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Evaluation of mustard based intercropping systems under organic management in Bundelkhand region

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ABSTRACT

A field experiment entitled "Evaluation of mustard based intercropping system under organic management in Bundelkhand Region" was conducted during rabi season of 2021-22 at the Organic Research Farm of the Institute of Agricultural Sciences, Bundelkhand University, Jhansi (U.P.). The experiment was laid out in Randomized Block Design with three replications. Treatment combinations were sole crop of mustard, kabuli chickpea, field pea, fenugreek, desi chickpea, mustard + kabuli chickpea (1:2), mustard + field pea (1:2), mustard + fenugreek (1:2), mustard + desi chickpea (1:2). The results revealed that intercropping of mustard with different crops has significant effect on plant height, fresh root weight, dry root weight, fresh shoot weight, dry root weight of mustard, number of siliqua, seed yield, straw yield and biological yield. The intercropping of mustard +desi chickpea in 1:2 ratio under organic management in skip-row pattern was found to be significantly better among all the treatments in the current investigation with regard to LER and growth parameters.

***Keywords*:** Chickpea, fenugreek, field pea, intercropping, LER, mustard, skip-row

The fundamental goal of intercropping is to maximise overall productivity per unit of space and time. There is ample evidence to show that the total yield can be increased with intercropping over sole cropping through the efficient use of resources like water, fertilizers and sunshine. It offers potential advantages over monoculture by improving production. Intercropping is the practice of growing two or more crops in various row configurations on the same piece of land. By using resources more effectively, intercrops may need less expensive inputs. Oilseed crops have a significant role in the agricultural system of India, which is the world's largest producer of them (Roy *et al.,*2022). After soybean and palm oil, the mustard crop is ranked third. The range of the oil content is 37 to 49%. Among all other species grown in northern India, Indian mustard (*Brassica juncea* M.) provides the majority of the cooking oil and takes up roughly 80-85% of the combined rapeseed and mustard growing area (Mala *et al.,* 2022). The seed and oil are used as seasonings for making pickles, curries, vegetable dishes, hair oils, medications and greases. Crop may experience varying levels of nutrient and water stress throughout crop cycle. Data from this region's long-term trend study indicates that when the crop is sown in a late condition, heat stress has an adverse effect on it (Kumari *et al.,* 2019). In order to enhance the area planted with chickpeas and thereby their output, rice fallows may have better opportunities (Subbarao *et al*., 2001). It was grown on 149.66 lakh ha of land in the world in 2017–18, producing a total of 162.25 lakh tonnes with an average productivity of 1252 kg ha^{-1} (FAOSTAT, 2019). The field pea, also known as *Pisum sativum* L., is a vital cool-season, frost-hardy, nutritive legume that is widely farmed. With a productivity of 923 kg ha^{-1} on average, it was grown in 9.98 lakh ha in India in 2018–19 and produced 9.20 lakh tonnes of grain (FAO STAT, 2019**)**. Fenugreek (*Methi*) is a crucial annual herb which plays significant role in medicinal value and that is mostly cultivated for its leaves (fresh or dried) as well as seed. The seeds are used as a spice and cooked food as "Panchphoran". In India during the year 2019-20, chickpea covered an area of 10.17 million ha and production of 11.35 million tonnes with average yield of 1116 kg ha^{-1} Anon., 2021. Its condiments boost food's flavour and nutritional value of food. *Desi* chickpea (*Cicer arietinum* L.), a crucial pulse crop, accounts for 50% of India's overall production of pulses which covers around 38% of the country's total land under pulse crops (Anon., 2021).

