety selection. It also provides valuable insights for enhancing yield efficiency and sustainability in soybean farming.

In the study, the higher harvest index observed in 100% RDF +Foliar Spray of Nano DAP @ 4% at 35 and 55 DAS (T_5), which was 45.40%, indicates that this treatment achieved a superior ratio of seed yield to total biomass. This high harvest index results from 100% RDF +Foliar Spray of Nano DAP @ 4% at 35 and 55 DAS (T_5) ability to produce a significantly greater number of seed compared to its straw yield. Essentially, 100% RDF +Foliar Spray of Nano DAP @ 4% at 35 and 55 DAS (T_5) successfully allocated a larger proportion of its total biomass to the seeds rather than to vegetative parts of the plant. This efficient conversion of biomass into harvestable seeds reflects effective resource utilization and optimal growing conditions for this treatment, leading to a higher economic yield. Absolute Control (T_1) demonstrates a significantly weaker performance compared to the other methods evaluated.

Effect of foliar spray of DAP and Nano DAP on economics of soybean

Cost of Cultivation:

The cost of cultivation for each treatment was determined by aggregating the expenses associated with all operational procedures carried out for that treatment. Among the treatments, the GRDF (50:75:45 N, P_2O_5 , K_2O kg ha^{-1} +12 t FYM ha^{-1}) (T_2) incurred the higher cultivation cost of Rs. 86215/- per hectare, primarily due to the application of FYM. Within the all-other treatment this 100% RDF+ Spray of Nano DAP @ 4% at 35 and 55 DAS (T_5) shows higher cost of cultivation after GRDF (50:75:45 N, P_2O_5 , K_2O kg ha^{-1} +12 t FYM ha^{-1}) (T_2). The Absolute Control (T_1) had the lowest cost of

cultivation of Rs. 64820/- per hectare, as no additional RDF was applied after sowing and no any foliar spray is given.

Concordant result was reported by Korade *et al.*, (2019), Sruthi *et al.*, 2020.

Gross Monetary Returns:

Gross monetary returns were determined by assessing the market prices for both grain and straw. Among the various treatments, the combination of 100% RDF +Foliar Spray of DAP @ 4% at 35 and 55 DAS (T_7) generated the higher gross monetary return, amounting to Rs. 1,72,025/- per hectare. This impressive return can be attributed to the exceptional yield performance of this treatment. Following this 100% RDF+ Spray of Nano DAP @ 4% at 35 and 55 DAS (T_5) and 100% RDF+ Foliar Spray of DAP @ 2% at 35 and 55 DAS (T_6) achieved notable gross monetary returns as well, with 100% RDF +Foliar Spray of Nano DAP @ 4% at 35 and 55 DAS (T_5) generating Rs. 1,70,345/- per hectare and 100% RDF+ Foliar Spray of DAP @ 2% at 35 and 55 DAS (T_6) yielding Rs. 1,69,459/- per hectare, demonstrating their substantial economic benefits.

In relation to the other methods evaluated, Absolute Control (T_1) demonstrates a clear decrease in gross monetary return.

Concordant result was reported by Pradeep Kumar *et al.*, (2013), Shashikumar *et al.*, (2013).

Net Monetary Returns:

Net monetary returns were determined by subtracting the cost of cultivation from the gross monetary returns. The 100% RDF +Foliar Spray of DAP @ 4% at 35 and 55 DAS (T_7) had the higher net monetary return, amounting to Rs. 100778/- per hectare. The next higher net return was achieved with 100% RDF+ Foliar Spray of DAP @ 2% at 35 and 55 DAS (T_6), which recorded Rs. 99,428/- per hectare. All other foliar spray yielded significantly higher net returns compared to the Absolute Control (T_1), which had the lowest net return of Rs. 22213/- per hectare.

Concordant result was reported by Shashikumar *et al.*, (2013), Meena *et al.*, (2018), Paikra *et al.*, (2018).

Benefit: Cost Ratio:

The Benefit: Cost (B:C) ratio is an important matrix for assessing the effectiveness of different foliar application of fertilizer. The higher B:C ratio was observed in 100% RDF+ Foliar Spray of DAP @2% at 35 and 55 DAS (T_6), resulting in a ratio of 2.42. The 100% RDF +Foliar Spray of DAP @ 4% at 35 and 55 DAS (T_7) achieved a B:C ratio of 2.41, while the 100% RDF+ Spray

of Nano DAP @ 4% at 35 and 55 DAS (T_5), had a ratio of 2.07. The cost of nano DAP is so high so it will ultimately decrease the B:C ratio. The Absolute Control (T_1) had the lowest B:C ratio of 1.34, primarily due to its lower yield.

Concordant result was reported by Paikra *et al.*, (2018), Korade *et al.*, (2019), Dikey *et al.*, (2020).

Conclusion

The application of 100% RDF along with foliar spray of 4% DAP resulted in the highest yield attributes No. of Pods plant⁻¹, Weight of pods (g Plant⁻¹), No. of Seeds Pod⁻¹, No. of Seeds plant⁻¹, Seed Weight (g Plant⁻¹), 100 Seed Weight (g) and yield (seed yield kg ha⁻¹ and straw yield kg ha⁻¹). 100% RDF along with foliar spray of 4% Nano DAP and 100% RDF along with foliar spray of 2% DAP shows at par result with it.

Whereas The treatment with GRDF, which includes FYM application, incurred the highest cultivation cost of Rs 86,215/- ha⁻¹. The highest gross monetary return of Rs 1,72,025/- ha⁻¹ was achieved with the 4% DAP foliar spray combined with 100% RDF, with similar returns observed for treatments using 4% Nano DAP and 2% DAP alongside 100% RDF. The 4% DAP foliar spray with 100% RDF also yielded the highest net monetary return of Rs 1,00,778 ha⁻¹/. The Benefit: Cost (B:C) ratio was highest for the 100% RDF with 2% DAP foliar spray at 35 and 55 DAS, was 2.42, due to the lower cost of 2% DAP.

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