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Chandanshiv PS
M.Sc, Department of
Agronomy, Dr. Panjabrao
Deshmukh Krishi Vidyapeeth,
Akola, Maharashtra, India

Dr. Dhule DT
Assistant Professor,
Department of Agronomy,
Dr. Panjabrao Deshmukh
Krishi Vidyapeeth, Akola,
Maharashtra, India

Pande AD
M.Sc, Department of
Agronomy, Dr. Panjabrao
Deshmukh Krishi Vidyapeeth,
Akola, Maharashtra, India

Dr. Ghanbahadur MR
Chairman of Advisory
Committee & Associate
Professor, Department of
Agronomy, Dr. PDKV,
Akola, Maharashtra, India

Corresponding Author:
Chandanshiv PS
M.Sc, Department of
Agronomy, Dr. Panjabrao
Deshmukh Krishi Vidyapeeth,
Akola, Maharashtra, India

Study on the effect of the different levels of nitrogen, phosphorous and zinc sulphate on economics of summer sesame

Chandanshiv PS, Dhule DT, Pande AD and Ghanbahadur MR

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Abstract

A field experiment was conducted to evaluate the effect of different levels of nitrogen, phosphorus, and zinc sulphate on the economics of summer sesame (*Sesamum indicum* L.) under irrigated conditions. The study aimed to identify the most profitable nutrient combination for enhancing the economic returns of summer sesame cultivation. The experiment was carried out during the summer season of 2017 at the Department of Agronomy Farm, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra. The soil of the experimental field was low in available nitrogen, medium in phosphorus, and high in potassium. Nine treatment combinations comprising different levels of recommended fertilizer dose (RDF) and zinc sulphate (ZnSO_4) application were evaluated in a Randomized Block Design with three replications. The treatments included control, 100% and 125% RDF, and combinations of these fertilizer levels with 10, 20, and 30 kg $\text{ZnSO}_4 \text{ ha}^{-1}$. Economic parameters such as gross monetary returns (GMR), net monetary returns (NMR), and benefit (B) ratio were computed, and the data were statistically analyzed using analysis of variance.

The results revealed that nutrient management significantly influenced the economics of summer sesame. Application of 125% RDF alone improved economic returns over the control and 100% RDF. Among all treatment combinations, 125% RDF combined with 30 kg $\text{ZnSO}_4 \text{ ha}^{-1}$ recorded the highest gross monetary return (₹143,791 ha^{-1}), net monetary return (₹86,649 ha^{-1}), and benefit ratio (2.52), proving significantly superior to most other treatments. Treatments comprising 100% RDF with 20 or 30 kg $\text{ZnSO}_4 \text{ ha}^{-1}$ also produced comparable economic benefits. The findings indicate that balanced fertilization with higher nutrient levels and zinc supplementation substantially enhances the profitability of summer sesame cultivation. It can be concluded that the application of 125% RDF along with 30 kg $\text{ZnSO}_4 \text{ ha}^{-1}$ is the most economically viable nutrient management practice for irrigated summer sesame under the agro-climatic conditions of Akola, Maharashtra.

Keywords: *Sesamum indicum*, summer sesame, nitrogen, phosphorus, zinc sulphate

1. Introduction

Sesame (*Sesamum indicum* Linn (Pedaliaceae) is antique oilseed crop in India and India ranks first in area (45 percent), production (32 percent) and export (40 percent) of sesame in the world. The total area of sesame in India during 2012-2013 was 17.09 lakh ha and total production was 7.48 lakh tones. Sesame is one of the most versatile crops that can be grown from semi-arid tropics and subtropics to temperate regions. Being subtropics to temperate regions. Being a short duration crop it has unique attributes that can fit almost any crop system. Sesame offers more return for less cost (less risk) than other crops; can be more profitable with limited resources than other crops using the same level of resources. Sesame crop has shown excellent tolerance to hot, dry conditions where other crops have failed. Sesame is a well-suited crop to include in a rotation because equipment used for other crops can be used to grow sesame. It has a deep tap root system that utilizes leached nutrient below the root zones of previous crop and can stretch water in areas with limited water by dividing acres with higher moisture demanding crops like corn or pea nuts. The crop grows well in no till and has shown relatively negligible economic damages from wild animals and birds.