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MATERIALS AND METHODS

A field experiment was conducted during *rabi* season of 2021-2022 at the Organic Research Farm, Institute of Agricultural Sciences, Bundelkhand University, Jhansi (U.P.). The climatic condition under Jhansi district of U.P. is subtropical to semi-arid with maximum temperature ranged from 18.3°C to 38.8°C while minimum temperature ranged from 4.4°C to 19.6°C during cropping period. The rainfall of 123.0 mm during 4th week of October, 12 mm during 4th week of December, 2021, 18.0 mm during 1st week, 23.8 mm during 2nd week and 3.6 mm during 4th week of January while 0.4 mm during 2nd week of February, 2022 was received in growing period, respectively (Fig. 1). The treatment comprised of 9 combinations, out of which five combinations comprised of individual crops viz. T_1: mustard, T_2: *kabuli* chickpea, T_3: field pea, T_4: fenugreek, T_5: *desi* chickpea, and four combinations comprised of intercropping viz. T_6: mustard+ *kabuli* chickpea (1:2), T_7: mustard + field pea (1:2), T_8: mustard+ fenugreek (1:2) and T_9: mustard + *desi* chickpea (1:2). It had three replications and was set up in a randomised block design. The experimental soil was silty loam having 8.2 pH, 0.32 per cent organic carbon, 136.5 kg ha^{-1} of accessible N, 14.5 kg ha^{-1} of P_2O_5, and 248.5 kg ha^{-1} of K_2O.The variety of NRCHB 101 of mustard, Prakash of field pea, L-552 of *kabuli* chickpea, Pusa Early Bold of fenugreek and RVG202 of *desi* chickpea were intercropped as per row proportions in replacement series. The crops were sown on October 29, 2021 and harvested during March, 2022 as per maturity. For the cultivation of experimental crops, every other set of materials and procedures were following accordingly. Data on characteristics relating to growth and yield were obtained and statistically analysed. Based on current market conditions, economic indicators including the land equivalent ratio (LER), aggressivity (A), intercropping advantage and mustard equivalent yield (MEY) of the intercropping systems were assessed.

The mustard equivalent yield was calculated based on the prevailing market prices of mustard, *desi* chickpea, *kabuli* chickpea, fenugreek, and pea. The grain yields from various treatments were converted into equivalent mustard yields as per procedure adopted by Verma and Modgal (1983) as given below:

$$MEY = \frac{Y\ X\ Pi}{Pc}$$

Where, Y = Yield of a crop, which need conversion, Pi = Price offered to a crop Y, Pc = Price offered in whose terms Y is being expressed.

The Land Equivalent Ratio (LER) indicates the proportion of land area planted in a single crop that is necessary to produce a yield equal to that obtained under a mixed or intercropping system at the same level of management. It was calculated as per Willey (1979) as given below:

$$LER = La + Lb = \frac{Ya}{Sa} + \frac{Yb}{Sb}$$

Where:

La = LER of crop a, Lb = LER of crop b.

Ya & Yb = Yield of individual crop a & b, respectively in mixture.

Sa & Sb = Yield of individual crop a & b, respectively in pure stand.

RESULTS AND DISCUSSION

Effect of intercropping on growth attributes

Plant height (cm)

At early stage (30 DAS), the plant height of mustard remained unaffected but increased in intercropping treatments compared to sole crop at 60 and 90 days after sowing. Plant height of all associated crops increased in intercropping treatments compared with respective sole crop treatment (Fig. 2), due to competition for search of sunshine. The outcomes are consistent with those reported by Kaparwan *et al.* (2020).

Number of plant leaves

The number of mustard leaves remained almost same at 30 DAS, while reduced at 60 DAS and 90 DAS in intercropping treatments. But in all associated crops, the number of leaves reduced in intercropping systems compared to respective sole cropping (Table 1). Similar results were reported by Arya *et al.* (2007).

Fresh root weight (g)

The fresh root weight of mustard was recorded highest (1.9 g) at 30 DAS when mustard was grown with field pea while at 60DAS it was maximum (3.4 g) when mustard was grown with *kabuli* chickpea, but at 90 DAS it was maximum in mustard+ *desi* chickpea intercropping system compared to sole crop of mustard (Table 1). But, all other associated crops showed reduced fresh root weight at 60 and 90 DAS in intercropping treatments compared to respective sole crops. Similar findings were also published by Chand *et al.* (2004) and Arya *et al*. (2007).

