Original Research Article

Influence of intercropping ratios on profitability of chickpea-linseed based intercropping.

ABSTRACT

A field experiment was conducted on student instructional farm (SIF) at Chandra Shekhar Azad University of Agriculture and Technology, Kanpur during the *rabi* season 2019-20 and 2020-21, In the present experiment 24 treatments, were laid out in split plot design with three replications, where allocation of treatments to intercropping system with 8 treatments in main-plots and cultural practices in with 3 treatments in sub-plots. Chickpea and Linseed are shown in different ratio with different cultural practices. Chickpea & Linseed (variety avrodhi & shekhar) intercropping was taken for study. The results revealed that the profitability of intercropping system respond significantly with the different treatment combination. The highest cost of cultivation (37231 & 40067 rupees^{-1}) was obtained sole cropping (I_1 treatment), gross return (105082 & 116581 rupees ha^{-1}), net return (69181 & 78124 rupees) and benefit cost ratio (1.292 & 1.303) was obtained with I_5 treatment {chickpea + linseed (5:1)} during both the years. The treatment combination I_5 was gave superior result in terms of gross return, net return and B:C ratio, while maximum cost of cultivation was found in treatment I_1 during 2019-20 and 2020-21.

Keywords: Chickpea, linseed, Inter-cropping, split plot design , profitability

Comment [H1]:

INTRODUCTION

All Pulses which have been an integral part of Indian diet predominantly vegetarian masses by virtue of being rich in protein and several essential amino acids are most popular among Indian farmers due to their easiness to fit into the crop rotation as well as crop mixture, along with restoration of soil fertility. Food legumes are of prime importance in human diet and animal feed contributing the major source of vegetable protein.Chickpea is known by different names such as "Gram, Chana, and Bengal

gram." Gram or Chickpea (*Cicer arietinum* L.) a member of family Fabaceae, is an ancient self-pollinated leguminous crop, diploid annual (2N=16), in different area of the world but its cultivation is mainly concentrated in semi-arid environments. The plants of the chickpea grow between 40-55cm and have feathery leaves on both sides of the stem.

They are good source of protein, carbohydrate and minerals particularly in vegetarian diet. On an average, pulses contain 20-25 percent protein, but in chickpea 20-22 percent protein and linseed is an important oilseed and fiber crop, it contain 33-44 percent oil content in their dry seeds, which is almost 2.5-3.0 times the value normally found in cereals. Thus, the food legumes ensure nutritional security to the poor masses of the country. Chickpea is the most important crop of *rabi* season which occupies an area of 13.3 million ha (m ha) and production of 11.75 million tons (MT) during 2011. In 2013 the area of chickpea cultivation increased to 13.5 m ha but production remained at 13.1 MT (FAOSTAT 2015). Chickpea is currently the second most important food legumes in the world after common bean. Chickpea is a cool season crop and general perception is that it requires cooler and longer winter season *i.e.* also comes under long day plants, and more suited to northern India. It was probably true for the earlier varieties which were bred for cooler, long-season environments confining the chickpea production to northern and central India.

Comment [H2]: Give recent figures

Chickpea (*Cicerarietinum L.*) is one of the most important pulse crops in India and preferred as an important constituent of Indian vegetarian diet.It is most important crop of Rabi season which occupies an area of 3.88 million hectare in the country with an annual production of 3.29 million tonnes and productivity of 8.49 q/h, followed by Myanmar 5.80 lakh hectare, China 0.6 lakh ha and Nepal 0.3 lakh ha. About 95% production of chickpea is from south Asia and 90% which belongs to India. In U.P, it is grown on an area of about 3.20 lakh with a annual production and productivity of 3.34 lakh tonnes and 10.4 q/h, respectively producing about 1.41 tons with the productivity of 911 kg ha-1 **(Anon., 2016-17).**

Comment [H3]: Add recent figures

Significant advantages is land use efficiency, crop productivity and monetary returns in intercropping, as compared with sole cropping of component crops have been recorded by various research workers covering diverse agro-ecological situations. Intercropping results more efficient use of solar energy and harnessing benefits of positive interactions in crop associations. Overall mixture densities and relative

proportion of component crops are important in determining yields and production efficiency of intercropping system. There is obviously not a direct substitution of one plant of a component crop for one plant of the other component crop **(Reddy, 2004)**.