In India sesame seeds are used for oil extraction (78%) edible purpose (20%) and seed purpose (2%) out of that 70% sesame seeds are used for edible purpose such as salad and cooking oil and remaining 30% for toilet soap and manufacture margarine.

Sesame is known as benniseed, gingelly, sesame, sisim, til and hawari. The sesame seeds are rich source of food and edible oil, nutritious, healthcare and biomedicine. Its oil content generally varies from 48 to 52% and contain 6355 Kcal/kg energy in seeds (Kumar and Goel in 1994) [6] the seeds are also rich source of proteins (20%-28%), sugars (14-16%), minerals (5-7%) and nutrients like calcium (1.31%) and phosphorous (0.07%) (Dinosa and Gupta 1993) [3].

In Maharashtra, Vidarbha region comes under semi-arid eco-region, is the most important sesame growing area occupying 60% of the total area under sesame cultivation in the state. In summer, under irrigated condition, in general, preference is given to groundnut crop. However, because of higher cultivation cost and more water requirement, reducing yield potential and threat of early onset of monsoon create great difficulties in harvesting of groundnut resulting in deterioration of quality and yield. Moreover, farmers in most of the time do not go for cultivation during summer season with scanty irrigation water and also for the fear of crop losses. Hence, summer sesame becomes necessary to be an alternative oil seed crop which can be fit for fairly hot conditions during summer and can be produced with limited irrigation requirement to obtain maximum yield which ultimately uplift the economy of the farmers during the season. Besides, the irrigation command area may be covered for summer cultivation of sesame crop after harvest of paddy and early *rabi* crops. Due to weak financial status, farmers are not able to add fertilizers to the soil for maximizing sesame production. May this combination of treatments will give them a chance to produce higher sesame yield with maximum RDF 25:25:00 and availability of irrigation water along with good agronomic practices. Also the sources of nutrients used like DAP, Urea and ZnSO_4 heptahydrate are readily available and less costly. This research is supposed to be evaluating the most economic dose of NPK, Zn and S for summer sesame. Therefore, sesame may be the suitable answer because of less cost of cultivation, low water requirement and higher selling price. High temperature and low humidity in summer used to lower down the activity of insects and pests, which usually keeps the crop free from damage or less prone to damage. Being comparatively short duration crop and since it has a great advantage to harvest the crop at physiological maturity stage, a quality crop can be harvested safely. Therefore a field trial was undertaken to study the "effect of the different levels of nitrogen, phosphorous and zinc sulphate on economics of summer sesame."

2. Materials and Methods

A field experiment entitled "Response of summer sesame (*Sesamum indicum* L.) to the levels of nitrogen, phosphorus and zinc sulphate under irrigated condition" was conducted in summer season during the year 2017, at Department of Agronomy Farm, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola (M.S.).

2.1 Soil

To determine the physico-chemical properties of soil, samples from surface 0-30 cm depth were drawn before laying out the experiment from randomly selected spots from the entire experimental area. The soil under the very experimental area was analyzed which was low in available nitrogen (N) medium in available phosphorus (P), and high

in available potassium (K).

2.2 Climate and weather

Akola is situated in the subtropical region at 22.42° N latitude and of 77.02° E longitude and at an altitude of 307.4 meters above mean sea level. The climate of the area is semi-arid characterized by three distinct season viz., hot and dry summer from March to May, warm and rainy monsoon from June to October and mild cold winter from November to February.

2.3 Preparatory tillage

After harvest of the previous crop the land was ploughed with tractor drawn plough 30 cm deep. It was subsequently harrowed twice with the blade harrow to achieve good tilth. The crop residues were removed from the experimental plot and finally the plot was leveled. After completing all the preparatory tillage operations, layout was marked.

2.3 Harvesting and drying of pullies

The crop was harvested by cutting the plants near the ground level with the help of sickle when the capsules turned yellow to brown colour. The suitable sized pullies were tied plot wise. The pullies from each net plot were carefully labeled as per treatment and kept separately on drying yard for drying.

2.4 Threshing and winnowing

After sufficient drying, grains were collected by shaking and beating the pullies inversely on carpet. Finally, grains were cleaned by hand winnowers. The grain was weighed and recorded plot wise followed by bagging in sample bag with carefully labeling plot wise. At the same time straw yield was also weighed plot wise and recorded.