Dry root weight (g)

The dry root weight of mustard was almost equal at 30 and 60 DAS, while it was maximum (1.9g) when mustard was grown with *desi* chickpea at 90 DAS in

intercropping system compared to sole treatment (Table 1). It may be due to vigorous growth of root. The similar results were also reported by Arya *et al.* (2007**).**

Fresh shoot weight (g)

The fresh shoot weight of mustard was recorded highest (8.5 g) at 30DAS when mustard was grown with fenugreek, while at 60 and 90DAS it was maximum (54.8g) when mustard was grown with *kabuli* chickpea in intercropping system compared to sole crop of mustard (Table 1), But all associate crops showed reduced fresh shoot weight at 90 DAS in intercropping treatments compared to respective sole crops. It was due to less intercrop competition and better use of soil moisture from different layers of soil. The findings are consistent with those reported by Arya *et al.* (2011).

Dry shoot weight (g)

The dry shoot weight of mustard was recorded highest (1.1g) at 30 DAS when mustard was grown with fenugreek, while at 60 DAS it was maximum (8.3g) when mustard was grown with *kabuli* chickpea and at 90DAS it was maximum (15.2 g) with *desi* chickpea in intercropping system compared to sole crop of mustard due to less intercrop competition and better uses of resources (Table 1). Similar findings were also reported by Rajput and Kushwaha (2020).

Effect of intercropping on yield attributes and yield

Number of siliqua

The number of siliqua (plant^{-1}) of mustard was recorded highest (184) when mustard was grown alone while the number of siliqua was reduced when mustard was grown with *kabuli* chickpea (144), field pea (149), fenugreek (163), *des*i chickpea (135) in intercropping system treatments compared to sole crop (Table 2), due to better utilization of nutrients and space which resulted in more number of branches and caused the maximum number of siliqua. Abraham *et al*. (2011), Gokhale *et al*. (2008) and Karwasara and Kumar (2007) also reported similar findings.

Number of seed siliqua^{-1}

The number of seed siliqua^{-1}of mustard was recorded highest when mustard was grown with *desi* chickpea (18), fenugreek (17) and *kabuli* chickpea (15) in intercropping system compared to sole crop of mustard (14) due to better utilization of nutrients and space (Table 2). Similar findings were also reported by Tripathi *et al.* (2005), Ahalawat *et al.* (2005) and Kumar and Singh (2006).

The grain yield (q ha^{-1})

Mustard produced greater grain yield (13.7 q ha^{-1}) when grown alone while yield was reduced to the tune of 19.7, 15.3, 8.7 and 1.4% when intercropped with *kabuli* chickpea, fenugreek, field pea and *desi* chickpea respectively. It shows that there was competition for resources when mustard was intercropped with *kabuli* chickpea and fenugreek (Table 3). On the other hand, the mustard yield was increased to the tune of 8.7%, when *desi* chickpea was intercropped with mustard showing positive relationship of intercropping of mustard with *desi* chickpea. The findings from this investigation were also corroborated with Ahlawat *et al*. (2005), Kumar and Singh (2006) sand Thakur *et al.* (2000).

The stover yield (q ha^{-1})

The highest straw yield of mustard (44.9 q ha^{-1}) was recorded when mustard was grown with *desi* chickpea while yield was reduced to the tune of 47.6, 20.0, and 10.9% when intercropped with fenugreek, field pea and *kabuli c*hickpea, respectively (Table 3). There was yield increase to the tune of 16.5% when mustard was grown with *desi* chickpea. It shows that there was competition for resources when mustard was intercropped with fenugreek, field pea and *kabuli* chickpea. The results of this investigation were also supported by Kumar and Singh (2006).

Land Equivalent Ratio (LER)

Highest land equivalent ratio (1.7) was obtained when mustard was intercropped with *desi* chickpea contrasting to sole crop of mustard (Table 4). It shows that mustard + *desi* chickpea intercropping system is beneficial.

Aggressivity

Highest (1.9) aggressivity was obtained when mustard was grown with field pea in intercropping system compared to other associate crops (Table 4) showing higher competition for resources of field pea specially at early stage was more aggressive in intercropping system.