India is the third largest (14.88%) linseed growing countries in the world and production wise it ranks fourth (6.57%) in the world after Canada (31.80%), China (14.74%), and Kazakhstan (13.18%). In India linseed is predominantly grown under rain fed (63%) and *utera* (25%) and irrigated (12%) conditions and the prominent states are Madhya Pradesh, Maharashtra, Chhattisgarh, Uttar Pradesh, Bihar, Jharkhand, Odisha, Karnataka, West Bengal and Assam. The major impediments for the lower national productivity is due to its continued cultivation under sub-marginal, un-irrigated, input starved and poor crop management conditions coupled with low seed replacement rate. Linseed is basically an industrial oilseed crop and its each and every part is endowed with commercial and medicinal importance. Tolerance to biotic and abiotic stresses is another important characteristic of this crop and because of this property the survival and cultivation of linseed is still prevailing in a wide range of climate conditions and regions. After the inception of AICRP on linseed in late sixties (1967), the organized crop improvement programs undertaken in the project have culminated in the development of 65 high yielding varieties (56 seed and 9 dual purpose types) mostly of multi-regional adaptation with mono/multiple disease resistance. The present yield level is still very low (435 kg ha^{-1}) as compared to the production potential realized in the frontline demonstrations (965 kg ha^{-1}). Hence, in order to bridge this vast gap, I trust and believe that this technology bulletin will be of immense help for researchers, development agencies and extension personnel engaged in the upliftment of this crop.

Linseed is an important *rabi* oilseed crop of Uttar Pradesh, Madhya Pradesh, Chhattisgarh, Maharashtra, Odisha and Bihar. There has been a continuous decline in linseed area in the country during the last four decades so to sustain linseed production mainly in irrigated area. The cultivation of linseed is restricted mostly to marginal and sub marginal land under restricted supply of fertilizer and irrigation, lack of improved varieties and untimely sowing, resulting in low crop yield. The linseed crop maintained its increasing trend in productivity while, the area registered the declining trend resulting in stagnant production. The decrease in area might be due

to socio-economic factors as the per capita holding is shrinking owing to population increase, thereby pressing the growers to grow other crops for their sustenance. In addition to this, improper selection of varieties in this region, also affects the crop yield. At present there is a tremendous scope for increasing the yield of linseed with the use of multi-character high yielding varieties. Among the different practices to obtain higher crop yield with suitable agro technique under different agro-climatic zone, The production potentiality of linseed has tremendous potential to increase productivity per unit area by using high yielding.

Mishra *et al.* (2001) conducted a field experiment in Kanpur during 1998 – 2000 with three chickpea (*C. arietinum*) genotypes (BG 256, KPG 59 and KWR 108)intercropped with linseed (*L. usitatissimum* cv. Neelam) under row arrangements of 2:1, 4: 2 or 6: 2 (chickpea: linseed) to determine the best genotype combination and planting pattern for the test plants. KWR 108 exhibited the highest seed yield of 2406 kg ha^{-1} in its sole stand. Intercropping of KWR 108 with BG 256 was the mostcompatible among the combinations. Highest productivity (2601 kg ha^{-1}) (chickpeaequivalent), monetary return (Rs 6253 ha^{-1}) and income equivalent ratio (1.57) were recorded from BG 256 + Neelam under the 6: 2 row arrangement.

