Plant Archives Vol. 24, No. 1, 2024 pp. 452-458 e-ISSN:2581-6063 (online), ISSN:0972-5210

Plant Archives

Journal homepage: http://www.plantarchives.org

DOI Url : https://doi.org/10.51470/PLANTARCHIVES.2024.v24.no.1.063

GROWTH ATTRIBUTES AND ECONOMICS OF CHICKPEA (*CICER ARIETINUM* L.) AND MUSTARD (*BRASSICA JUNCEA* L.) AS INFLUENCED BY INTERCROPPING SYSTEM UNDER DIFFERENT ROW RATIO AND LIQUID MANURES

Dhananjay Tiwari[1]*, Vikram Singh[2] and Mukesh Kumar[1]

[1]Department of Agronomy, Narayan Institute of Agricultural Sciences, Gopal Narayan Singh University, Jamuhar, Sasaram, Rohtas - 821 305 (Bihar), India.

[2]Sam Higginbottom University of Agriculture Technology and Sciences, Prayagraj - 211 007 (Uttar Pradesh), India.

*Corresponding author E-mail dhananjaytiwariald@gmail.com

(Date of Receiving-29-11-2023; Date of Acceptance-05-02-2024)

ABSTRACT

A field experiment was conducted during two consecutive *rabi* seasons of 2018-2019 and 2019-2020 at Crop Research Farm, Department of Agronomy, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj (U.P.), India. The experiment was conducted in split plot design with two sole crops of chickpea and mustard including three different row ratio of chickpea + mustard (1:1, 2:1, 3:1) and four liquid manures viz. control (no spray of liquid manures), panchagavya 3%, cow urine 10% and vermiwash 10%. Total 20 treatment combination. Results indicates that chickpea + mustard (3:1) among the different intercropping system recorded higher growth attributes *viz.* plant height and dry matter and as well as in respect to economics.

Key words : Intercropping systems, Row ratio, Liquid manures, Chickpea, Mustard, Economics.

Introduction

Chickpea is the most important winter pulse crop cultivated in almost all parts of the country including Asia, Africa Europe, North America and South America continent. In India it is grown both under assured irrigation and residual soil moisture conditions. In India, gram is grown on approximately 10.00 million hectares, with a production of 11.91 million tonnes and a productivity of 1192 kilograms per hectare. Uttar Pradesh ranks fifth in both area and production, with 0.61 million hectares (6.11%) and 0.76 million tonnes (6.38%), respectively. Gujarat has the highest productivity of 1568 kg/ha (Directorate of Economics & Statistics, DAC & FW, 2020-2021). Mustard stands second in edible oil production after soybean in India and most important oilseed in winter season. There is very little chance for horizontal growth of the crop. Thus, production of mustard can beincreased by vertical growth of the crop through intercropping with other crops. Nowadays, mustard has been found successfully intercropped mainly with different crops *viz.* chickpea, lentil, sugarcane, potato, wheat, etc. under various agro climatic zones of the country. In India, mustard is grown on approximately 6.70 million hectares, with a production of 10.21 million tonnes and a productivity of 1524 kilograms per hectare. Uttar Pradesh ranks fourth in both area and production, with 0.70 million hectares (10.46%) and 1.01 million tonnes (9.87%), respectively. Haryana has the highest productivity of 2028 kg/ha (Directorate of Economics & Statistics, DAC & FW, 2020-2021). The selection of an appropriate intercropping system for each case is quite complex as the success of intercropping systems depend much on the interactions between the component species, available management practices and the environmental conditions. Intercropping provides year-round ground cover, or at least for a longer period than monocultures, in order to

protect the soil from desiccation and erosion. By growing more than one crop at a time in the same field, farmers maximize water use efficiency, maintain soil fertility and minimize soil erosion, which are the serious drawbacks of mono-cropping. Foliar application of liquid organics manures supplies essential micro nutrients and growth hormones, which greatly influence the growth, yield attributes and yield in pulses. Natural preparations and concoctions containing plant growth-promoting bacteria, rhizosphere fungi and endophytic fungi that function as plant bio inoculants. Keeping the above facts in mind, the presentexperimentwas conducted atCrop Research Farm, Department of Agronomy, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj (Uttar Pradesh), India.

