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Effect of different row arrangement of linseed (*Linum usitatissimum* L.) and chandrasur (*Lepidium sativum* L.) sole and intercropping system on growth pattern, seed yield and linseed equivalent yield in Chhattisgarh plains

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Abstract
A field experiment was carried out at university farm, IGKV. Raipur (C.G.) during *rabi* season of 2020-21 to study the effect of row arrangement on growth and yield of linseed based intercropping system. The experiment was laid out in randomized block design with three replications and comprises of eight different planting pattern combinations of linseed and chandrasur crops are sole linseed, sole chandrasur, linseed + chandrasur (1:1), linseed +chandrasur (2:1), linseed +chandrasur (3:1), linseed +chandrasur (2:2), linseed +chandrasur (4:2), linseed +chandrasur (5:2). Results revealed that significantly highest values for growth parameters *viz*. plant height, branches plant-1, dry matter accumulation, seed yield and stover yield were recorded with their pure stands of the crops. But as when compare with different intercropping system, the highest linseed equivalent yield (1513 kg ha-1) was obtained with 3:1 row ratio of linseed+ chandrasur over sole planting.

Keywords: Chandrasur, intercropping system, linseed, linseed equivalent yield, planting pattern and row arrangement

Introduction
Linseed (*Linum usitatissimum* L.) belongs to the Linum genus and family Linaceae. Since ancient times, it has been grown for its fiber (flax) and seed, which is rich in oil. Linseed is one of the widely grown economically important species, cultivated in many countries like Ethiopia, the USA, Russia, France, Belarus, China etc. In India, linseed is grown mainly in the central parts of the country, like MP, eastern Maharashtra, Chhattisgarh, Bihar, UP. Linseed is commercially grown for seed oil (industrial oil linseed), fiber, or both (dual use linseed), but linseed oil is the richest plant source of alpha linolenic acid (ALP), an important omega 3 fatty acid, and lignin content, which account for about 57 percent of total fatty acids in linseed. Linseed oil is high in linolenic acid, an Omega-6 essential fatty acid (66 percent above), which makes it a great drying oil.
Chandrasur (*Lepidium sativum* L.) is an annual, fast growing edible herbaceous plant that belongs to Brassicaceae family which are used to treat hyperactive airway disorders like asthma, bronchitis, and cough. Imidazole, lepidine, semi-lepidinoside A and B, -carotenes, ascorbic acid, linoleic acid, oleic acid, palmitic acid, stearic acid, sinapic acid, and sinapin are all recognized components of the plant. Chandrasur is reported to exhibit antihypertensive, diuretic, anti-inflammatory, analgesic, anticoagulant, antirheumatic, hypoglycemic, laxative, prokinetic, antidiarrheal, and antispasmodic properties. Intercropping is the cultivation of two or more crops simultaneously on the same field. The main subject of intercropping, is to augment total productivity per unit area and time, besides judicious and equitable utilization of land resources and farming inputs. (Marer *et al.* 2007) [3]. Higher crop productivity and efficiency in resources use was observed in linseed and field pea intercropping systems than the sole cropping (Prakash *et al.* 2009). The present study was conducted to analyse the influence of planting pattern on growth, yield, quality and economics of linseed and chandrasur intercropping system.

Materials and Methods
The present investigation on was carried out during rabi season of 2020-2021 at the university farm, I.G.K.V., Raipur (C.G.).

Climate of the region is dry moist, sub- humid with average rainfall of 1170 mm. The experiment was laid out in randomized block design with eight treatments and three replications. The treatment comprises of various planting pattern are sole linseed, sole chandrasur, linseed + chandrasur (1:1), linseed + chandrasur (2:1), linseed + chandrasur (3:1), linseed + chandrasur (2:2), linseed + chandrasur (4:2), linseed + chandrasur (5:2). The soil of the experimental field was clayey in texture. The linseed variety "RLC-138" and chandrasur variety "GA-1" were used for the experiment. To evaluate the treatment effect, the various morphological observations, growth parameters were recorded in the experiment at 30,60,90 DAS and at harvest stage were taken as per schedule and requirement of investigation.

The yields of different intercrops are converted into equivalent yield of anyone crop based on price of the produce. The LEY was calculated as follows:

$$\text{LEY (kg ha}^{-1}) = \frac{\text{Economic yield of a crop x kg}^{-1}\text{ price of chandrasur}}{\text{kg}^{-1}\text{ price of linseed}}$$

Result and Discussion

Growth and yield of linseed

Sole linseed recorded significantly highest plant height (68.17 cm), no. of branches plant-1 (22.36), dry matter accumulation (6.25 g) than in its intercropping treatments. Maximum seed yield (1396 kg ha-1) and stover yield (2919 kg ha-1) was recorded in sole planting. Among the intercropping treatments, 3:1 row ratio of linseed + chandrasur recorded higher plant height (66.22 cm), no. of branches plant-1 (21.89), dry matter accumulation (5.58 g), seed yield (1143 kg ha-1) and stover yield (2596 kg ha-1) followed by 4:2 row ratio of linseed + chandrasur. Harvest index were non significantly influenced by different row arrangement on linseed. The maximum HI (31.99%) of linseed was recorded under 1:1 row arrangement followed by 2:2 and 5:2 row ratios of linseed +chandrasur. Similar findings are reported by Jerai *et al.* (2010) [2] and Rahman *et al.* (2009) [5].