Mustard Equivalent Yield (MEY)

Significantly highest mustard equivalent yield (26.7q ha^{-1}) was obtained when mustard was intercropped with *desi* chickpea compared to sole crop of mustard. But, it was statistically at par with other treatments, respectively (Table 3). Yadav *et al*. (2018) and lslam *et al*. (2011) also reported similar findings. Due to better nutrition and less competition, mustard's overall improvement in growth and yield in combination with *kabuli* chickpea, pea, fenugreek, and desi chickpea component crops may

Table 1: Plant height, number of leaves plant^{-1}, fresh root weight, dry root weight, fresh shoot weight, dry shoot weight of mustard and associated crops at varying days after sowing as affected by intercropping treatments

	Treatment	Plant height (cm)			Number of leaves plant^{-1}			Fresh root weight (g)			Dry root weight (g)			Fresh shoot weight (g)			Dry shoot weight (g)		
		30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS
T_0	Mustard alone	22.8	101.9	156.9	6	11	37	0.9	2.3	2.7	0.1	1.0	0.8	7.6	31.9	34.3	0.9	6.5	7.5
T_1	*Kabuli* Chickpea alone	13.5	37.1	49.5	30	31	82	0.8	1.6	2.9	0.2	0.4	0.6	3.7	17.2	31.1	0.7	3.8	5.2
T_2	Pea alone	16.6	60.8	92.1	8	18	30	0.5	0.7	1.8	0.1	0.2	0.3	5.3	32.0	74.9	0.7	5.4	14.0
T_3	Fenugreek alone	13.4	42.6	71.4	10	21	37	0.6	0.8	2.1	0.1	0.2	0.5	1.1	12.0	29.7	0.3	2.8	5.7
T_4	*Desi* Chickpea alone	15.5	31.4	43.3	26	28	77	0.8	2.1	2.5	0.2	0.2	0.5	1.9	16.5	24.6	0.6	2.7	4.8
T_5	Mustard +	22.3	111.2	182.3	7	9	47	1.5	3.4	5.1	0.1	1.1	1.4	7.4	52.4	54.8	0.7	8.3	13.6
	Kabuli Chickpea	21.3	42.2	65.4	38	29	87	1.0	1.5	2.6	0.3	0.4	0.5	7.7	18.4	27.4	0.9	3.6	5.1
T_6	Mustard +Pea	20.4	125.0	151.2	6	7	45	1.9	3.3	3.3	0.1	1.1	0.9	5.0	31.2	33.8	0.8	8.2	13.6
		22.9	59.7	101.1	10	19	27	0.5	0.8	2.3	0.2	0.2	0.4	5.2	33.6	55.4	1.1	5.1	7.8
T_7	Mustard +	24.4	111.3	169.4	7	10	45	1.4	2.6	4.2	0.1	1.0	1.2	8.5	34.2	44.6	1.1	6.6	11.3
	Fenugreek	13.1	57.0	86.2	13	20	27	0.5	0.6	2.1	0.1	0.2	0.3	1.6	11.9	17.5	0.2	2.1	3.7
T_8	Mustard +	21.9	118.3	154.0	6	9	44	0.7	3.0	5.5	0.1	1.1	1.9	6.4	38.8	54.0	1.0	8.1	15.2
	Desi Chickpea	15.4	37.1	57.6	30	21	71	0.5	0.8	1.3	0.2	0.2	0.3	2.1	9.4	12.8	0.6	3.0	4.6

Table 2 : Number of siliqua or pod plant^{-1} and number of seed siliqua^{-1} or seed pod^{-1} of mustard and associated crops affected by intercropping

	Treatments	Number of siliqua or pod plant^{-1}		Number of seed siliqua^{-1}or pod^{-1}	
		Main crop (Number of siliqua)	Associated crops (Number of pods)	Main crop (Number of seed siliqua^{-1})	Associated crops (Number of seed pod^{-1})
T_0	Mustard alone	184	-	14	-
T_1	*Kabuli* Chickpea alone	29	-	1	-
T_2	Pea alone	10	-	5	-
T_3	Fenugreek alone	44	-	14	-
T_4	*Desi* Chickpea alone	52	-	2	-
T_5	Mustard + *Kabuli* Chickpea	144	23	15	1
T_6	Mustard + Pea	149	4	13	3
T_7	Mustard +Fenugreek	163	27	17	10
T_8	Mustard +*Desi* Chickpea	135	37	18	1