Materials and Methods

A field study was conducted at the Crop Research Farm, Department of Agronomy, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj (U.P.) during the winter (*rabi*) seasons of 2018–2019 and 2019–2020. The twenty treatment combinations used in this study included four liquid manures (No spray) (L1), panchagavya 3% (L2), cow urine 10% (L3) and vermiwash 10% (L4), as well as five intercropping systems: sole chickpea (I1), sole mustard (I2), chickpea + mustard (1:1) (I3), chickpea + mustard (2:1) (I4) and chickpea + mustard (3:1) (I5) row ratios in replacement series. Mustard and chickpea sole crops were maintained for comparison. Thus, in a split plot design that was replicated three times, twenty treatment combinations were investigated. The experiment comprised sixty plots total, with liquid manures in sub-plots and an intercropping system in the main plot. The experimental plot's soil had a sandy loam texture, a pH of 7.7 and 7.2, low organic carbon (0.46 and 0.47%), high potassium (312 and 316 kg/ha), medium phosphorus (26.5 and 28 kg/ha) and low nitrogen (118 and 120 kg/ha) during the course of two years study. The total plot area of individual plot 4 m × 4 m (16 m^2). Planking was done after one deep ploughing and two cross harrowings in the field. During the trial, the seed rates for mustard and chickpea were 6 kg/ha and 80 kg/ha, respectively, for crop sowing. On 11 November, 2018 and 11 November, 2019, the crop was sowed using the Pusa-362 and Varuna varieties for chickpea and mustard, respectively. For sowing, a standard spacing of 45 cm × 10 cm was chosen for all intercrop as well as sole crop of experiment. For mustard, the recommended fertilizer dose is 80 kg N, 40 kg P_2O_5 and 40 kg K_2O per hectare. The fertilizers were used as a urea, single super phosphate, and muriate of potash for supplying essential nutirnets to the crop. For chickpea, the recommended fertilizer dose is 20 kg N, 40 kg P_2O_5 and 20 kg K_2O/ha. Fertilizer and seed rates of both crop in intercropping combinations as well as in sole crop treatments were determined based on the number of rows arranged. For both crops, foliar applications of liquid manures were applied at the branching and flowering stages. The crop was grown in an irrigated environment, by providing two irgations during the critical growth stages. Crop protection measures were followed to crop when necessary. The chickpea and mustard were manually harvested at a height of about 10 cm above the ground, and they were left to dry in the field for a few days in the sun. The bundles from each plot were threshed, the grains were dried, cleaned and weighed. For distinct observations, the data were subjected to an ANOVA split-plot design (Gomez and Gomez, 1984). To compare the means of the various treatments, critical difference (CD) values were calculated and the results were given at the 5% level of significance (P = 0.05).

Results and Discussion

Intercropping system (row ratios) and liquid manures

Chickpea growth attributes

The data pertaining to plant height and dry weight of chickpea and mustard among intercropping systems and liquid manures at 50 DAS were depicted in Table 1.

Plant height of chickpea (cm)

At 50 DAS, significant variations were observed among all intercropping row ratios. In first year, significantly superior plant height (14.88 cm) was observed in chickpea + mustard (3:1) which was at par with chickpea + mustard (2:1) (14.51 cm). In second year, significantly higher plant height (15.48 cm) was observed in chickpea + mustard (3:1) and at par value of plant height (14.95 cm) was observed in chickpea + mustard (1:1). However, in pooled data significantly highest plant (15.18 cm) was recorded in chickpea + mustard (3:1) and any of the other treatments was not found at par value. This might be due to sunlight was used more efficiently than other intercropping treatments due to dense leaf foliage of single crop, absence of inter pace competition and limited disturbance of habitat. Results also confirmed by Ramarao and Chandranath (2019). At 50 DAS, liquid manures treatments varied significantly to each other. Significantly maximum plant height (16.5, 17.05 and 16.77 cm) obtained through foliar application of panchagavya 3% in first year, second year

and as well as in pooled data also, respectively. None of the treatments found at par with the foliar application of panchagavya 3% in all of the years. Increase in growth attributes due to the presence of macro and micro nutrients in panchagavya also, different microflora aid in increased plant height. Presence of naturally occurring beneficial microorganisms predominantly yeast, actinomycetes, bacteria, photosynthetic bacteria and some fungi were detected in organic liquid manures. Similar results of findings were also reported by Tiwari *et al*. (2021).

