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Amar Kumar
Faculty of Agricultural Sciences and Allied Industries, Rama University, Kanpur Nagar, Uttar Pradesh, India

Dr. AS Yadav
Faculty of Agricultural Sciences and Allied Industries, Rama University, Kanpur Nagar, Uttar Pradesh, India

Corresponding Author:
Amar Kumar
Faculty of Agricultural Sciences and Allied Industries, Rama University, Kanpur Nagar, Uttar Pradesh, India

Response of organic, inorganic source of nutrient and Sulfur on linseed (*Linum usitatissimum* L.) crop

Amar Kumar and Dr. AS Yadav

Abstract
This experiment was carried out during *Rabi* season of 2021-22 at Agricultural Research Farm of faculty of Agricultural Sciences and Allied Industries, Rama University, Mandhana, Kanpur Nagar (U.P). The present experiment was laid out in random block design, the experiment consists of 9 treatments *viz*; where organic, inorganic source of nutrient and Sulfur T_1- Control, T_2- RDF 100%, T_3-RDF + S (15 kg ha^{-1}), T4-RDF + 3 t ha^{-1} Vermicompost + S (15 kg ha^{-1}), T_5- RDF + 5 t ha^{-1} Vermicompost + S (15 kg ha^{-1}), T_6-RDF + 7 t ha^{-1} FYM + S (15 kg ha^{-1}), T_7- RDF + 10 t ha^{-1} FYM + S (15 kg ha^{-1}), T_8- RDF + 1 t ha^{-1} Poultry Manure + S (15 kg ha^{-1}), T_9- RDF + 3 t ha^{-1} Poultry Manure + S (15 kg ha^{-1}) with three replications in linseed crop. The results of this experiment result indicate the growth parameter *viz*; plant height, number of primary, secondary and tertiary branches was estimated with 100% RDF + 5 t ha^{-1} Vermicompost + S (15 kg ha^{-1}) which was statistically at par with 100% RDF + 3 t ha^{-1} Poultry Manure + S (15 kg ha^{-1}) but statistically superior than 100% RDF + 10 t ha^{-1} FYM + S (15 kg ha^{-1}) and RDF + 3 t ha^{-1} Vermicompost + S (15 kg ha^{-1}) but both were statistically at par with each other. The minimum plant height at 60 DAS was estimated from control plot and yield attributing characture *viz*; Number of capsules per plant, Number of seed per capsule and Test weight of linseed crop and seed and straw yield linseed crop was recorded maximum from 100% RDF + 5 t ha^{-1} Vermicompost + S (15 kg ha^{-1}) which was statistically more than 100% RDF + 3 t ha^{-1} Poultry Manure + S (15 kg ha^{-1}) and 100% RDF + 10 t ha^{-1} FYM + S (15 kg ha-1), RDF + 3 t ha^{-1} Vermicompost + S (15 kg ha^{-1}) and RDF + 1 t ha^{-1} Poultry Manure + S (15 kg ha^{-1}). The maximum Net return and B:C ratio of linseed crop was estimated with 100% RDF + 5 t ha^{-1} Vermicompost + S (15 kg ha^{-1}) (Rs. 87075/ha) which was more than with 100% RDF + 3 t ha^{-1} Poultry Manure + S (15 kg ha^{-1}) (Rs. 80683/ha) and 100% RDF + 10 t ha^{-1} FYM + S (15 kg ha^{-1}) (Rs. 67985 /ha). The minimum Net return was estimated from control plot (Rs. 51256 /ha).

Keywords: RDF, Sulfur, vermicompost, poultry manure, FYM

Introduction
Linseed (*Linum usitatissimum* L.) also well-known as flax that is grown in north India, is a crucial Rabi season oil seed crop. It is fitting for temperate climate with cold season. Linseed crop is one of the primitive oil seed crops, among all oilseed crops grown in north India, that cultivated for both oil and fiber purpose. Linseed crop is conventionally grown on marginal and sub-marginal soil with subsidiary use of agricultural inputs in Indian states. The oil contains in linseed crop 34-43% and also utilized in industry such as pulp making, paper, and paint and as fiber (Rowland *et al*. 1995) [27].