2.5 Experimental details

2.5.1 Treatments

The experiment was carried out with 9 treatment combinations replicated 3 times. The allotment of the treatments to various plot were done randomly.

Treatment details:

- T₁-CONTROL
- T₂-100% RDF
- T₃-125% RDF
- T₄-100% RDF + 10 Kg ZnSO_4
- T₅-125% RDF + 10 Kg ZnSO_4
- T₆-100% RDF + 20 Kg ZnSO_4
- T₇-125% RDF + 20 Kg ZnSO_4
- T₈-100% RDF + 30 Kg ZnSO_4
- T₉-125% RDF + 30 Kg ZnSO_4

Various field operations carried out for the experiment undertaken for summer sesame crop during the crop season

2.5.2 Economic studies

2.5.2.1 Gross monetary return (Rs ha⁻¹)

The cost of cultivation ha⁻¹ was calculated for the individual treatment on the basis of inputs used and prevailing market price of the produce. Gross monetary returns were estimated by multiplying economic yield with prevailing market price of sesame seed. Yield of sesame was converted in money values (Rs ha⁻¹) at the prevailing market rates.

2.5.2.2 Net monetary return (Rs ha⁻¹)

Net monetary return was calculated by subtracting the cost of cultivation from gross return, treatment wise, since this represent the actual income to the farmer.

2.5.2.3 Benefit: cost ratio

It Is also called as input output ratio. The benefit cost ratio was worked out by following formula.

$$\text{Benefit-cost ratio} = \frac{\text{Gross monetary return (Rs ha}^{-1}\text{)}}{\text{Cost of cultivation (Rs ha}^{-1}\text{)}}$$

2.6 Statistical analysis and interpretation of data

The experimental data collected during the course of investigation were statistically analyzed with randomized block design (RBD) programmed by adopting standard statistical techniques of analysis of variance (Gomez and Gomez, 1984) [4]. Wherever, the results were significant, critical differences at $P = 0.05$ levels were used for comparison of treatment means. Data on interaction effects are presented wherever found significant.

3. Results and Discussion

3.1 Economic studies

Data in respect of gross monetary returns, net monetary returns and B: C ratio are presented in Table 1.

3.1.1 Gross Monetary Returns (GMR)

Table 1 revealed that, gross monetary returns (GMR) was affected significantly due to various treatments and the average GMR was Rs. 119885 ha⁻¹.

3.1.1.1 Effect of nitrogen

Data in Table 1 indicated that, significantly a higher gross monetary return (GMR) of Rs. 106457 ha⁻¹ was obtained in T₃ (125% RDF) than control of Rs. 71009 ha⁻¹ and T₂ (100% RDF) value is 103086 Rs. ha⁻¹. Treatment T₉ (100% RDF + 30 kg ZnSO₄) with 143791 Rs. ha⁻¹ is the best and superior to all and at par with T₈ with 141796 Rs. ha⁻¹ and almost at par with T₆ but differ slightly. Results found are in conformity with Kalpana Jamdhade *et al.* (2011) [5], H. K. Patel *et al.* (2014) [10] and R. R. Damdar *et al.* (2014) [1].

3.1.1.2 Effect of phosphorus

Levels of phosphorus significantly influenced the GMR. The highest GMR (Rs. 143791 ha⁻¹) was obtained with Treatment T₉ (100% RDF + 30 kg ZnSO₄) which was significantly superior over all the treatments and at par with T₈ (100% RDF + 30 kg ZnSO₄) with 141796 Rs. ha⁻¹ and almost at par with T₆ but differ slightly. These results found are in agreement with S. Tripathi *et al.* (2009) [14].

3.1.1.3 Effect of zinc sulphate

Application of zinc sulphate at differential increasing rate significantly influenced the GMR. In combination with RDF and ZnSO₄ Treatment T₉ (100% RDF + 30 kg ZnSO₄) with 143791 Rs. ha⁻¹, which was significantly superior over all the treatments and at par with T₈ (100% RDF + 30 kg ZnSO₄) with 141796 Rs. ha⁻¹ and almost at par with T₆ (100% RDF + 20 kg ZnSO₄) but differ slightly having value 139494 Rs. ha⁻¹. Results found are similar with N. N. Parmar *et al.* (2018) [9] and R. A. Yadav *et al.* (2009) [14].