Table 3 : Seed yield and straw yield of mustard and associated crops affected by intercropping

Treatments	Seed yield (q ha^{-1})		Effect of main crop on associated crops (% P)	Effect of associated crops on main crop (% ±)	Straw yield (q ha^{-1})		Effect of main crop on associated crops (% ±)	Effect of associated crops on main crop (% ±)	Mustard equivalent yield (q ha^{-1}) *
	Main crop	Associated crops			Main crop	Associated crops			
T_0 - Mustard	13.7	-	-	-	38.5	-	-	-	13.7
T_1 - Kabuli Chickpea alone	14.6	-	-	-	18.1	-	-	-	18.2
T_2 - Pea alone	14.5	-	-	-	4.5	-	-	-	13.5
T_3 - Fenugreek alone	10.6	-	-	-	13.6	-	-	-	15.6
T_4 – Desi chickpea alone	12.6	-	-	-	21.3	-	-	-	13.5
T_5 - Mustard + kabuli. Chickpea	11.0	12.6	-19.7	-13.7	34.3	18.8	-10.9	+3.8	25.9
T_6 – Mustard + Pea	12.5	11.1	-8.7	-23.4	30.8	8.1	-20.0	+80.0	22.3
T_7- Mustard + Fenugreek	11.6	8.3	-15.3	+43.0	-21.7	19.5	-47.6	+43.0	24.5
T_8 - Mustard + Desi chickpea	12.6	13.7	-1.4	+8.7	44.9	15.6	+16.5	-26.7	26.7
SEm(±)	-	-	-	-	-	-	-	-	**2.8**
LSD (0.05)	-	-	-	-	-	-	-	-	**8.7**

* Based on Sale price (Rs/ q) of mustard, *Kabuli* chickpea, Pea, Fenugreek and *Desi* chickpea was Rs 5050, 6000, 4500, 7000 and 5230, respectively.

Table 4: Land equivalent ratio (LER) and aggressivity of mustard and legume intercropping systems

	Treatments	Land equivalent ratio (LER)	Aggressivity
T_5	Mustard + *Kabuli* Chickpea	1.6	1.5
T_6	Mustard + Pea	1.3	1.9
T_7	Mustard + Fenugreek	1.5	1.7
T_8	Mustard + *Desi* Chickpea	1.7	1.4
SEm(±)		**0.2**	**NS**
LSD(0.05)		**NS**	**NS**