Plant dry weight of chickpea (g/plant)

At 50 DAS, no significant difference was noticed among different intercropping systems. However, highest plant dry weight of chickpea was noticed under chickpea + mustard (3:1) row ratio (1.16 g/plant in first year, 1.17 g/plant in second year and 1.17 g/plant in pooled data) and minimum plant dry weight was noticed under cropping system of chickpea alone (1.07, 1.06 and 1.07 g/plant) in first year, second year and in pooled data, respectively. At 50 DAS, analysed data represent significant difference among all the treatments. In first year, second year and pooled analysis, panchagavya 3% recorded significantly higher in plant dry weight (1.32, 1.36 and 1.34 g/plant) and there is no at par value recorded among the treatments. Foliar application of organic liquid manures significantly improved the development of crop plants since it contain the advantageous micro and macronutrients and plant growth stimulants and enzymes present in concoctions helps in rapid cell division and multiplication which improves the distribution of plant food source from aerial parts leaves through stem leads to the superior pods and more number of seed and highest hundred grain weight. The outcomes are in close similar with the results of Sridhara *et al* (2022).

Mustard growth attributes

The data pertaining to plant height and dry weight of mustard among intercropping systems and liquid manures at 50 DAS were presented in Table 1.

Plant height of mustard (cm)

At 50 DAS, there was no significant value observed in among all the treatments. However, highest plant height (42.82, 43.35 and 43.09 cm) was observed in chickpea + mustard (3:1) in first year, second year as well as in pooled data also. However, minimum plant height (40.51, 41.21 and 40.86 cm) was observed in sole mustard cropping system in first year, second year and in pooled data, respectively. Plant height of mustard decreased significantly when intercropped with chickpea than its sole cropping whereas, the plant height of chickpea significantly increased in intercropping systems. Similar results were given Kaparwan *el al*. (2021).

Table 1 : Growth parameters of chickpea and mustard as influenced by different row ratio of chickpea and mustard intercropping system and liquid manures.

Treatments	Chickpea at 50 DAS						Mustard at 50 DAS					
	Plant height (cm)			Dry weight (g/plant)			Plant height (cm)			Dry weight (g/plant)		
	2018	2019	Pooled	2018	2019	Pooled	2018	2019	Pooled	2018	2019	Pooled
Factor : A Intercropping systems (Row ratio) (Main Plot)												
Sole chickpea	14.05	14.38	14.21	1.06	1.07	1.06	-	-	-	-	-	-
Sole mustard	-	-	-	-	-	-	40.51	41.21	40.86	8.31	8.49	8.43
Chickpea + mustard (1:1)	14.33	14.95	14.64	1.08	1.10	1.09	40.90	41.51	41.21	8.91	8.63	8.57
Chickpea + mustard (2:1)	14.51	14.73	14.62	01.12	1.13	1.13	42.07	42.47	42.27	8.77	8.87	8.82
Chickpea + mustard (3:1)	14.88	15.48	15.18	1.16	1.17	1.17	42.82	43.35	43.09	9.07	9.28	9.17
F-test	S	S	S	NS	NS	NS	NS	NS	NS	NS	NS	NS
SEm±	0.14	0.19	0.13	0.02	0.05	0.03	0.74	0.64	0.59	0.21	0.29	8.43
CD (P = 0.05)	0.47	0.66	0.44	-	-	-	-	-	-	-	-	-
Factor : B Liquid manures (Sub Plot)												
Control	12.25	12.96	12.60	0.90	0.89	0.90	33.09	33.92	33.50	6.64	6.96	6.80
Panchagavya 3%	16.5	17.05	16.77	1.32	1.36	1.34	51.12	51.49	51.31	10.79	11.08	10.93
Cow urine 10%	13.86	14.46	14.16	1.03	1.04	1.03	37.53	37.71	37.62	8.06	8.10	8.08
Vermiwash 10%	15.16	15.06	15.11	1.17	1.18	1.17	44.56	45.44	45.00	9.23	9.13	9.18
F-test	S	S	S	S	S	S	S	S	S	S	S	S
SEm±	0.24	0.32	0.23	0.05	0.04	0.04	0.78	0.68	0.63	0.23	0.24	0.21
CD (P = 0.05)	0.71	0.95	0.69	0.14	0.12	0.11	2.26	1.99	1.85	0.66	0.69	0.63

Table 2 : Effect of different row ratios and liquid manures on economics of chickpea and mustard intercropping system.