Table 1: GMR, NMR and B : C ratio as influenced by various treatments.

Treatment	(Rs. ha ⁻¹)		B:C Ratio
	GMR	NMR	
T ₁ -Control	71009	15788	1.29
T ₂ -100% RDF	103086	47552	1.86
T ₃ -125% RDF	106457	50846	1.91
T ₄ -100% RDF + 10 kg ZnSO ₄	118215	62111	2.11
T ₅ -125% RDF + 10 kg ZnSO ₄	120101	63919	2.14
T ₆ -100% RDF + 20 kg ZnSO ₄	139494	82910	2.47
T ₇ -125% RDF + 20 kg ZnSO ₄	135020	78358	2.38
T ₈ -100% RDF + 30 kg ZnSO ₄	141796	84731	2.48
T ₉ -125% RDF + 30 kg ZnSO ₄	143791	86649	2.52
SE(m)±	1473	1473	0.03
CD @ 5%	4417	4417	0.08
General mean	119885	63652	2.13

3.1.2 Net Monetary Returns (NMR)

Data in Table 1 revealed that, net monetary returns (NMR) were affected significantly due to various treatments and the average NMR was Rs. 63652 ha⁻¹.

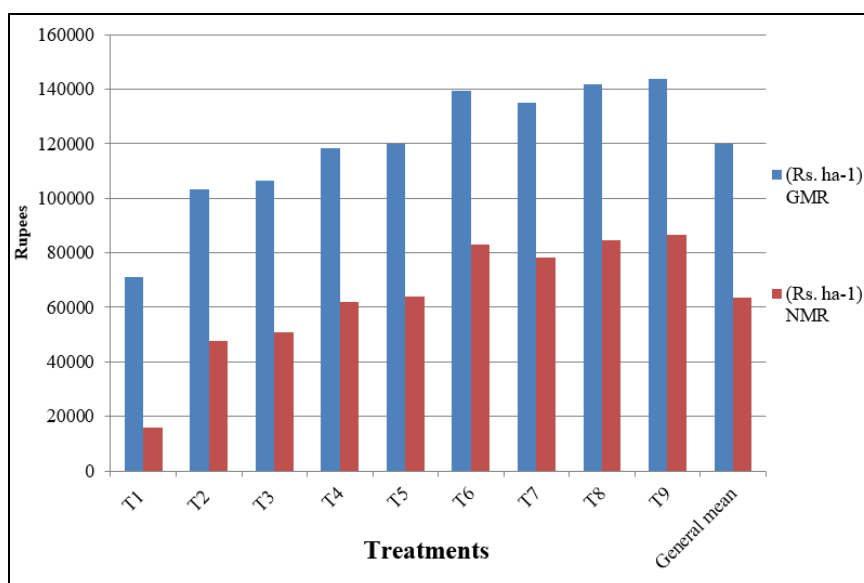


Fig 1: Economics as GMR, NMR influenced by various treatments

3.1.2.1 Effect of nitrogen

Table 1 indicated that T₃ recorded significantly higher net monetary returns (NMR) of Rs. 50846 ha⁻¹ over T₂ treatment (Rs. 47552 ha⁻¹) and T₁ (Rs. 15788 ha⁻¹). T₉ is superior to all whereas T₆ and T₈ are at par with each other and T₅ and T₇ are also found at par with each other. Results found are in conformity with Kalpana Jamdhade *et al.* (2011)^[5], H. K. Patel *et al.* (2014)^[10] and R. R. Damdar *et al.* (2014)^[11].

3.1.2.2 Effect of phosphorus

Levels of phosphorus significantly influenced the NMR. The similar trend of NMR is found here also as it is found in nitrogen levels. The highest NMR (Rs. 50846 ha⁻¹) was obtained with application of 125% RDF which was significantly superior over T₂ (Rs. 47552 ha⁻¹), T₁ (Rs. 15788 ha⁻¹). Whereas T₉ (Rs. 86649 ha⁻¹) was also found significantly superior over all and T₆ & T₈ also T₅ and T₇ found at par with each other respectively. The lowest NMR

(Rs.15788 ha⁻¹) was found under T₁ (control). These results found are in agreement with B. H. Prasanna Kumara *et al.* (2014)^[11].