Growth and yield of Chandrasur

At different time intervals of observation, highest plant height (97.32 cm), no. of branches plant-1 (16.35), dry matter accumulation (25.56 g), seed yield (1453 kg ha^{-1}) and stover yield (3568 kg ha-1) were recorded higher in the sole planting followed by 1:1 row ratio of linseed + chandrasur intercropping system. Maximum HI (32.55%) was recorded in treatment 3:1 row ratio of linseed+ chandrasur followed by 4:2, 5:2 and 2:1 row arrangement The lower seed yield in intercropping system might be due to lesser number of plants/unit area. This finding supports the results of Bhuva *et al.* (2017) [1].

System productivity

Linseed equivalent yield (LEY)

Intercrop productivity was evaluated by the equivalent yield of the component crops. Linseed equivalent yield (LEY) was influenced significantly due to different row arrangement of sole and intercropping of linseed and chandrasur practices**.** The examination of the data clearly revealed the highest LEY (1513 kg ha-1) was recorded under 3:1 row arrangement of linseed+ chandrasur followed by row ratio of 4:2. This can be attributed to better performance of both the intercrops and better utilization of resources in intercropping as well as good yield of chandrasur as in intercrop can be the possible reasons for higher linseed equivalent yield. Sarkar *et al*. (2004) [6] and Tanwar *et al.* (2011) [7] also reported similar findings in different intercropping system.

Table 1: Effect of planting pattern on plant height (cm), branches plant-1 (No.), dry matter accumulation (g plant-1) of linseed and chandrasur intercropping system at different interval of time

Treatment	Plant height (cm)		Branches plant^{-1} (No.)		Dry matter accumulation (g plant-1)	
	Linseed	Chandrasur	Linseed	Chandrasur	Linseed	Chandrasur
T_1: Sole Linseed	68.17	-	22.36	-	6.25	-
T_2: Sole Chandrasur	-	97.32	-	16.35	-	25.56
T_3: Linseed+Chandrasur (1:1)	59.80	95.93	19.05	15.23	3.38	23.03
T_4: Linseed+Chandrasur (2:1)	61.02	87.57	20.07	14.20	3.56	21.32
T_5: Linseed+Chandrasur (3:1)	66.22	81.02	21.89	13.56	5.58	19.04
T_6: Linseed+Chandrasur (2:2)	62.11	93.41	20.22	15.03	4.03	22.31
T_7: Linseed+Chandrasur (4:2)	64.67	85.23	20.74	13.19	4.65	20.97
T_8: Linseed+Chandrasur (5:2)	63.20	90.58	20.34	14.46	4.32	21.76
S.Em±	0.93	1.25	0.53	0.58	0.31	0.91
CD(P=0.005)	2.87	3.85	1.64	1.77	0.95	2.73

Table 2: Effect of planting pattern on seed yield, stover yield, harvest index and linseed equivalent yield (LEY) of linseed and chandrasur intercropping system

Treatment	Linseed			Chandrasur			Linseed Equivalent yield (LEY)
	Seed Yield (kg ha-1)	Stover yield (kg ha-1)	Harvest Index (%)	Seed yield (kg ha-1)	Stover Yield (kg ha-1)	Harvest Index (%)	
T_1: Sole Linseed	1396	2919	30.62	-	-	-	1396
T_2: Sole Chandrasur	-	-	-	1453	3568	28.93	1453
T_3: Linseed+Chandrasur (1:1)	701	1523	31.50	722	1734	29.38	1319
T_4: Linseed+Chandrasur (2:1)	868	1845	31.99	610	1356	31.02	1390
T_5: Linseed+Chandrasur (3:1)	1143	2596	30.56	432	895	32.55	1513
T_6: Linseed+Chandrasur (2:2)	824	1804	31.35	693	1512	31.42	1418
T_7: Linseed+Chandrasur (4:2)	986	2269	30.29	570	1185	32.47	1474
T_8: Linseed+Chandrasur (5:2)	919	2072	30.72	501	1091	31.46	1348
S.Em±	45	71	0.93	28	66	0.85	42
CD(P=0.05)	139	219	NS	86	204	NS	131

Conclusion

The increase in plant height, no. of branches, dry matter accumulation, seed yield and stover yield was noticed in sole planting of linseed and chandrasur. However, highest linseed equivalent yield (LEY) was obtained under 3:1 row ratio of linseed + chandrasur intercropping system followed by 4:2 row ratio.

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