Journal of Pharmacognosy and Phytochemistry
Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2018; SP1: 2003-2006

Tej Lal Kashyap
Scientist, DKS college of Agriculture and Research Station, Bhatapara, IGKV, Chhattisgarh, India

SN Khajanji
Professor, College of Agriculture, IGKV, Raipur, Chhattisgarh, India

GK Shrivastava
Professor & DSW, Indira Gandhi Krishi Vishwavidhyalaya, Raipur, Chhattisgarh, India

Correspondence
Tej Lal Kashyap
Scientist, DKS college of Agriculture and Research Station, Bhatapara, IGKV, Chhattisgarh, India

Effect of sowing methods x varieties and fertilizer levels on Oil content and Oil yield of linseed Grown after Rice in Alfisols of Chhattisgarh plain

Tej Lal Kashyap, SN Khajanji and GK Shrivastava

Abstract
Ph.D research on “Agro-resource management studies on growth, yield, quality and economics of linseed (*Linum usitatissimum* Linn.) grown after rice in Alfisols of Chhattisgarh plains” was conducted during *rabi* seasons of 2009-10 and 2010-11 at Research cum Instructional Farm, Indira Gandhi Krishi Vishwavidyalaya, Raipur with the specific objectives to study the interaction effect of sowing methods and fertilizer management on growth, yield, nutrient uptake, oil content and economics of linseed varieties. Two different experiments on linseed crop were undertaken during two consecutive *rabi* seasons of 2009-10 and 2010-11. The experiment was sown on 26th November, 2010 and harvested on 24th March, 2011. Based on 2 years experimentation it is concluded that treatment line sowing x RLC-92 (S_1V_1) registered significantly oil content as well as maximum oil yield. Among the fertilizer levels, maximum oil yield was obtained under 50% more RDF (F_2) followed by RDF + S (F_1) during both the years and on mean basis.

Keywords: Linseed, Economics, Management

Introduction
Linseed is also highly responsive to sulphur application, as it is constituent of “glucothione” which plays an important role in synthesis of oil in seed. Sulphur is needed for development of cell and increase cold resistance and drought hardiness of the plant. Sulphur requirement of linseed is quite high ranging from 20 to 60 kg ha^{-1}, depending on the soil status and yield potential of the variety (Aulakh and Pasricha, 1997). The low yield of linseed is characterized mainly due to lack of high yielding genotypes, further lack of response to better conditions and the instability in yield of linseed due to varying environment are also of great concern. Information is not available on the response of linseed to management strategies like tillage manipulation, planting methods and irrigation management to optimise seed yield of linseed after harvest of rice under the agro-climatic conditions of Chhattisgarh plains.
Linseed is grown after rice on marginal and sub-marginal lands with low or no-fertilizers, mostly under rainfed both as relay cropping “*utera*” in paddy fallow and as upland in unbunded fields. In *utera* cultivation, most of the farmers use broadcasting method of sowing without fertilizer application, resulting in poor soil seed moisture content and seed may not get proper germination with decreases plant growth. So, there is urgent need to find out efficient method of sowing for optimum stand establishment and higher production and productivity of the crop.
Keeping above facts in view and considering the benefits and increased popularity of linseed, Ph.D research entitled “Agro-resource management studies on growth, yield, quality and economics of linseed (*Linum usitatissimum* Linn.) grown after rice in Alfisols of Chhattisgarh plains” was conducted during *rabi* seasons of 2009-10 and 2010-11 at Research cum Instructional Farm, Indira Gandhi Krishi Vishwavidyalaya, Raipur with the following specific objectives: To study the interaction effect of sowing methods and fertilizer management on growth, yield, nutrient uptake, oil content and economics of linseed varieties.

Materials and Methods
Location and Experimental Site
The location of the experimental site was Research cum Instructional Farm, Indira Gandhi Krishi Vishwavidyalaya, Raipur (Chhattisgarh) located at 21°4' N latitude and 81°39' E longitude with an altitude of 298 metre above mean sea level having sub tropical humid climate.

Climate Conditions

The climate of Raipur region is sub humid with hot and dry summer and mild winter. It comes under the Chhattisgarh plains agro- climatic sub zone of seventh agro climatic region of India i.e. eastern plateau and hills. The average annual rainfall is about 1320 mm of which about 88 % is received during a span of four months i.e. between June to September. The rainfall is largely contributed by south-west monsoon. The maximum temperature raises up to 45°C during summer and minimum temperature falls to 5-6 °C during winter season. The relative humidity reaches maximum 93 % and minimum 41 % in August and March, respectively.