3.1.2.3 Effect of zinc sulphate

Application of ZnSO₄ in combination with 100% and 125% RDF increased the cost of cultivation provides higher GMR though NMR is more. The highest NMR in T₉ (Rs. 86649 ha⁻¹) was found significantly superior over all and T₆ (Rs. 82910 ha⁻¹) & T₈ (Rs. 84731 ha⁻¹) also T₇ (Rs. 78358 ha⁻¹) & T₅ (Rs. 63919 ha⁻¹) found at par with each other respectively. The lowest NMR as far as ZnSO₄ combination is concerned (Rs. 62111 ha⁻¹) was found under T₄ (100% RDF + 10 kg ZnSO₄). Results found are similar with N. N. Parmar *et al.* (2018)^[9] and R. A. Yadav *et al.* (2009)^[14].

3.1.3 Benefit: Cost ratio

Data in Table 1 revealed that, B:C ratio was affected due to various treatments and the average B:C ratio was 2.13

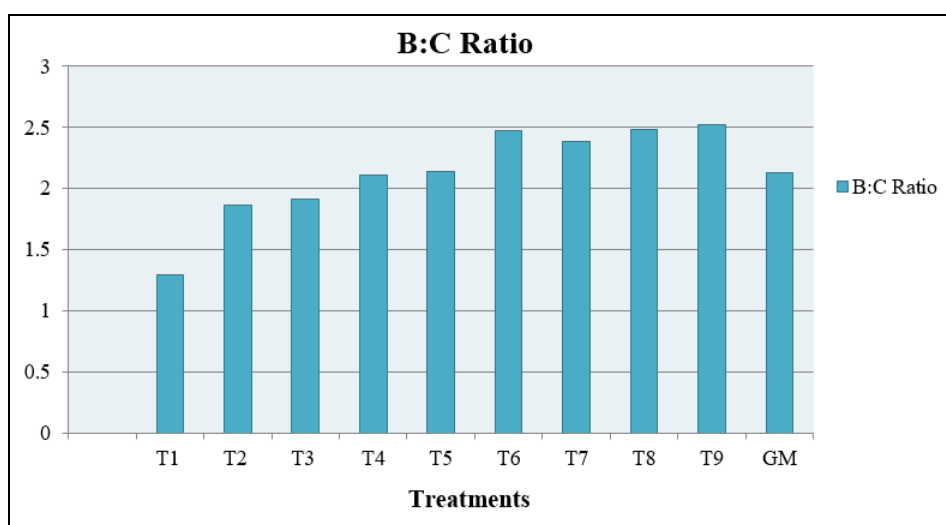


Fig 2: Benefit: Cost ratio of various treatments

3.1.3.1 Effect of nitrogen

Higher B: C ratio of (1.91) was recorded in T₃ (125% RDF) as compared to control (1.29) and at par with T₂ (1.86) i.e. 100% RDF. The highest B: C ratio is found in T₉ (125% RDF + 30 kg ZnSO₄) which is (2.52). Results found are in conformity with Kalpana Jamdhade *et al.* (2011)^[5], H. K. Patel *et al.* (2014)^[10] and R. R. Damdar *et al.* (2014)^[11].

3.1.3.2 Effect of phosphorus

The highest B:C ratio (1.91) was recorded in T₃ (125% RDF) as compared to control (1.29) and at par with T₂ (1.86) i.e. 100% RDF. The highest B:C ratio is found in T₉ (125% RDF + 30 kg ZnSO₄) which is (2.52). Results are pretty similar as found with levels of nitrogen. These results found are in agreement with B. H. Prasanna Kumara *et al.* (2014)^[11].

3.1.3.3 Effect of zinc sulphate

The highest B:C ratio is found in T₉ (125% RDF + 30 kg ZnSO₄) which is (2.52) and at par with T₈ (2.48) and T₆ (2.47) in combination with 100% RDF plus 30 and 20 kg ZnSO₄. The lowest B:C ratio is obtained in T₄ i.e. 100% RDF + 10 kg ZnSO₄ which is (2.11). Results found are similar with N. N. Parmar *et al.* (2018)^[9] and R. A. Yadav *et al.* (2009)^[14].

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