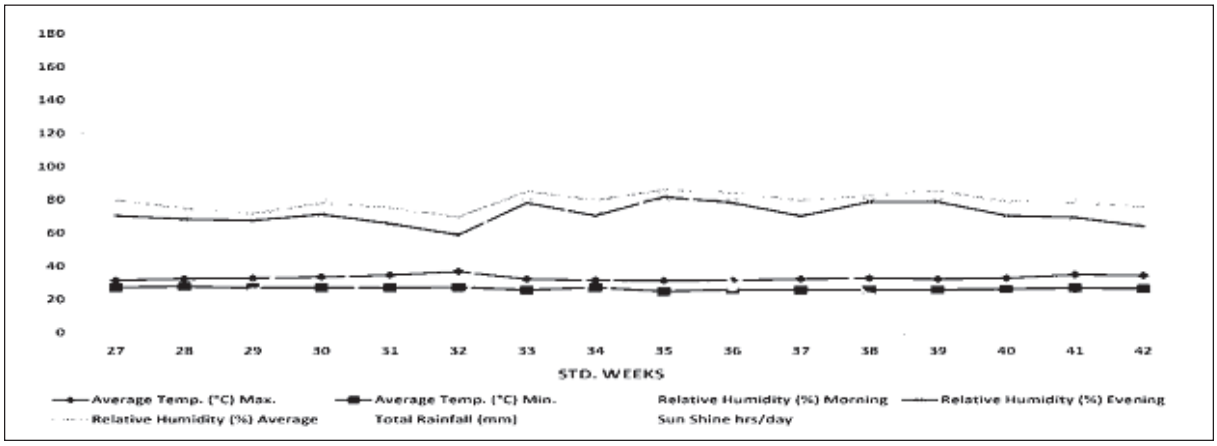

Fig. 1: Metrological data during cropping period of 2021-22

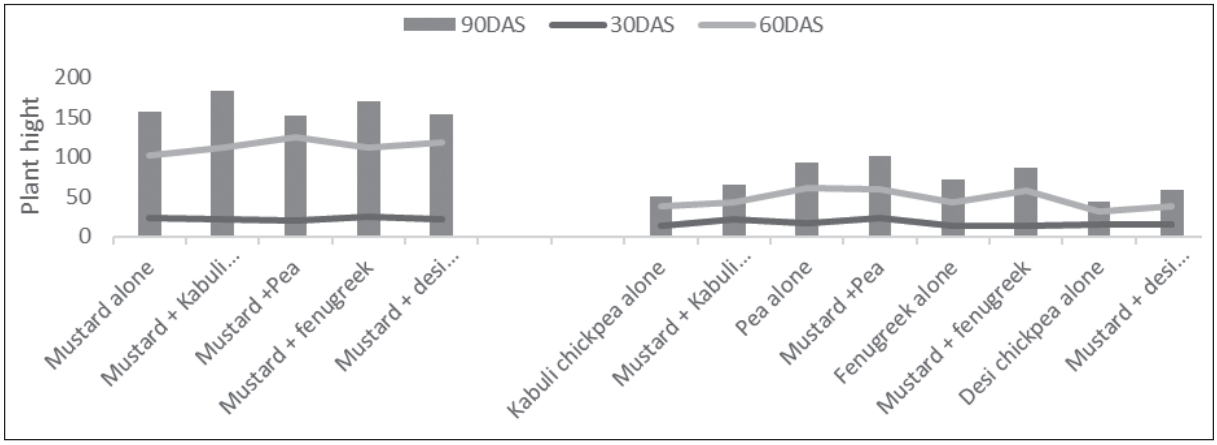

Fig. 2: Effect of associated crops on plant hight of mustard and effect of mustard on plant hight of associated crops

have led to an increase in photosynthetic efficiency and a shift in the location of photosynthates toward grain and biomass, which may have increased grain yield.

CONCLUSION

The associated crops affected the growth and yield of mustard adversely. But, the equivalent yield was higher in intercropping treatments compared to mustard alone. *Desi* chickpea was indentified to be most suitable companion crop of mustard in Bundelkhand.

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REFERENCES

Anonymous. 2021. Agricultural statistics at a glance. Directorate of Economics and Statistics, Department of Agriculture, Cooperation & Farmers' Welfare-Ministry of Agriculture and Farmer Welfare, Govt of India.

Abraham, T., Thenua, O.V.S. and Sharma, U.C. 2011. Evaluation performance of chickpea and mustard intercropping of system vis.-a-vis. their sole crops as influenced by irrigation regimes and fertility gradients. *Indian J. Agric. Sci.*, **81**: 772-775.

Ahlawat, I.P.S., Gangaiah, B. and Singh, O. 2005. Production potential of chickpea (*Cicer arietinum*) based intercropping systems under irrigated conditions. *Indian J. Agron.*, **50**: 27-30.

Arya, R., Awasthi, O.P., Singh, J., Singh, I.S.and Manmohan, J.R. 2011. Performance of component crops in the tree-crop farming system under arid region. *Indian J.Hortic.,* **68** (1) : 6-11.

Arya, R.L., Varshney, J. and Kumar, L. 2007. Effect of integrated nutrient application in chickpea mustard intercropping system in the semi-arid tropics of North India. *Commu. Soil Sci. Plant Anal.*, **38**: 229–240.