Malik *et al.* (2001) chickpea sole had lower yield than chickpea sole (strips 15/45 cm) which enhanced the return per ha. Chickpea intercropped with Indian mustard significantly reduced total seed yield, lentil produced 1045 kg seed/ha and had net returns of Rs. 12102.00/ha while the ratio of per rupee investment was 1:2.82. Intercropped of lentil with chickpea enhanced yield level (1527 kg/ha) with a net return of Rs. 17023.00 while ratio of per rupees investment was 1:3.60. intercropping of chickpea with Indian mustard had poor performance and had net return of only Rs. 2905.00 and 5105.00/ha while C:B ratio were 1:1.47 and 1:1.78 during 1993 and 1994 respectively.

Kumar *et al.* (2002) reported from Kanpur (U.P.) that intercropping of linseed + mustard in 5:1 row ratio gave significantly higher net profit than all other treatments including sole cropping.

Tiwari *et al.* (2003) field experiment were conducted during the winter session of 2000-01 and 2001-02 out at Bahraich and Rewa, Madhya Pradesh, India to evaluate the suitability of intercropping pulses and oilseeds in rice fallows under

rainfed conditions. Sole cropping of chickpea was superior to sole cropping of either mustard (*Brassica juncia*) or linseed. However, intercropping chickpea with linseed in a 2:2 row ratio recorded the highest grain yield (4.42 + 3.92 q/ha), net return (Rs. 8900.00/ha) and benefit cost ratio (2.16).

Reddy *et al.* (2004) reported the among either intercropping systems; WRG-53 and WRG-27 either with greengram or blackgram have produced significantly higher yields of pigeonpea, greengram, blackgram and pigeonpea equivalent yield as compared to all other systems during *kharif* 2002 and 2003. Significantly higher LER, protein content, net returns and benefit: cost ratio were observed in the above intercropping systems with WRG-53 followed by WRG-27 and ERG-56 under rainfed conditions in Vertisols (black soil) at Agricultural Research Station, Warangal.

Tripathi *et al.* (2005) in a field experiment conducted in Uttar Pradesh during the winter of 1998– 2000, studied sole cropped or intercropped chickpea cv. Udai and Indian mustard cv. Basanti supplied with 0, 30, 60 or 90 kg Pha^{-1}. Intercropping of chickpea and Indian mustard resulted in the highest land equivalent ratio (1.19), relative crowing coefficient (2.30) net returns (Rs. 17101 ha^{-1}) and benefit: cost ratio (2.11). The number of pods per plant and seeds per pod, 1000-seed weight, seed yield, land equivalent ratio and relative crowing coefficient increased with increasing rates of P. Returns and benefit: cost ratio increased with increasing rates of P up to 60 kg $ha^{-1.}$

Comment [H4]: Not required in introduction

MATERIALS AND METHODS

2.1 Study Site:- A field experiment was conducted at field no. 6 Student's Instructional Farm at **Chandra Shekhar Azad University of Agriculture and Technology, Kanpur** during the *Rabi* season 2019 and 2020. The experimental field was well drained with uniform topography and assured source of water supply through tube well. The farm is situated in the alluvial belt of the indo gangetic plain of central U.P., India. **2.2 Geographical Location:-** District Kanpur Nagar is situated in subtropical and semi-arid zone and lies between the parallel of 25°26'and 26°58'north latitude and 79°31' and 80°34' east longitude with an elevation of 125.9 m from sea level in the alluvial belt of Indo- gangetic plains of central Uttar Pradesh. **2.3 Experimental Details:** The experiment was laid out, 24 treatment combinations with 3 replications were tested in split-plot design where allocation of treatments to

intercropping system with 8 treatments in main-plots and cultural practices in with 3 treatments in sub-plots. The details of treatments along with symbols used are given below:

Main-plot treatments: intercropping systems with 8 treatments viz.

(i) I_1 - Chickpea Sole
(ii) I_2 - Linseed Sole
(iii) I_3 - Chickpea + Linseed (3:1)
(iv) I_4 – Chickpea + Linseed (4:1)
(v) I_5 – Chickpea + Linseed (5:1)
(vi) I_6-Chickpea + Linseed (4:2)
(vii) I_7 - Chickpea + Linseed (5:2)
(viii) I_8 – Chickpea + Linseed (6:2)

Sub-plot treatments: 3 Cultural practices viz.

