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## Site specific nutrient management through STCR on yield and economics of rabi safflower under rainfed condition

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**Abstract**

The field experiment was conducted at experimental farm, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during rabi season 2017-18, to study the impact of site specific nutrient management through soil test crop response on yield and economics of rabi safflower under rainfed condition. Experimental findings revealed that, amongst the different sources organic manures, the treatment with application of FYM @ 5 t ha<sup>-1</sup> noticed significantly higher in seed yield (1745 kg ha<sup>-1</sup>), straw yield (4661 kg ha<sup>-1</sup>), biological yield (6406 kg ha<sup>-1</sup>) and harvest index (27.21%) similarly, economics study of safflower recorded same results in case of GMR (70394 Rs.ha<sup>-1</sup>), NMR (43018 Rs.ha<sup>-1</sup>) and economics efficiency (344 Rs.ha<sup>-1</sup> day<sup>-1</sup>) however, it was found statistically at par with treatment of greengram residue incorporation. Highest B: C ratio (2.55) was displayed with treatment of greengram residue incorporation followed by treatments FYM @ 5 t ha<sup>-1</sup> and no manure. Whereas, all above mentioned parameters were obtained lowest with treatment of no manure.

Among different site specific nutrient management treatments, application of fertilizer with SSNM (STCR equation) + (ZnSO<sub>4</sub> @ 25 kg ha<sup>-1</sup> + S @ 10 kg ha<sup>-1</sup>) produced highest seed yield (1818 kg ha<sup>-1</sup>), straw yield (4948 kg ha<sup>-1</sup>), biological yield (6767 kg ha<sup>-1</sup>), harvest index (26.86%), GMR (73546 Rs. ha<sup>-1</sup>), NMR (46851 Rs. ha<sup>-1</sup>) and economic efficiency (375 Rs. ha<sup>-1</sup> day<sup>-1</sup>), being statistically on par with treatment of SSNM (STCR equation). Highest B: C ratio (2.76) was observed with application of fertilizer through SSNM (STCR equation) + (ZnSO<sub>4</sub> @ 25 kg ha<sup>-1</sup> + S @ 10 kg ha<sup>-1</sup>). The lowest value in respect to yield and economics of safflower were recorded under treatment of no fertilizer.

**Keywords:** SSNM, STCR, RDF, safflower, FYM, yield, rainfed and economics

**Introduction**

Safflower crop, like other crops, requires balanced nutrition, including secondary/micro nutrients and adequate moisture to realize higher seed and oil yield. Despite the fact that safflower is a drought tolerant crop Bitarafan *et al.*, (2011) [3] this crop often experiences moisture stress due to dry and hot weather prevalent during post-rainy season. Further, non-application of balanced nutrition based on the site-specific soil nutrient status is also another reason for lower safflower yields. Hence there was a need to test if site-specific nutrient management (SSNM) techniques in safflower crop to help to improve the yield. In addition application of FYM or organic residues would enhance SOM which in turn, help improve water holding capacity of soil. Therefore, combined application of organic and chemical nutrient elements based on site-specific nutrient status may not only enhance safflower yields but also help to build up drought resilience in the soil in long-run. [Weiss (2000) [16], Yogesh (2013)] [17].

Nutrient management is a major component of a soil and crop management system. Knowing the required nutrients for all stages of growth and understanding the soil's ability to supply those needed nutrients is critical for profitable crop production. Site specific nutrient management is applying that concept to areas within a field that are known to require different management from the field average. (Sushanta *et al.*, 2011) [13].

The component of site specific management may not be new but have the capability with new technology to use them more effectively. Site specific management include practices that have been previously associated with maximum economic yield management, best management practices as well as general agronomic principles.

The systematic implementation of these practices in site specific system is probably the best opportunity to develop a truly sustainable agriculture system. (Sushanta *et al.*, 2011) [13].