Worldwide, the linseed crop is a noteworthy while its production almost in the world 2.65 million tonnes from 2.62 million ha area with its standard productivity is 1011kg ha-1. However, its national production is 0.10 million tonnes from 0.28 million ha-1 along with national average productivity of 541 kg ha^{-1}(Annual Report, AICRP on linseed, 2019-20) [5]. India's have to be ranks 4th in term of total area coverage and 3rd in its total production followed by Canada, Russia, India, China, and USA. (Anonymous, 2020-21) [2].

In India, predominantly linseed crop has to be grown under rainfed condition (63%), its area under utera cropping system (25%) and irrigated condition (12%) along with marginal inputs. The foremost constraints for its lower national productivity are the all those areas that basically comes under sub-marginal, un-irrigated, input starving and marginal conditions of crop management practices, and its cultivation of traditionally along low yielding old and unimproved local linseed crops cultivars with marginal use of input. He malnourishes situation have to be major difficulty for the low productivity at country level.

The production of linseed crop has to be low because at a time of cultivation, too lack of proper management practices and proper fertilization by the traditional growing farmers.

Among high yielding improved cultivars of crops, greater emphasis has to be laid on the increased use of integrated supplement of nutrient sources and management practices for higher crop production. Among the non-existence of enough fertilizer supply, the only alternative source for crop production inputs such as application of organic manure and green manure and residual nutrient sources of previous crop. Therefore, the appropriate utilization of organic manures not only beneficial for increased crop production and also improve oil percent through their potential for contributing nutrients but also responsible for other beneficial effects on physical properties of soil. Among organic sources of nutrients like vermicompost, FYM etc. also have to be better utilization of available resource and also ability to produce highest potential yield of crops with lower expenses (Stockdale *et al*. 2001; Alabadan *et al.* 2009) [3]. INM has most outstanding approach in which integrated use of organic and inorganic sources of plant nutrient in linseed crop for its production and profitability, but it also helpful for stabilizing the permanent fertility status of the soil (Kumar *et al*., 2013).

Materials and Method

Geographically, Kanpur is situated in sub tropical region at an altitude of 125.9 meter from the mean sea level and latitude ranging of 25^0 56' to 28° 58' North and longitude 79° 31' to 80° 34' East. The climate of locality is semi arid with moderate rainfall and cold winters. The mean annual rainfall is 850 mm extending generally from the mid June to mid October. The temperature rises maximum during May - June (45 – 48 °C) and come down to 4 -5 ^0C during December - January. Occasional showers are also received during winter and summer.

The present experiment was laid out in random block design, the experiment consists of 9 treatments *viz*; where organic, inorganic source of nutrient and sulfur T_1- Control, T_2- RDF 100%, T_3-RDF + S (15 kg ha^{-1}), T4-RDF + 3 t ha^{-1} Vermicompost + S (15 kg ha^{-1}), T_5- RDF + 5 t ha^{-1} Vermicompost + S (15 kg ha^{-1}), T_6-RDF + 7 t ha^{-1} FYM + S (15 kg ha^{-1}), T_7- RDF + 10 t ha^{-1} FYM + S (15 kg ha^{-1}), T_8-RDF + 1 t ha^{-1} Poultry Manure + S (15 kg ha^{-1}), T_9- RDF + 3 t ha^{-1} Poultry Manure + S (15 kg ha^{-1}) with three replications in linseed crop.

Result and Discussion

The initial plant population and plant population at time of harvest per running meter row length of linseed crop does not show significant results due to organic, inorganic source of nutrient and application of Sulfur.

The plant height at 30 DAS of linseed crop does not show significant results due to organic, inorganic source of nutrient and application of sulphur. The maximum plant height of linseed crop at 60 DAS was estimated with 100%RDF + 5 t ha^{-1} Vermicompost + S (15 kg ha^{-1}) which was statistically at par with100%RDF + 3 t ha-1 Poultry Manure + S (15 kg ha^{-1}) but statistically superior than 100% RDF + 10 t ha^{-1} FYM + S (15 kg ha^{-1}) and RDF + 3 t ha^{-1} Vermicompost + S (15 kg ha^{-1}) but both were statistically at par with each other. The minimum plant height at 60DAS was estimated from control plot.

Although, the maximum plant height of linseed crop at 90 DAS was estimated with 100% RDF + 5 t ha^{-1} Vermicompost + S (15 kg ha^{-1}) which was statistically at par with 100% RDF + 3 t ha^{-1} Poultry Manure + S (15 kg ha^{-1})but statistically superior than 100% RDF + 10 t ha^{-1} FYM + S (15 kg ha^{-1}) and RDF + 3 t ha^{-1} Vermicompost + S (15 kg ha^{-1}) but both were statistically at par with each other. The minimum plant height at 90 DAS was estimated from control plot.