Treatments	Cost of cultivation (Rs./ha)			Gross returns (Rs./ha)			Net returns (Rs./ha)			B:C ratio		
	2018	2019	Mean	2018	2019	Mean	2018	2019	Mean	2018	2019	Mean
Chickpea + control	37398.10	37888.10	37643.10	76907.22	81806.10	79356.66	39509.12	43918.00	41713.56	1.06	1.16	1.11
Chickpea + foliar application of panchagavya 3%	38898.10	39388.10	39143.10	126465.84	133751.70	130108.77	87567.74	94363.60	90965.67	2.25	2.40	2.32
Chickpea + foliar application of cow urine 10%	38398.10	38888.10	38643.10	95896.90	102006.50	98951.70	57498.80	63118.40	60308.60	1.50	1.62	1.56
Chickpea + foliar application of vermiwash 10%	41398.10	41888.10	41643.10	115980.44	123499.20	119739.82	74582.34	81611.10	78096.72	1.80	1.95	1.87
Mustard + control	33130.40	33630.40	33380.40	86676.47	90381.75	88529.11	53546.07	56751.35	55148.71	1.62	1.69	1.65
Mustard + foliar application of panchagavya 3%	34630.40	35130.40	34880.40	96080.79	101508.92	98794.86	61450.39	66378.52	63914.46	1.77	1.89	1.83
Mustard + foliar application of cow urine 10%	34130.40	34630.40	34380.40	86962.95	91929.00	89445.98	52832.55	57298.60	55065.58	1.55	1.65	1.60
Mustard + foliar application of vermiwash 10%	37130.40	37630.40	37380.40	93671.09	99111.00	96391.05	56540.69	61480.60	59010.65	1.52	1.63	1.58
Chickpea + Mustard (1:1) + control	35406.75	35906.75	35656.75	88611.06	94917.15	91764.11	53204.31	59010.40	56107.36	1.50	1.64	1.57
Chickpea + Mustard (1:1) + foliar application of panchagavya 3%	36906.75	37406.75	37156.75	123720.11	131968.65	127844.38	86813.36	94561.90	90687.63	2.35	2.53	2.44
Chickpea + Mustard (1:1) + foliar application of cow urine 10%	36406.75	36906.75	36656.75	103049.30	109892.51	106470.91	66642.55	72985.76	69814.16	1.83	1.98	1.90
Chickpea + Mustard (1:1) + foliar application of vermiwash 10%	39406.75	39906.75	39656.75	124166.83	131131.05	127648.94	84760.08	91224.30	87992.19	2.15	2.29	2.22
Chickpea + Mustard (2:1) + control	36165.30	36665.30	36415.30	90095.83	96393.16	93244.49	53930.54	59727.86	56829.20	1.49	1.63	1.56
Chickpea + Mustard (2:1) + foliar application of panchagavya 3%	37665.30	38165.30	37915.30	132557.94	141259.63	136908.79	94892.65	103094.34	98993.49	2.52	2.70	2.61

Table 2 continued...

Table 2 continued...

Chickpea + Mustard (2:1) + foliar application of cow urine 10%	37165.30	37665.30	37415.30	103308.03	110433.97	106871.00	66142.74	72768.68	69455.71	1.78	1.93	1.86
Chickpea + Mustard (2:1) + foliar application of vermiwash 10%	40165.30	40665.30	40415.30	127470.95	136240.61	131855.78	87305.65	95575.31	91440.48	2.17	2.35	2.26
Chickpea + Mustard (3:1) + control	36544.93	37044.93	36794.93	103111.92	109837.75	106474.84	66567.00	72792.83	69679.91	1.82	1.96	1.89
Chickpea + Mustard (3:1) + foliar application of panchagavya 3%	38044.93	38544.93	38294.93	151036.91	160253.62	155645.27	112991.99	121708.7	117350.34	2.97	3.16	3.06
Chickpea + Mustard (3:1) + foliar application of cow urine 10%	37544.93	38044.93	37794.93	119458.03	127123.89	123290.96	81913.10	89078.97	85496.04	2.18	2.34	2.26
Chickpea + Mustard (3:1) + foliar application of vermiwash 10%	40544.93	41044.93	40794.93	143597.89	152782.39	148190.14	103052.96	111737.47	107395.21	2.54	2.72	2.63