Treatment Details

Two different experiments on linseed crop were undertaken during two consecutive *rabi* seasons of 2009-10 and 2010-11. The experiment treatments were divided into main plots and sub plots in split plot design with three replications. Treatments comprised of three sowing methods with two varieties viz., broadcast x RLC-92 (S_0V_1), line sowing x RLC-92 (S_1V_1), criss-cross x RLC-92 (S_2V_1), broadcast x Deepika (S_0V_2), line sowing x Deepika (S_1V_2), criss-cross x Deepika (S_2V_2) as main plot treatment and three fertilizer levels viz. RDF (F_0), RDF + S (F_1) and 50% more of RDF (F_2) as sub plot treatment. The experiment was sown on 26th November, 2010 and harvested on 24th March, 2011.

Oil content (%) and yield (kg ha^{-1})

Oil content (%) in linseed seeds was estimated by the Nuclear Magnetic Resonance (NMR). Oil content in seed sample of each treatment was multiplied by corresponding seed yield (kg ha^{-1}) to get the oil yield (kg ha^{-1}).

Result and discussion

Economic yield (q ha^{-1})

The data on Economic yield of linseed as influenced by sowing methods x varieties and fertilizer levels are given in Table 1. The results revealed that among sowing methods x varieties significantly higher seed yield of linseed was observed under line sowing x RLC-92 (S_1V_1) as compared to other treatments, however, it was at par to criss-cross x RLC-92 (S_2V_1) and line sowing x Deepika (S_1V_2) during both the years and on mean basis. Linseed seeded under fertilizer levels showed significant variation in seed yield. The 50% more RDF (F_2) produced significantly higher seed yield (11.53, 11.34 and 11.44 q ha^{-1} in 2009-10, 2010-11 and on mean basis, respectively) than RDF (F_0), but it was comparable to RDF + S (F_1) during both the years and on mean basis.

The data on Economic yield of linseed reveal that significantly highest seed yield of 11.71 q ha^{-1} on mean basis was noted under line sowing x RLC -92 (S_1V_1) followed by criss-cross x RLC -92 (S_2V_1) and line sowing x Deepika (S_1V_2). Increase in seed yield was also contributed due to corresponding increase in growth parameters viz., plant height, number of branches plant^{-1}, leaf area index and dry matter accumulation and yield components viz. number of seeds capsule^{-1}, number of capsules plant^{-1} and 1000-seed weight. It is well known fact that nitrogen, phosphorus and potassium play a major role in photosynthesis, development of capsules plant^{-1}, 1000-seed weight consequently helping in increased yield. This observation is in close conformity with the findings of Sharma and Thakur (1989), Sood and Kumar (1993), Dhiman *et al.* (1997), Singh *et al.* (1997) and Khare *et al.* (1999).

The treatment line sowing produced higher yield followed by broadcast. Higher seed yield may be because of proper placement of seed and fertilizer through seed-cum-fertilizer drill and availability of nutrient for longer period. Whereas, in broadcast some of the applied nitrogen might have been lost due to volatilization from surface application as the soil reaction was conducive for such a loss. Similar results were reported by Bhatia *et al.* (1989).

The higher yield of linseed under 50% more RDF treatment can be ascribed due to higher value for growth parameters like plant height, dry biomass of plant, number of branches plant^{-1}, LAI and CGR during both the years. The above findings clearly suggest that higher nutrient doses enhanced the growth parameters, which ultimately increase seed yield. The higher yield obtained was also due to higher yield attributes *viz*., number of seeds capsule^{-1}, number of capsules plant^{-1} and 1000-seed weight. The similar findings were also obtained by Mahmud *et al*. (1997) and Ramamoorthy *et al.* (1997).

Stalk yield (q ha^{-1})

The data presented in Table-1 reveals that among sowing methods x varieties, the stalk yield of linseed was significantly higher under line sowing x RLC-92 (S_2V_1) as compared to other treatments, however, it was at par to criss-cross x RLC-92 (S_2V_1), broadcast x RLC-92 (S_0V_1) and broadcast x Deepika (S_0V_2) during 2009-10 and on mean basis. During 2010-11, treatment criss-cross x RLC-92 (S_2V_1) registered significantly higher stalk yield of linseed as compared to other treatments, but it was comparable to line sowing x RLC-92 (S_1V_1) and broadcast x Deepika (S_0V_2).