The maximum number of primary branches of linseed crop was estimated with 100% RDF + 5 t ha^{-1} Vermicompost + S (15 kg ha^{-1}) which was statistically at par with 100% RDF + 3 t ha^{-1} Poultry Manure + S (15 kg ha^{-1}) but statistically superior than 100% RDF + 10 t ha^{-1} FYM + S (15 kg ha^{-1}) and RDF + 3 t ha^{-1} Vermicompost + S (15 kg ha^{-1}). The minimum number of primary branches was estimated from control plot.

The maximum number of secondary branches of linseed crop was estimated with 100% RDF + 5 t ha^{-1} Vermicompost + S (15 kg ha^{-1}) which was statistically at par with 100% RDF + 3 t ha^{-1} Poultry Manure + S (15 kg ha^{-1}) but statistically superior than 100% RDF + 10 t ha^{-1} FYM + S (15 kg ha^{-1}) and RDF + 3 t ha^{-1} Vermicompost + S (15 kg ha^{-1}) but both were statistically at par with each other. The minimum number of secondary branches was estimated from control plot.

The maximum number of tertiary branches of linseed crop was estimated with 100% RDF + 5 t ha^{-1} Vermicompost + S (15 kg ha^{-1}) which was statistically at par with 100% RDF + 3 t ha^{-1} Poultry Manure + S (15 kg ha^{-1}) but statistically superior than 100% RDF + 10 t ha^{-1} FYM + S (15 kg ha^{-1}) and RDF + 3 t ha^{-1} Vermicompost + S (15 kg ha^{-1}) but both were statistically at par with each other. The minimum number of tertiary branches was estimated from control plot.

The maximum Number of capsules per plant of linseed crop was estimated with 100% RDF + 5 t ha^{-1} Vermicompost + S (15 kg ha^{-1}) which was statistically at par with 100% RDF + 3 t ha^{-1} Poultry Manure + S (15 kg ha^{-1}) but statistically superior than 100% RDF + 10 t ha^{-1} FYM + S (15 kg ha^{-1}) and RDF + 3 t ha^{-1} Vermicompost + S (15 kg ha^{-1}). The minimum Number of capsules per plant was estimated from control plot.

The maximum Number of seed per capsule of linseed crop was estimated with 100% RDF + 5 t ha^{-1} Vermicompost + S (15 kg ha^{-1}) which was statistically at par with 100% RDF + 3 t ha^{-1} Poultry Manure + S (15 kg ha^{-1}) but statistically superior than 100% RDF + 10 t ha^{-1} FYM + S (15 kg ha^{-1}) and RDF + 3 t ha^{-1} Vermicompost + S (15 kg ha^{-1}). The minimum Number of seed per capsule was estimated from control plot.

The maximum Test weight of linseed crop was estimated with 100% RDF + 5 t ha^{-1} Vermicompost + S (15 kg ha^{-1}) which was statistically at par with 100% RDF + 3 t ha^{-1} Poultry Manure + S (15 kg ha^{-1}) but statistically superior than 100% RDF + 10 t ha^{-1} FYM + S (15 kg ha^{-1}), RDF + 3 t ha^{-1} Vermicompost + S (15 kg ha^{-1}) and RDF + 1 t ha^{-1} Poultry Manure + S (15 kg ha^{-1}). The minimum Test weight was estimated from control plot.

The maximum seed yield of linseed crop was estimated with 100% RDF + 5 t ha^{-1} Vermicompost + S (15 kg ha^{-1}) which was statistically more than 100% RDF + 3 t ha^{-1} Poultry Manure + S (15 kg ha^{-1}) and 100% RDF + 10 t ha^{-1} FYM + S (15 kg ha^{-1}), RDF + 3 t ha^{-1} Vermicompost + S (15 kg ha^{-1}) and RDF + 1 t ha^{-1} Poultry Manure + S (15 kg ha^{-1}). The minimum seed yield was estimated from control plot.

The maximum biological yield of linseed crop was estimated with 100% RDF + 5 t ha^{-1} Vermicompost + S (15 kg ha^{-1}) which was statistically more than 100% RDF + 3 t ha^{-1} Poultry Manure + S (15 kg ha^{-1}) and 100% RDF + 10 t ha^{-1} FYM + S (15 kg ha^{-1}). The minimum biological yield was estimated from control plot.