At 50 DAS, liquid manures treatments varied significantly to each other. Significantly maximum plant height (51.12, 51.49 and 51.31 cm) obtained through foliar application of panchagavya 3% in first year, second year and as well as in pooled data also, respectively. None of the treatments found at par with the foliar application of panchagavya 3% in all of the years. This increased plant growth characters might be due to the better availability of nutrients from organic and foliar sources of nutrients and effective conversion of nutrients from organics such as Fe, Mg and Zn available at the site of photosynthesis. Further the liquid organic manures have resulted in higher leaf area production and captured more solar radiation resulted in higher photosynthesis and consequently improvement in all growth parameters and these results are also supported by Yadav *et al.* (2017).

Plant dry weight (g/plant)

At 50 DAS, no significant difference was noticed among different intercropping system row ratio. However, highest plant dry weight of mustard was noticed under chickpea + mustard (3:1) row ratio (9.07 g/plant in first year, 9.28 g/plant in second year and 9.17 g/plant in pooled data) and minimum plant dry weight was noticed under cropping system of mustard alone (8.31, 8.49 and 8.43 g/plant) in first year, second year and in pooled data, respectively.

At 50 DAS, analysed data represent significant difference among all the treatments. In first year, second year and pooled analysis, panchagavya 3% recorded significantly higher in plant dry weight (10.79, 11.08 and 10.93 g/plant) and there is no at par value recorded among the treatments. This indicated that with increase in proportion of intercrops, there was more interception of light which made the mustard plant to grow faster as a result of enhanced photosynthetic activities and accumulation of dry matter during vegetative and reproductive stage (Chavda *et al.*, 2021). Panchgavya contains N, P, K, S, Fe, Zn. Thus, balanced nutrition might have resulted in better development and robust growth panchagavya is also known to contain beneficial microorganism such as *Azospirilum*, *Azotobacter*, *Phosphobacteria* and *Pseudomonas* besides *Lactobacillus* which promotes the plant growth parameter. Similar results of findings were also reported by Tiwari *et al.* (2020).

Economics

It is clear from the data presented in Table 2 that there was considerable difference among total cost of cultivation (Rs./ha), gross returns (Rs./ha), net returns (Rs./ha) and benefit cost ratio of chickpea and mustard

crop of different treatments under study.

Cost of cultivation (Rs./ha)

Among treatment combinations of chickpea and mustard intercropping systems along with liquid manures, the highest cost of cultivation (Rs. 41,398.10, 41,888.10 and 41, 643.10/ha) was obtained in chickpea with foliar application of vermiwash 10% in both the years of experimentation and in pooled data. While, lowest cost of cultivation (Rs. 33,130.40, 33,630.40 and 33,380.40/ ha) was obtained in mustard crop sown alone without application of liquid manures in both the years of experimentation and in pooled data. Similar trend of result also reported by Tripathy *et al.* (2023).

Gross returns (Rs./ha)

The result of gross returns indicated that chickpea grown with mustard (3:1) row ratio intercropping system along with foliar application of panchagavya 3% found maximum gross returns (Rs. 1,51,036.91, 1,60,253.62 and 1,55, 645.27/ha) in first year, second year as well as in pooled data. Whereas, minimum gross returns was (Rs. 76,907.22, 81,806.10 and 79,356.66/ha) recorded in chickpea sown alone without application of liquid manures during both the years as well as in pooled data, respectively. These results are line with those of Chavda *et al.* (2021).

Net returns (Rs./ha)

Chickpea with mustard (3:1) row ratio intercropping system along with foliar application of panchagavya 3% gave highest net returns (Rs. 1,12,991.99, 1,21,708.7 and 1,55, 645.27/ha) in both the experimental years and in pooled data and lowest net returns (Rs. 39,509.121, 43,918.00 and 41,713.66/ha) were observed in sole chickpea with no application of liquid manures in first year, second year and in pooled data. The higher gross and net returns with chickpea + mustard intercropping system was mainly due to higher economic yield and better price structure for chickpea and mustard (Ramaraoand and Chandranath, 2019) and also similar results trend also obtained by Tripathy *et al.* (2023).

B:C ratio

Treatment combination of chickpea and mustard (3:1) row ratio intercropping system along with application of panchagavya 3% liquid manure recorded highest benefit cost ratio (2.97, 3.17 and 3.06) and least benefit: cost ratio sole chickpea with no application of liquid manures (1.06, 1.16 and 1.11) in both the years of experimentation and in pooled data, respectively.