Chand, S., Anwar, M., Patra, D.D. and Khanuja, S. P. S. 2004. Effect of mint distillation waste on soil microbial biomass in a mint-mustard cropping sequence. *Commu. Soil Sci. Plant Anal*., **35**: 243-254.

FAOSTAT, 2019. Website (http://faostat3.fao.org/home/E).

Gokhale, D.N., Wadhvane, S.V., Kalegore, N.K., Khalge, M.L. and Shaikh, F.G. 2008. Response of linseed (*Linum usitatissimum* L.) varieties to row spacing and phosphorus level under irrigated conditions. *J. Oilseeds Res*., **25**: 94- 95.

Islam, M., Begum, M., Maniruzzaman, M. and Alam, M. 2015. Yield performance of lentil as a mixed crop with rapeseed. *Bangladesh Agron. J.*, **17**: 33-40.

Kaparwan, D., Rana, N.S., Vivek and Dhani, B.P. 2020. Effect of different through ratios and nutrients management strategies on growth yield and quality of mustard in chickpea + mustard intercropping systems. *J. Pharmacog. Phytochem.*, **9**:853-857.

Karwasra, R.S. and Kumar, A. 2007. Response of raya to NPK fertilization under the rain-fed condition in Haryana. *Haryana. J. Agron.*, **23**:109-110.

Kumar, A. and Singh, B.P. 2006. Effect of row ratio and phosphorus level on performance of chickpea (*Cicer arietinum*) + Indian mustard (*Brassica juncea*) intercropping. *Indian J.Agron.*, **51**: 100-110.

Kumari, V.V., Banerjee, P., Nath, R., Sengupta, K., Chandran, M.A.S. and Kumar, R. 2019. Effect of foliar spray on phenology and yield of lentil sown on different dates. *J. Crop and Weed*. **15**: 54-58.

Mala, A., Singh, S., Nath, R., John, A., Kumar, P. and Bera, A. 2022. Variation in yield and yield attributes of hybrid mustard (*Brassica juncea* M.) influenced by different spacing and fertilizer levels. *J. Crop and Weed*, **18**: 31-37.

Rajput, R.L. and Kushwaha,B.B. 2020.Yield analysis of chickpea (*Cicer arietinum* L.) intercropping system as influenced by weed management practices . *Legume Res.*, **44**:94-97.

Roy, A., Sarkar, S. and Bera, B. 2022. Estimation of cost of cultivation, profitability in different farm sizes as well as growth and instability of mustard in West Bengal. *J. Crop and Weed*, **18**: 273-277.

Subbarao, G.V., Kumar Rao, J.V.D.K., Kumar, J., Johansen, C., Deb, U.K., Ahmed, I., Krishna Rao, M.V., Venkataratnam, L., Hebber, K.R., Sai, M.V.S.R. and Harris, D. 2001. Spatial distribution and quantification of rice-fallows in south Asia - potential for legumes. ICRISAT, Patancheru, Andhra Pradesh, India, 316p.

Tripathi, H.N., Chand, S. and Tripathi, A.K. 2005. Biological and economical feasibility of chickpea (*Cicer arientinum*) + Indian mustard (*Brassica juncea*) cropping systems under varying levels of phosphorus. *Indian J. Agron.,* **50**: 31-34.

Thakur, N.S., Pannase, S.K. and Sharma, R.S. 2000. Production potential of a gram (*Cicer arietinum*) based intercropping system under rainfed condition. *Indian J. Agron.*, **45**: 534-539.

Verma, S.P. and Modgal, S.C. 1983. Production potential and economics of fertilizer application as resource constraints in maize, wheat crop sequence. *Himachal J. Agric. Res*., **9**: 89-92.

Yadav, P.K., Singh, S.P., Dohare, A.P.S. and Singh, S. 2018. Phosphorus requirement in chickpea (*Cicer arietinum* L.) + Indian mustard (*Brassica juncea* L.) intercropping system under rain-fed conditions. *Int. J. Curr. Microbiol. Appl.Sci.,* **7**: 3117 - 3121.