Fertilizer recommendation based on soil test crop response correlation (STCR) concept is more quantitative, precise and meaningful because the combined use of soil and plant analysis is involved in it. While developing the STCR targeted yield equation contribution of nutrients from soil, fertilizer and organics are taken in to consideration. Similarly, by taking these into consideration, nutrient requirement (NR) to produce a quintal of grain or any economic produce are considered. It gives a real balance between applied nutrients and the available nutrients already present in the soil. Therefore, under taken with a view of evolving soil test and targeted yield based fertilizer recommendation for safflower and test their adoptability under rainfed condition.

### Material and Methods

A field experiment was conducted at research farm, Department of Agronomy, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola (MS), during rabi season of 2017-18. The experimental soil was medium deep black, alkaline in reaction pH (8.0), EC (0.30 dSm<sup>-1</sup>), low in available nitrogen (194.0 kg ha<sup>-1</sup>), medium in available phosphorus (26.10 kg ha<sup>-1</sup>) and slightly high in available potassium (327 kg ha<sup>-1</sup>). The status of organic carbon content (0.59) which was medium in category. Fertilizers were applied to the crop based on target yield and fertility status. Initial value of available nitrogen (194 kg ha<sup>-1</sup>), phosphorus (26.10 kg ha<sup>-1</sup>) and potassium (327 kg ha<sup>-1</sup>) were considered to calculate the fertilizer requirement for targeted yields of safflower. The experiment was laid out in FRBD with fifteen treatments combination *viz.*, Factor A consisting three treatments M<sub>0</sub> - No manure, M<sub>1</sub> - 5 t FYM ha<sup>-1</sup> and M<sub>2</sub> - greengram residue incorporation likewise Factor B consist of five nutrient management treatments *i.e.* F<sub>0</sub> - control (no fertilizer), F<sub>1</sub> - Recommended NPK, F<sub>2</sub> - SSNM (STCR equation), F<sub>3</sub> - SSNM (STCR equation) + (ZnSO<sub>4</sub> @ 25 kg ha<sup>-1</sup> + S @ 10 kg ha<sup>-1</sup> and F<sub>4</sub> - SSNM (NPK) (deficient + 25% rec.; medium: rec.; high: - 25% rec.). This treatments combination replicated four times. The fertilizers used were urea, Diammonium phosphate and muriate of potash. Sulphur was supplied through single super phosphate. Zinc was applied through zinc sulphate @ 25 ha<sup>-1</sup>. The variety of safflower was AKS-207 on 6<sup>th</sup> October 2017-18 by keeping 45 cm x 20 cm spacing and harvesting was done 23<sup>th</sup> February 2018. FYM @ 5 t/ha<sup>-1</sup> and greengram residue incorporation @ 2 t/ha<sup>-1</sup> content 0.46%, 0.17%, 0.48% and 1.61%, 0.22%, 0.55% NPK respectively. Yield and yield attributes were recorded at the time of harvest. The results were analyzed by using standard procedures. The experimental data on yield

and economics were statistically analysed to draw valid conclusions of significance by using the methods prescribed by Gomez and Gomez, (1984) [5]. The gross realization in term of rupees per hectare was worked out separately for each treatment considering the yields of seed and straw and their respective prices prevailed during the respective year. Likewise, the cost of cultivation was worked out by considering the expenses incurred on routine operations from preparatory tillage to harvesting including threshing, cleaning as well as the cost of inputs *viz.*, seeds, fertilizers etc. The total cost of cultivation was deducted from the gross realization to work out the net income for each treatment combinations and was recorded accordingly.

Net return (Rs.ha<sup>-1</sup>) = Gross return (Rs.ha<sup>-1</sup>) – Cost of cultivation (Rs.ha<sup>-1</sup>).

The targeted yield equations developed for the safflower crop under AICRP on STCR scheme were used for the calculation of fertilizer N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O by considering the targeted yield of 15 q ha<sup>-1</sup> was done by the equation listed below.