Linseed seeded under fertilizer levels showed significant variation in stalk yield. The 50% more RDF (F_2) produced significantly higher stalk yield (25.11, 23.19 and 24.15 q ha^{-1} during 2009-10, 2010-11 and on mean basis, respectively) than RDF (F_0), however, it was comparable to RDF + S (F_1) treatment during both the years and on mean basis. Similar findings have been also reported by Subbain and Ramaih (1981).

The different sowing methods x varieties influenced the stalk yield and maximum stalk yield was obtained under line sowing x RLC-92 (S_1V_1) in 2009-10 and on mean basis and under criss-cross sowing x RLC-92 (S_2V_1) during 2010-11 as compared to other sowing methods x varieties. This treatment may be attributed to better performance of plant growth parameters (plant height, primary and secondary branches) through optimum utilization of resources which had direct bearing on the production of higher dry matter. This might also because of favourable physical environment that might have increased the mineralization mobility of fertilizer resulting higher nutrient uptake and crop growth thus, leading to higher dry matter production. The results are in conformity with the findings of Kondazatowicz (1970) and Jaiswal and Singh (2001).

Biological yield (q ha^{-1})

The data presented in Table-1 reveal that among sowing methods x varieties, the biological yield was significantly higher under line sowing x RLC-92 (S_1V_1) as compared to other treatments, however, it was at par to criss-cross x RLC-92 (S_2V_1) during both the years and on mean basis. Treatment line sowing x Deepika (S_1V_2) was also found comparable during 2010-11. The biological yield was significantly affected due to fertilizer levels. Significantly higher biological yield of linseed was observed under 50% more RDF (F_2) than RDF (F_0), however, it was statistically at par to RDF + S (F_1)

during both the years and on mean basis.

Oil content (%) and oil yield (kg ha^{-1})

Oil content and oil yield studies are presented in Table 2. Data of oil content and oil yield were significantly affected due to sowing methods x varieties and fertilizer levels. Among the sowing methods x varieties, oil content and oil yield were significantly higher under line sowing x RLC-92 (S_1V_1) as compared to other treatments, but it was at par to line sowing x Deepika (S_1V_2) and criss-cross x RLC-92 (S_2V_1) during both the years and on mean basis.

As regards to fertilizer levels, significantly higher oil content was observed under RDF + S (F_1) than RDF (F_0) but, it was comparable to 50% more RDF (F_2) during both the years and on mean basis. Whereas, oil yield was significantly higher under 50% more RDF (F_2) than RDF (F_0), but, it was at par to RDF+S (F_1) during both the years and on mean basis.

The higher oil yield with application of S was because of the increase in seed yield and oil content. These results are in agreement with the findings of Singh and Singh (2007). Higher level of S favourably increased transformation of carbohydrates in oil that increased oil content and oil yield by hydrolyzing more glucocides due to increased availability and presence of sulphur (Rathore and Manohar, 1989). The efficacy of sulphur in enhancing oil content of linseed was also reported by Jaggi *et al.* (1993).

Table 1: Economic yield, stalk yield and biological yield of linseed as influenced by sowing methods x varieties and fertilizer levels

Treatment	Economic yield (q ha^{-1})			Stalk yield (q ha^{-1})			Biological yield (q ha^{-1})		
	2009-10	2010-11	Mean	2009-10	2010-11	Mean	2009-10	2010-11	Mean
S_0V_1: Broadcast x RLC-92	9.33	8.92	9.13	23.72	21.61	22.67	32.01	31.40	31.71
S_1V_1: Line sowing x RLC-92	11.76	11.67	11.71	23.94	21.94	22.94	35.47	33.28	34.38
S_2V_1: Criss-cross x RLC-92	10.73	10.63	10.68	22.92	22.92	22.92	34.55	32.65	33.60
S_0V_2: Broadcast x Deepika	9.02	8.68	8.85	22.68	22.48	22.58	32.96	30.62	31.79
S_1V_2: Line sowing x Deepika	10.60	10.56	10.58	21.47	21.47	21.47	32.07	32.03	32.05
S_2V_2: Criss-cross x Deepika	9.36	8.97	9.16	21.80	21.86	21.83	32.16	31.83	31.99
SEm±	0.47	0.42	0.44	0.46	0.33	0.36	0.61	0.52	0.41
CD (P=0.05)	1.48	1.33	1.39	1.46	1.04	1.13	1.92	1.64	1.30
F_0 : RDF	8.06	8.00	8.03	20.90	18.82	19.97	28.12	27.93	28.02
F_1 : RDF + S	10.76	10.42	10.59	24.26	22.14	23.09	34.68	34.12	34.40
F_2 : 50 % more RDF	11.53	11.34	11.44	25.11	23.19	24.15	35.31	35.36	35.34
SEm±	0.27	0.33	0.31	0.32	0.36	0.40	0.47	0.55	0.38
CD (P=0.05)	0.80	0.98	0.91	0.93	1.06	1.17	1.38	1.63	1.13