(i) C_1 – Farmer Practices
(ii) C_2 –Weedicide (pre-emergence)
(iii) C_3 – Dust Mulch at 25 DAS

2.3.1 Details

Number of total plots	:	72
No. of plots/replication	:	24
No. of main plots/replication	:	8
No. of sub-plots/main plot	:	3
Gross plot size	:	5.0 m x 3.6 m =18 m^2
Row spacing	:	45 cm
Crop season	:	*Rabi*
Crop variety	:	Chickpea (*Avrodhi)*
		Linseed (Shekhar)

2.5 Economics

Economics of the treatment is very important to find out the most profitable treatment and for determining the overall profit from a practical point of view. For computing the economics, different variable cost items were considered. The expenditure on seeds, manures, fertilizers, plant protection, irrigation and labour charges were calculated at prevailing market price during 2020. Labour requirement was worked out on the basis of labours engaged for performing different field operations. So, economics of different treatments were worked out in terms of cost of cultivation, gross return, net return and benefit: cost ratio (B:C Ratio) to ascertain economic variability of the treatments.

2.5.1 Cost of Cultivation:- Analyed the cost of cultivation on the basis of different inputs used for raising the crops under different treatments. **2.5.2 Gross Return:-** The gross return was calculated plot wise. For this purpose, grain yield was converted into rupees hectare^{-1} at prevailing market price of maize. **2.5.3 Net return:-** It is the total income obtained after subtracting the cost of cultivation of each treatment from the gross income of the respective treatment plot. Monetary value gained after compensating the spent money can be said as net return. **Net return = Gross return – Cost of cultivation 2.5.4 Benefit: Cost Ratio:-** It is an indicator that attempts to summarize the overall value for money of cultivation. It is the ratio of benefit or net income, expressed in monetary value, relative to the cost of cultivation. It was calculated by dividing the net income of a treatment plot to the cost of cultivation of that particular treatment.

2.6 Statistical Analysis:- The experiment was laid out in factorial randomized block design and replicated thrice.The data on various characters studied during the course of investigation were statistically analyzed for factorial randomized block design. Wherever treatment differences were significant (“F” test), critical differences were worked out at five per cent probability level. The data obtained during the study were analyzed statistically using the methods advocated by **Chandel (1990).**

3. RESULTS

3.1 COST OF CULTIVATION

3.1.1 Common cost:

Common cost of cultivation in all treatments under different intercropping systems of chickpea linseed intercropping as Rs. 27311 ha^{-1} during 2019-20 and Rs. 27907 ha^{-1} during 2020-21 year for all treatments of growing of intercrops.

3.1.2 Variable cost :

Effect of different intercropping system reveal that variable cost of different treatments was recorded highest variable cost under **I_1**, Chickpea sole Rs. 9920 ha^{-1} during 2019-20 and Rs. 12160 ha^{-1} during 2020-21 year followed by other cropping system. However, minimum variable cost occurred in sowing of **I_6**, (4:2) Chickpea + Linseed Rs.34585 ha^{-1} during 2019-20 and Rs.36865 ha^{-1} during 2020-21 year of experiment.

3.1.3 **Total cost of cultivation:**

The results indicate that different intercropping system in respect to total cost of cultivation per hectare of chickpea –linseed intercropping system during both the year. Results reveal that total cost of cultivation was recorded maximum under the Chickpea sole Rs. 37231 ha^{-1} during 2019-20 and Rs.40067 ha^{-1} during 2020-21 year of experiment followed by different intercropping systems during both the years. The lowest total cost of cultivation was recorded under the **I_6**, (4:2) Chickpea + Linseed Rs. 34585 ha^{-1} during 2019-20 and Rs.36865ha^{-1} during 2020-21 year of experiment. However, among the cultural practices **C_2** (weedicide) - the response was recorded significantly higher cost of cultivation Rs. 30263 ha^{-1} during 2019-20 and Rs. 30712 ha^{-1} during 2020-21 followed by **C_3**, **(**Dust Mulch) – Rs. 29321 ha^{-1} and Rs. 29917 ha^{-1} during both year of experiment.