F.N = 9.11 x T – 0.45 x S.N;

F. P<sub>2</sub>O<sub>5</sub>: 6.27 x T – 2.19 x S. P;

F. K<sub>2</sub>O: 9.27 x T – 0.38 x S. K

### Research findings and Discussion

#### Effect of manures

#### Seed yield and straw yield

The data pertaining to the effect of different organic manure sources on seed yield, straw yield, biological yield and harvest index of safflower grown under rainfed condition are given in Table 1. The treatments with application of 5 t FYM ha<sup>-1</sup> (M<sub>1</sub>) recorded significantly highest seed yield (1745 kg ha<sup>-1</sup>), straw yield (4661 kg ha<sup>-1</sup>) and biological yield (6406 kg ha<sup>-1</sup>) as compared no manure (M<sub>0</sub>). However, it was statistically at par with treatment greengram residue incorporation (M<sub>2</sub>). Maximum harvest index was registered with treatment of 5 t FYM ha<sup>-1</sup> (M<sub>1</sub>) followed by treatments greengram residue incorporation (M<sub>2</sub>) and no manure (M<sub>0</sub>). Likewise, lowest seed yield (1311 kg ha<sup>-1</sup>), straw yield (3879 kg ha<sup>-1</sup>), biological yield (5180 kg ha<sup>-1</sup>) and harvest index (25.16%) were noticed under the no manure applied treatment during investigation. The improvement in seed yield, straw yield and biological yield of safflower over no manure treatment (M<sub>0</sub>) was 33.10%, 20.15% and 23.66%, respectively by the application of 5 t FYM ha<sup>-1</sup> (M<sub>1</sub>). This might be due that Increased in seed yield, straw yield and biological yield due to application of 5 t FYM ha<sup>-1</sup> this might be due to its beneficial effects both on soil and plant by making sufficient amounts available to plant nutrients throughout the growth period resulting in better uptake, plant vigour and superior seed yield (Shivakumar and Ahlawat, 2008) [11].

**Table 1:** Seed yield, straw yield, biological yield (kg ha<sup>-1</sup>) and harvest index (%) of safflower as influenced by manure application and site specific nutrient management practices under *rainfed* condition

Treatments	Seed yield kg ha <sup>-1</sup>	Straw yield kg ha <sup>-1</sup>	Biological yield kg ha <sup>-1</sup>	Harvest index (%)
<b>Manure application</b>				
M <sub>0</sub> : No Manure	1311	3879	5180	25.16
M <sub>1</sub> : 5 t FYM ha <sup>-1</sup>	1745	4661	6406	27.21
M <sub>2</sub> : Greengram residue incorporation	1629	4568	6198	26.29
SE m±	46	140	184	-
CD @ 5%	132	399	524	-
<b>SSNM practices</b>				
F <sub>0</sub> : Control (No fertilizer)	1214	3555	4770	25.50

F <sub>1</sub> : Recommended NPK	1504	4296	5801	25.78
F <sub>2</sub> : SSNM (STCR equation)	1698	4677	6375	26.59
F <sub>3</sub> : SSNM (STCR equation) + (ZnSO <sub>4</sub> @ 25 kg ha <sup>-1</sup> + S @ 10 kg ha <sup>-1</sup> )	1818	4948	6767	26.86
F <sub>4</sub> : SSNM (NPK) (deficient + 25% rec.; Medium: rec.; high: - 25% rec.)	1573	4370	5943	26.38
SE m±	60	180	237	-
CD @ 5%	171	515	677	-
<b>Interaction (M x F)</b>				
SE m±	104	312	411	-
CD at 5%	NS	NS	NS	-
GM	1562	4370	5931	26.22