The maximum Harvesting index of linseed crop was

estimated with 100% RDF + 5 t ha^{-1} Vermicompost + S (15 kg ha^{-1}) which was statistically at par with 100% RDF + 3 t ha^{-1} Poultry Manure + S (15 kg ha^{-1}) but statistically superior than 100% RDF + 10 t ha^{-1} FYM + S (15 kg ha^{-1}) and RDF + 3 t ha^{-1} Vermicompost + S (15 kg ha^{-1}). The minimum Harvesting index was estimated from control plot.

The maximum B: C ratio of linseed crop was estimated with 100% RDF + 10 t ha^{-1} FYM + S (15 kg ha^{-1}) followed by 100% RDF + 3 t ha^{-1} Poultry Manure + S (15 kg ha^{-1}) and 100% RDF + 5 t ha^{-1} Vermicompost + S (15 kg ha^{-1}). The minimum B: C ratio was estimated from control plot.

Discussion

Growth and development studies on crop: Application of vermicompost, FYM, sulphur and poultry manure on linseed crop was exhibited significant difference in plant height at 60 and 90 DAS. The maximum plant height of linseed crop at 60 and 90 DAS was estimated with 100% RDF + 5 t ha-1 Vermicompost + S (15 kg ha-1) which was statistically at par with 100% RDF + 3 t ha-1 Poultry Manure + S (15 kg ha-1) but statistically superior than 100% RDF + 10 t ha-1 FYM + S (15 kg ha-1) and RDF + 3 t ha-1 Vermicompost + S (15 kg ha-1) but both were statistically at par with each other. The maximum number of primary branches, secondary and tertiary branches of linseed crop was estimated with 100% RDF + 5 t ha-1 Vermicompost + S (15 kg ha-1) which was statistically at par with 100% RDF + 3 t ha-1 Poultry Manure + S (15 kg ha-1) but statistically superior than 100% RDF + 10 t ha-1 FYM + S (15 kg ha-1) and RDF + 3 t ha-1 Vermicompost + S (15 kg ha-1). This could be happened because vermicompost, FYM, sulphur and poultry manure is the important sources of many organic and inorganic amino acid, hormones and growth regulator. This growth promoting substance increase the root and shoot growth of plant. Similar finding has been reported by Sharma *et al*. (2003) and Patil *et al.* (2018), Bharat *et al.* (2013), Mahammad *et al*. (2013), Jangid et al. (2022) [25, 8, 23, 16].

Yield and yield attributes studies on crop: Organic and inorganic sources of nutrient along with sulphur should be increase the yield attributing character and yield of crop. The maximum Number of capsules per plant, Number of seed per capsule and Test weight of linseed crop was estimated with 100% RDF + 5 t ha^{-1} Vermicompost + S (15 kg ha^{-1}) which was statistically at par with 100% RDF + 3 t ha^{-1} Poultry Manure + S (15 kg ha^{-1}) but statistically superior than 100% RDF + 10 t ha^{-1} FYM + S (15 kg ha-1) and RDF + 3 t ha-1 Vermicompost + S (15 kg ha^{-1}). This could be happened that organic sources not only supplement the primary and secondary nutrient but also important sources of micronutrient. Well balanced nutrient supplement to the plant not only increase the growth but also increased yield of crop. The similar result has been representing by Badiyala, and Kumar (2003) [10], Kumar and Deka (2016), Badiyala, and Kumar (2003) [10], Verma and Yadav (2017).

Economics

The maximum Net return of linseed crop was estimated with 100% RDF + 5 t ha-1 Vermicompost + S (15 kg ha-1) (Rs. 87075/ha) which was more than with 100% RDF + 3 t ha-1 Poultry Manure + S (15 kg ha-1) (Rs. 80683/ha) and 100% RDF + 10 t ha-1 FYM + S (15 kg ha-1) (Rs. 67985 /ha). The minimum Net return was estimated from control plot (Rs. 51256 /ha).The maximum B: C ratio of linseed crop was estimated with 100% RDF + 10 t ha-1 FYM + S (15 kg ha-1) followed by 100% RDF + 3 t ha-1 Poultry Manure + S (15 kg ha-1) and 100% RDF + 5 t ha-1 Vermicompost + S (15 kg ha-1). Patil *et al*. (2014) [24].