Table No. 1: Cost of cultivation, gross return, net return and B: C ratio under various intercropping system during 2019-20.

Treatment	Cost of cultivation (Rs ha^{-1})			Gross return (Rs ha^{-1})			Net return (Rs ha^{-1})	B : C ratio
	Common	Variable	Total	By seed	By stover	Total		
	A.MAIN PLOT							
I_1(sole)	27311	9920.	37231	78634	2672	81306	44075	1:2.18
I_2(sole)	27311	1975.	29286	54552	4410	58962	29676	1:2.01
I_3(3:1)	27311	7934	35245	78342	3636	81978	46733	1:2.32
I_4(4:1)	27311	8331.	35642	85215	3911	89126	53484	1:2.50
I_5(5:1)	27311	8590.	35901	100133	4949	105082	69181	1:2.92
I_6(4:2)	27311	7274	34585	70737	2661	73398	38813	1:2.12
I_7(5:2)	27311	7650	34961	74783	3313	78096	43135	1:2.23
I_8(6:2)	27311	7934	35245	80243	3595	83838	48593	1:2.37
	B.SUB-PLOT							
C_1	27311	0	27311	70054	3775	73829	46518	1:2.70
C_2	27311	2952	30263	81413	4309	85722	55459	1:2.83
C_3	27311	2010	29321	75563	3976	79539	50218	1:2.71

Table No. 2: Cost of cultivation, gross return, net return and B: C ratio under various intercropping system during 2020-21.

Treatment	Cost of cultivation (Rs ha^{-1})			Gross return (Rs ha^{-1})			Net return (Rs ha^{-1})	B : C ratio
	Common	Variable	Total	By seed	By Stover	Total		
	A.MAIN PLOT							
I_1(sole)	27907	12160	40067	90831	2937	93768	53701	1:2.34
I_2(sole)	27907	2550	30457	60792	4682	65474	35017	1:2.14
I_3(3:1)	27907	9758	37665	88842	3890	92732	55067	1:2.40
I_4(4:1)	27907	10238	38145	95880	4191	100071	61926	1:2.62
I_5(5:1)	27907	10550	38457	111435	5146	116581	78124	1:3.03
I_6(4:2)	27907	8958	36865	78336	3004	81340	44475	1:2.20
I_7(5:2)	27907	9413	37320	82875	3464	86339	49019	1:2.31
I_8(6:2)	27907	9757	37664	89352	3710	93062	55398	1:2.47
	B.SUB-PLOT							
C_1	27907	0	27907	78336	5300	83636	55729	1:2.79
C_2	27907	2805	30712	89709	6058	95767	65055	1:3.11
C_3	27907	2010	29917	81141	5463	86604	56687	1:2.89

GROSS AND NET RETURN:

The data regarding to gross income ha^{-1} summarized and presented in Table 1 & 2 it is apparent from the result that different intercropping systems significantly in respect of gross and net returns per hectare of Chickpea – Linseed intercropping systems during both the years. Results reveal that gross return was recorded maximum under **I_5**, (5:1) Chickpea + Linseed Rs. 105082 ha^{-1} during 2019-20 and Rs.116581 ha^{-1} during 2020-21 year of experiment followed by **I_4**, (4:1) Rs.89126 ha^{-1} during 2019-20 and Rs.100071ha^{-1} during 2020-21. The lowest gross and net returns was recorded under the **I_6**, (4:2) Chickpea + Linseed Rs. 73398 ha^{-1} and Rs.38813ha^{-1} during 2019-20 and Rs. 81340 ha^{-1} and Rs.44475.ha^{-1} during 2020-21 year of experiment.