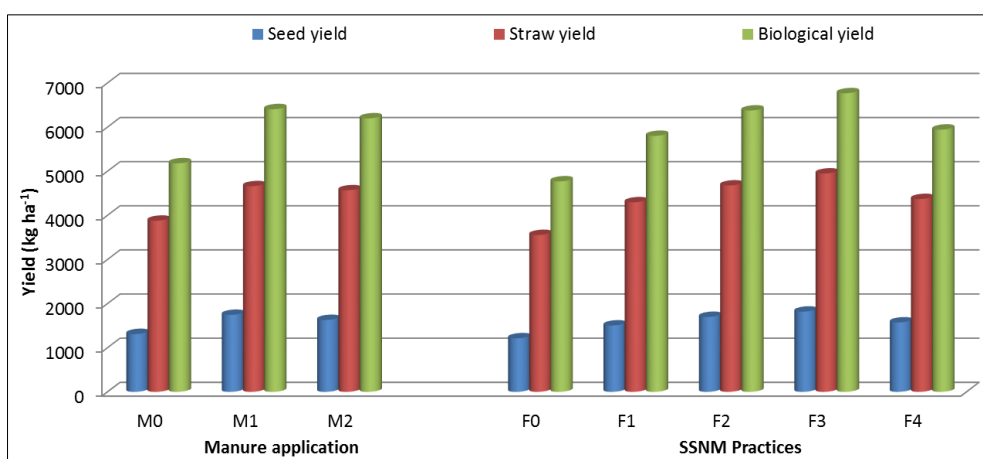


Fig 1: Seed yield, Straw yield and Biological yield (kg ha<sup>-1</sup>) as influenced by different treatments

### Effect site specific nutrient management

Seed is the ultimate output of a crop which determines the profitability of the crop production enterprise. Site specific nutrient management practices had significant effects on the seed yield, straw yield, biological yield and harvest index of safflower and their interaction was found to be non-significant (Table 1). Among the different site specific nutrient management practices, significantly higher seed yield (1818 kg ha<sup>-1</sup>), straw yield (4948 kg ha<sup>-1</sup>) and biological yield (6767 kg ha<sup>-1</sup>) produced the treatment with application of fertilizer through SSNM (STCR equation) + (ZnSO<sub>4</sub> @ 25 kg ha<sup>-1</sup> + S @ 10 kg ha<sup>-1</sup>) (F<sub>3</sub>) superior over rest of site specific nutrient management treatments. However, it was found to be statistically on par with treatment SSNM (STCR equation) (F<sub>2</sub>). Higher harvest index (26.86%) was recorded in treatment where SSNM (STCR equation) plus ZnSO<sub>4</sub> @ 25 kg ha<sup>-1</sup> and S @ 10 kg ha<sup>-1</sup> (F<sub>3</sub>) followed by treatments F<sub>2</sub>, F<sub>4</sub>, F<sub>1</sub> and F<sub>0</sub>. Whereas, the treatment i.e. no fertilizer was observed lowest seed yield (1214 kg ha<sup>-1</sup>), straw yield (3555 kg ha<sup>-1</sup>), biological yield (4770 kg ha<sup>-1</sup>) and harvest index (25.50%) during the experimental year of safflower. The increment in seed yield, straw yield and biological yield of safflower over (F<sub>0</sub>) no fertilizer treatment was 49.75%, 39.18% and 41.86%, respectively by the application of SSNM (STCR equation) + ZnSO<sub>4</sub> @ 25 kg ha<sup>-1</sup> + S @ 10 kg ha<sup>-1</sup> (F<sub>3</sub>). Increased in seed yield, straw yield and biological yield due to application of balanced fertilizer of SSNM (STCR equation) + ZnSO<sub>4</sub> @ 25 kg ha<sup>-1</sup> + S @ 10 kg ha<sup>-1</sup> might be due to enhancement in yield usually depends upon the total dry matter produced and its distribution among different parts of the plant. The higher seed yield may be attributed to higher total dry matter accumulation which in turn might be due to the availability of balanced and higher nutrition viz. available nitrogen, phosphorus, potassium as well sulphur and zinc and

their uptake and translocation to the reproductive parts and their cumulative effect on improvement in yield attributing characters. Similar results were obtained by Mishra and Vyas (2015)<sup>[9]</sup>, Subramanivan *et al.*, (2001), Biradar *et al.*, (2006)<sup>[2]</sup>, Anand *et al.*, (2017)<sup>[11]</sup> and Rahevar *et al.*, (2017)<sup>[10]</sup>.