Table 2: Oil content (%) and oil yield (kg ha^{-1}) of linseed as influenced by sowing methods x varieties and fertilizer levels

Treatment	Oil content (%)			Oil yield (kg ha^{-1})		
	2009-10	2010-11	Mean	2009-10	2010-11	Mean
Sowing methods x Varieties						
S_0V_1: Broadcast x RLC-92	39.03	39.07	39.05	368.90	353.08	360.99
S_1V_1: Line sowing x RLC-92	40.81	40.54	40.68	481.88	475.03	478.45
S_2V_1: Criss-cross x RLC-92	39.76	39.43	39.59	426.78	428.14	427.46
S_0V_2: Broadcast x Deepika	38.48	38.13	38.31	352.68	335.54	344.11
S_1V_2: Line sowing x Deepika	39.70	39.33	39.52	423.00	417.48	420.24
S_2V_2: Criss-cross x Deepika	39.27	39.01	39.14	370.31	352.00	361.15
SEm±	0.37	0.48	0.41	18.69	19.10	21.77
CD (P=0.05)	1.19	1.52	1.29	58.90	60.20	68.59
Fertilizer levels						
F_0 : RDF	36.08	35.79	35.93	291.97	288.08	290.02
F_1 : RDF + S	41.48	41.18	41.33	447.05	429.99	438.52
F_2 : 50 % more RDF	40.96	40.79	40.88	472.75	462.57	467.66
SEm±	0.18	0.19	0.18	11.80	13.46	13.22
CD (P=0.05)	0.53	0.56	0.54	34.45	39.29	38.60

References

1. Aulakh, Pasricha. Influence of sulphur application on mustard. Journal of Soils and Crops. 1997; 15(1):175-178.
2. Bhatia DS, Mali AL, Singh S, Jat RC. Effect of chemical weed control and methods of sowing on nitrogen uptake, quality and correlation studies in cumin. Crop Research Hisar. 1989; 2(2):154-158.
3. Dhiman SD, Sharma HC, Hariom Nandal DP, Singh D. Influence of irrigation, methods of planting and fertilizer management on yield and yield attributes in rice-wheat system. Haryana Journal of Agronomy. 1997; 13(2):100-105.
4. Jaggi RC, Kanwal RS, Dixit SP. Effect of nitrogen and sulphur on yield quality of linseed in an acid Alfisol. Journal of Indian Society of Soil Science. 1993; 41(2):283-287.
5. Jaiswal VP, Singh GR. Effect of planting methods, source and level of nitrogen on growth and yield of rice and on succeeding wheat. Indian Journal of Agronomy. 2001; 46(1):5-11.
6. Khare JP, Sharma RS, Soni NK. Effect of sulphur and Antitranspirants on Chlorophyll content, dry matter production and oil yield of rainfed linseed. Journal of Oilseed Research. 1999; 16(1):48-50.
7. Kondratowicz J. The effect of increasing nitrogen rates and different proportions of N:P:K on yield and quality of flax fibre. Field Crop Abstract. 1970; 25(2):2463.
8. Mahmud M, Chiezey UF, Ahmed MK, Rufai I. Effect of different levels of phosphorus fertilizer and intra-row spacing on the grain yield, growth and yield components of blackgram. Discovery of Innovation. 1997; 9(1-2):47-

51.
9. Ramamoorthy K, Balasubramanian A, Arokia Raj A. Response of rainfed blackgram to phosphorus and sulphur nutrition in red lateritic soil. Indian Journal of Agronomy. 1997; 42(11):191-193.
10. Singh AK, Singh GR, Dixit RS. Influence of plant population and moisture regime on nutrient uptake and quality of winter maize (*Zea mays*). Indian Journal of Agronomy. 1997; 42(1):107-111.
11. Sharma RS, Thakur CL. Economic and energy factors in soybean cultivation. Indian Journal of Agronomy. 1989; 34 (3):337-340.
12. Sood BR, Kumar N. Effect of cropping system and sowing methods on yield and quality of rabi forages under rainfed condition. Haryana Journal of Agronomy. 1993; 9(1):56-58.
13. Subbian P, Ramaih S. Influence of P and Mo and Rhizobium inoculation on P transfer efficiency in red gram. Madras Agricultural Journal. 1981; 68:133-134.