However, among the cultural practices **C_2** (weedicide) - the response was recorded significantly higher gross and net returns Rs. 85722 ha^{-1} and Rs.55459 ha^{-1} during 2019-20 and Rs. 95767 ha^{-1} & Rs.65055 ha^{-1} during 2020-21followed by **C_3** , **(**Dust Mulch) – Rs. 86604 ha^{-1} and Rs. 56687 ha^{-1} during both year of experiment.

COST: BENEFIT RATIO

The pertaining to benefit cost ratio summarized and presented in Table 1 & 2 It is apparent from the results that different cropping systems showed their response in respect of B: C ratio of chickpea – linseed intercropping system during both the years as showed in Table. Results revealed that cost benefit ratio highest under **I_5**, (5:1) Chickpea + Linseed 1:2.92 during 2019-20 and 1:3.03 during 2020-21 year of experiment followed by **I_4**, (4:1) 1:2.50 during 2019-20 and 1:2.62 during 2020-21. The lowest B: C ratio was recorded under **I_2**, Linseed sole 1:2.01 and 1:2.14 during both year of experiment. However, among the cultural practices **C_2** (weedicide) - the response was recorded significantly higher B: C ratio 1:2.83 during 2019-20 and 1:3.11 during 2020-21 followed by **C_3**, **(**Dust Mulch) –1:2.71 and 1:2.89 during both year of experiment.

It is clear from the data that different intercropping systems had significant variations among the treatments in respect of B: C ratio as recorded. It is apparent from the results that the Chickpea –Linseed intercropping system recorded maximum B: C ratio. Further, data revealed that minimum B: C ratio was recorded under Linseed sole during both year of experiment.

4. Discussion

Total cost of cultivation per hectare of chickpea + linseed intercropping system during both the years. Results reveal that total cost of cultivation was recorded (37231 **Rs. ha^{-1}**) maximum under the chickpea aloneduring first year and during second year (40067 **Rs. ha^{-1}**) during both the years **cf. Table 1 & 2.** It might be attribut ed due to total population adjustment under different cropping systems in component crop their total input requirements. chickpea alone required highest cost during both year crop of chickpea might be attributed to thinning operation and more seed cost of crop.

Results reveals that gross return was recorded maximum under chickpea + Linseed (5:1) (105082 and 116581 **Rs. ha^{-1})** during both years followed by chickpea + Linseed (4:1) during both years. However, minimum gross return recorded under linseed alone during both the years. **Mehta *et al.* (2017)**, observed that, highest gross return (10234/ha) was recorded with 1:1 row ratio of chickpea + linseed intercropping followed by 3:1 row ratio of chickpea + linseed intercropping system (9895/ha).

In respect of net returns per hectare of chickpea + linseed intercropping systems results reveals that net return was recorded maximum (69181 and 116581 **Rs. ha^{-1}**) under the chickpea + linseed (5:1) followed by chickpea + linseed (4:1) system respectively. The lowest net return was recorded under the treatment with linseed aloneduring both years. **Sharma and Nandan (2000)** reported that when chickpea + linseed was grown in 6:1 and 6:2 row ratio at net return did not differ significantly with respect to intercropping of chickpea and linseed in 6:1 and 6:2 row ratio. However, intercropping of chickpea and linseed in 6:1 row ratio gave higher net return (Rs. 25,163/ha) than in 6:2 row ratio with the net return of (Rs. 23,490/ha). Similar, results reported by **Sharma *et al.* (2010), Kalaghatagi *et al* .(2017) and Gupta *et al.* (2019).**

Different intercropping systems had significant variations among the treatments in respect of B:C ratio as recorded **(Table- 1 & 2)**. It is apparent from the results that the chickpea + Linseed (5:1) recorded (1.2.92 and 1.3.03) maximum B:C ratio. Further, data revealed that minimum B:C ratio was recorded under linseed aloneduring both years. **Kumar and Sharma (2006)** reported that chickpea + Indian linseed in 6:2 row ratio recorded the highest net return (Rs. 16831/ha) and B: C ratio (2.63). Similar results reported by the **Malik *et al.* (2001) and Tanwar *et al.* (2011)**.