Table 1: Response of organic, inorganic source of nutrient and Sulfur on Plant Population, Plant height, Number of Branches

Symbol	Treatments	Plant Population		Plant height			Number of Branches		
		Initial	At Harvest	30 DAS	60 DAS	90DAS	Primary	Secondary	Tertiary
T_1	Control	79.210	78.100	16.640	28.340	48.750	3.12	6.300	9.320
T_2	RDF 100%	80.210	79.100	16.200	32.620	50.750	3.150	6.450	9.450
T_3	RDF + S (15 kg ha^{-1})	81.000	80.600	16.520	33.850	52.120	3.250	6.550	9.500
T_4	RDF + 3 t ha^{-1} Vermicompost + S (15 kg ha^{-1})	80.850	78.750	16.260	34.600	53.710	3.520	7.550	10.120
T_5	RDF + 5 t ha^{-1} Vermicompost + S (15 kg ha^{-1})	81.520	80.420	16.420	38.100	58.450	4.100	8.250	12.160
T_6	RDF + 7 t ha^{-1} FYM + S (15 kg ha^{-1})	81.110	80.100	16.300	33.100	53.620	3.450	6.950	9.620
T_7	RDF + 10 t ha^{-1} FYM + S (15 kg ha^{-1})	81.720	80.620	16.120	34.400	54.100	3.850	7.360	10.520
T_8	RDF + 1 t ha^{-1} Poultry Manure + S (15 kg ha^{-1})	81.810	80.160	16.090	33.720	53.920	3.620	7.360	9.700
T_9	RDF + 3 t ha^{-1} Poultry Manure + S (15 kg ha^{-1})	81.10	80.90	15.46	35.42	55.12	4.0	8.36	12.08
	C.D.	N/A	N/A	N/A	3.10	4.385	0.271	0.526	0.823
	S.E(m)	2.188	2.153	0.442	0.879	1.432	0.089	0.172	0.269
	S.E(d)	3.094	3.044	0.625	1.243	2.025	0.125	0.243	0.380
	C.V.	4.682	4.676	4.690	4.514	4.663	4.761	4.490	4.631

Table 2: Response of organic, inorganic source of nutrient and Sulfur on Number of capsules/plant, Number of seed/plant, test weight, Grain Yield, Biological Yield, Harvesting Index, B:C ratio

Symbol	Treatments	Number of capsules per plant	Number of seed per capsule	Test weight (g)	Grain yield (Kg/ha)	Biological Yield (Kg/ha)	Harvesting index (%)	B:C Ratio
T_1	Control	42.210	5.750	6.630	12.920	19.950	64.427	1.95
T_2	RDF 100%	47.550	7.150	7.800	13.750	20.160	68.200	1.99
T_3	RDF + S (15 kg ha^{-1})	48.160	7.300	7.850	13.900	20.450	68.940	1.98
T_4	RDF + 3 t ha^{-1} Vermicompost + S (15 kg ha^{-1})	48.460	7.400	8.100	14.740	21.900	70.520	2.15
T_5	RDF + 5 t ha^{-1} Vermicompost + S (15 kg ha^{-1})	54.630	8.350	8.900	20.450	27.850	75.09	2.44
T_6	RDF + 7 t ha^{-1} FYM + S (15 kg ha^{-1})	48.000	7.340	7.900	14.100	20.460	68.910	2.00
T_7	RDF + 10 t ha^{-1} FYM + S (15 kg ha^{-1})	51.600	7.850	8.250	16.260	22.670	71.720	2.99

T_8	RDF + 1 t ha^{-1} Poultry Manure + S (15 kg ha^{-1})	49.100	6.760	8.200	15.460	20.900	70.590	2.08
T_9	RDF + 3 t ha^{-1} Poultry Manure + S (15 kg ha^{-1})	52.16	8.16	8.57	18.85	25.10	73.420	2.48
	C.D.	4.019	0.595	0.453	1.244	1.785	2.924	
	S.E(m)	1.312	0.194	0.213	0.406	0.583	0.955	
	S.E(d)	1.856	0.275	0.301	0.574	0.824	1.350	
	C.V.	4.636	4.647	4.684	4.629	4.632	2.376	

Conclusion

It is concluded from the above finding that the application of 100% RDF + 5 t ha^{-1} Vermicompost + S (15 kg ha^{-1}) is being found to be best in the terms of Growth parameters, Yield and Yield attribute parameters and Benefit cost ratio.

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