### Economics analysis

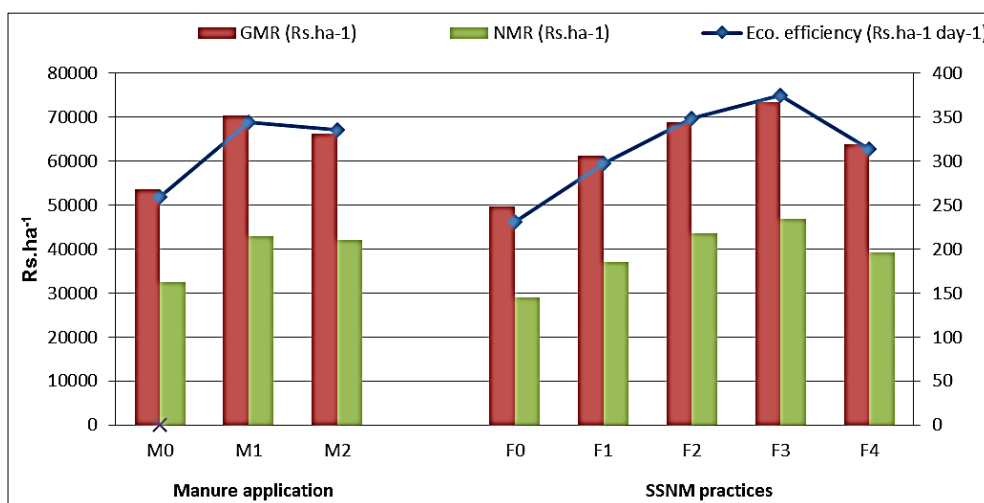
#### Effect of manures

Economic analysis of the treatments is of utmost importance in any study to work out the suitability of any intervention for higher returns. The data pertaining to the effect of different treatments on economics parameters have been presented in Table 2 and graphically depicted in Fig. 1. In respect of gross monetary returns (70394 Rs. ha<sup>-1</sup>), net monetary returns (43018 Rs. ha<sup>-1</sup>) and economics efficiency (344 Rs. ha<sup>-1</sup>) were significantly higher with application of 5 t FYM ha<sup>-1</sup> (M<sub>1</sub>) over the treatment no manure applied (M<sub>0</sub>). However, it was found comparable with treatment of greengram residue incorporation (M<sub>2</sub>). Highest B:C ratio was observed under the treatment with residue incorporation of greengram (2.73) and 5 t FYM ha<sup>-1</sup> (2.55) remained second in order. While, minimum gross monetary returns (53630 Rs. ha<sup>-1</sup>), net monetary returns (32405 Rs. ha<sup>-1</sup>) economic efficiency (259 Rs. ha<sup>-1</sup> day<sup>-1</sup>) and B:C ratio (2.52) were achieved under the treatment no manure (M<sub>0</sub>). Similar results were reported by Thakur and Sharma, (2005)<sup>[15]</sup> and Choudhary *et al.*, (2017)<sup>[4]</sup> reported an increase in GMR with application of FYM @ 5 t ha<sup>-1</sup>.

The cost of cultivation of safflower is given in Table 2. The cost of cultivation of a particular treatment did not vary in four replications; hence, data on cost of cultivation were not analysed statistically. Average cost of cultivation was 24461 Rs. ha<sup>-1</sup> during experimentation.