Conclusion

From the above results it can be concluded that the maximum gross return, net return and benefit cost ratio was found with (I_5) Chickpea + Linseed intercropping system application during crop seasons 2019-20 and 2020-21.

REFERENCES

Anonymous (2014). Ministry of Statistics and Programme Implementation, *Statistical Year Book, India, 2014.*

Chandel, S.R.S. (1990). A handbook of agriculture statistics, Achal Prakashan mandir, Pandu Nagar, Kanpur, pp. 843-853.

Gupta A K. C., Kumar V. Praharaj C. S. yadav M. R. (2019) Productivity and profitability of chickpea + linseed intercropping system as influenced by spatial arrangement of crops in Semi – arid Eastern Plain Zone of Rajasthan *Division of Agronomy , Rajasthan Agricultural Research Institute , Durgapur Jaipur -302018, journal of Crop and Weed , 15(2) ;110-114(2019) , ISSN –O : 23499400; P : 09746315*

Kalaghatagi S.B, Guggari A.K.,Kambrekar D.N. and Malamsur Kadasiddappa (2017).Performance of Linseed Based Intercropping Systems in Different Row Ratio underSemi Arid Region of Karnataka .*Indian j.Dryland Agric. Res. Dev. 2017 32(1) :26-31.*

Kumar, P., Rathi, K.S. and Kedar Prasad (2002). Effect of component crops in intercropping of linseed + mustard under increasing rates of nitrogen. *Crop Research Hisar, 23 (2) : 283-286.*

Malik, M., R. Khan, H.R. Haqqani, A.M. Zahad, M.A. Malik and B.A. Sarhad (2001).Production potential and economic viability of different chickpea - based cropping systems.*Journal of Agriculture, 17 (1) : 111-117.*

Malik, M., R. Khan, H.R. Haqqani, A.M. Zahad, M.A. Malik and B.A. Sarhad (2001).Production potential and economic viability of different chickpea - based cropping systems.*Journal of Agriculture, 17 (1) : 111-117.*

Mishra, J.P., Masood Ali and Arya R. L. (2001). Genotypic compatibility in relation to row ratio in the intercropping of linseed (*Linum usitatissimum*) and gram (*Cicer arietinum*) under rainfed conditions.*IndianJournal of Agricultural Sciences, 71 (6): 359 –362.*

Mehta, R. S., Meena, S. S., & Lal, G. (2017). Effect of intercropping seed spices with vegetable for enhancing system profitability.

Reddy, S.R. (2004). Cropping system : Planting patterns and plant densities. *Principles of Crop Production, pp. 561, Kalyani Publishers, New Delhi.*

Sharma P. B., Maheshwari N. L., Ambawatia G. R. and Raghuwanshi P. S.(2000). Studies on the suitability of linseed based intercropping systemunder limited irrigation. *BhartiyaKrishiAnusandhanPatrika, 13 (1 –2): 39 – 42.*

Sharma R. K. and Goswami V. K. (2010). Comparative performance of chickpea and linseed in their pure and intercropping system *Green Farming, 1(2):128– 131.*

Tanwar .P.S., Rokadia P. and Singh A.K. (2011) Effect of row ratio and fertility levels on the performance of chickpea (*Cicer arietinum*) and linseed (*Linum usitatissimum*) intercropping system under rainfedconditions*. Indian Journal of Agronomy2011 56 (3): 87-92*

Tiwari, R.K., Panday, R.P. and Khan, R.A. (2003). Economics of suitability of pulse and oil seed intercropping in rice-fallow under rainfed condition. JNKVV. *Research Journal, 37 (2) : 79 - 80.*

Tripathi,H.N., Subash Chand and Tripathi A.K. (2005). Biological and economical feasibility of chickpea (*Cicerarietinum*) + Indian mustard (*Brassica juncea*) cropping systems under varying levels of phosphorus. *Indian Journal of Agronomy,* 50 (1):31 – 34.