**Table 2:** Gross monetary returns, net monetary return, cost of cultivation (Rs.ha<sup>-1</sup>) and B:C ratio of safflower as influenced by manures application and site specific nutrient management practices under rainfed condition

Treatments	Gross monetary return (Rs. ha <sup>-1</sup> )	Net monetary return (Rs. ha <sup>-1</sup> )	Cost of cultivation (Rs. ha <sup>-1</sup> )	Economic efficiency (Rs. ha <sup>-1</sup> day <sup>-1</sup> )	B:C ratio
Manure application					
M <sub>0</sub> : No Manure	53630	32405	21271	259	2.52
M <sub>1</sub> : 5 t FYM ha <sup>-1</sup>	70394	43018	27881	344	2.55
M <sub>2</sub> : Greengram residue incorporation	66173	41987	24231	336	2.73
SE m±	1885	1885	-	15	-
CD @ 5%	5381	5381	-	43	-
SSNM practices					
F <sub>0</sub> : Control (No fertilizer)	49616	28899	21094	231	2.42
F <sub>1</sub> : Recommended NPK	61241	37108	24293	297	2.52
F <sub>2</sub> : SSNM (STCR equation)	68788	43593	25369	349	2.73
F <sub>3</sub> : SSNM (STCR equation) + (ZnSO <sub>4</sub> @ 25 kg ha <sup>-1</sup> + S @ 10 kg ha <sup>-1</sup> )	73546	46851	26869	375	2.76
F <sub>4</sub> : SSNM (NPK) (deficient + 25% rec.; Medium: rec.; high: -25% rec.)	63804	39232	24678	314	2.58
SE m±	2434	2434	-	19	-
CD @ 5%	6947	6947	-	56	-
Interaction (M x F)					
SE m±	4216	4216	-	34	-
CD at 5%	NS	NS	-	NS	-
GM	63339	39137	24461	313	2.60

**Fig 2:** GMR, NMR (Rs. ha<sup>-1</sup>) and economic efficiency (Rs. ha<sup>-1</sup> day<sup>-1</sup>) as influenced by different treatments

### Effect of site specific nutrient management

The economics study of safflower found statistically significant under different SSNM treatments during the year 2017-18 indicated in Table. 2 and graphically presented in fig. 1. Among the different site specific nutrient management, treatment of SSNM (STCR equation) + (ZnSO<sub>4</sub> @ 25 kg ha<sup>-1</sup> + S @ 10 kg ha<sup>-1</sup>) and SSNM (STCR equation) both being statistically at par with each other and significantly increased gross monetary returns (73546 Rs. ha<sup>-1</sup>), net monetary returns (46851 Rs. ha<sup>-1</sup>) and economic efficiency (375 Rs. ha<sup>-1</sup> day<sup>-1</sup>) over the control treatment (F<sub>0</sub>). Highest B: C ratio (2.76) value was recorded under treatment of soil applied fertilizer through SSNM (STCR equation) + (ZnSO<sub>4</sub> @ 25 kg ha<sup>-1</sup> + S @ 10 kg ha<sup>-1</sup>) (F<sub>3</sub>) followed by treatments of F<sub>2</sub>, F<sub>4</sub>, F<sub>1</sub> and F<sub>0</sub>. Lowest values with respect to gross monetary returns (49616 Rs. ha<sup>-1</sup>), net monetary returns (28899 Rs. ha<sup>-1</sup>), economic efficiency (231 Rs. ha<sup>-1</sup> day<sup>-1</sup>) and B: C ratio (2.42) obtained in control treatment during investigation. The results were in accordance with the findings of Gudadhe *et al.*, (2011) [6],

Kumar *et al.*, (2017) [7], Meena *et al.*, (2017) [8] and Thakare *et al.*, (2019) [14].

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### Conclusion

From the above enumeration, it may be concluded that application of 5 t FYM ha<sup>-1</sup> registered significantly highest values with respect to yield and economics of safflower. Similarly, among different site specific nutrient management treatments, application of fertilizer through SSNM (STCR equation) + ZnSO<sub>4</sub> @ 25 kg ha<sup>-1</sup> + S @ 10 kg ha<sup>-1</sup> recorded maximum yield, GMR, NMR, B: C ratio and economic efficiency of safflower under rainfed condition. Hence, it is advisable in Vidarbha region, that in rabi safflower, for higher productivity and remunerative crop, adequate amount of

fertilizer dose integrated with organic manure should be applied.

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