Conclusion

From the above study, it can be concluded that, intercropping of chickpea + mustard at 3:1 row ratio along foliar application of panchgavya 3% at branching and flowering stage was found to be more productive and profitable chickpea intercropping system as it recorded higher growth attributes, higher net returns and benefit cost ratio compared to other intercropping treatments and other liquid manures.

Acknowledgement

The authors are thankful to Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj-211007, Uttar Pradesh, India for providing the necessary facilities to undertake the studies.

References

Chavda, M., Vihol K., Vala Y. and Desai J. (2021). Intercropping in mustard (*Brassica juncea* L.) with chickpea and field pea. *J. Plant Develop. Sci*., **13(11)**, 829-836.

Gupta, K.C., Kumar V., Praharaj C.S. and 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. *J. Crop and Weed*, **15(2)**, 110-114.

Kaparwan, D., Rana N.S., Vivek and Dhyani B.P. (2021). Effect of Mustard on Yield Attributes, Nutrient Uptake and Quality of Chickpea under different Nutrient Management Levels and Intercropping Treatments in Chickpea + Mustard Intercropping system. *Int. J. Curr. Microbiol. App. Sci*., **10(03)**, 427-433.

Kaparwan, D., Rana N.S., Vivek and Dhayani, B.P. (2020). Effect of different row ratios and nutrient management strategies on growth, yield and quality of mustard in chickpea + mustard intercropping system. *J. Pharmacog. Phytochem*., **9(3)**, 852-857.

Raja, G., Singh S. and Dawson J. (2022). Effect of Nitrogen and Panchagavya on Growth and Yield of Cowpea (*Vigna unguiculata* L.) under the agro-climatic conditions of Prayagraj region. *The Pharma Innov. J*., **11(3)**, 2357-2360.

Ramarao and Chandranath H.T. (2019). Production and Economic Feasibility of Chickpea (*Cicer arietinum* L.) in Mustard (*Brassica juncea*) Intercropping System under different Row Ratio for Northern Dry Zone of Karnataka. *Int. J. Curr. Microbiol. App. Sci*., **8(10)**, 1909-1916.

Ramarao, Chandranath H.T.. Babalad H.B. and Hegde Y. (2020). Growth, Yield and Oil quality of Mustard in Chickpea (*Cicer arietinum*) and Mustard (*Brassica juncea* L.) Intercropping System under different Row Ratio in Northern Transition Zone of Karnataka. *Indian J. Agricult. Res*., **54(3)**, 322-328.

Shinde, P. and Hunje R. (2020). Influence of Soil Application of Organic Manures and Foliar Spray of Liquid Biofertilizers on Growth and Seed Yield of Kabuli Chickpea (*Cicer arietinum* L.) Varieties. *Legume Res. - An Int. J*., **43(2)**, 235-240.

Singh, S.K., Kushwaha H.S., Yadav R.S. and Verma S. (2021). Effect of row ratio and nutrient management practices on growth and yield of chickpea (*Cicer arietinum* L.) and mustard [*Brassica juncea* (L.) Czern. and Coss] intercropping system. *The Pharma Innov. J*., **10(12)**, 2858-2563.

Singh, U.K., Gangwar B. and Srivastava H. (2023). Effect of Mustard Based Intercropping Systems on Yield and Profitability under Organic Management in Bundelkhand Region. *Indian J. Ecol*., **50(3)**, 627-630.

Sridhara, M.R., Nandagavi R.A., Noolo S.S. and Biradar H. (2022). Influence of organic foliar application in chickpea (*Cicer arietinum* L.) under rainfed condition. *J. Crop and Weed*, **18(2)**, 56-63.

Tiwari, D., Singh V. and Kumar M.S.C. (2021). Productivity of Chickpea (*Cicer arietinum*. L.) and Mustard (*Brassica juncea*) Intercropping System as influenced by different Row Ratios and Liquid Manures. *Curr. J. Appl. Sci. Tech*., **40(2)**, 131-143.

Tiwari, D., Singh V. and Verma A.K. (2020). Growth and Yield of a Chickpea (*Cicer arietinum*) and Mustard (*Brassica juncea*) as Influenced by Row Ratio and Liquid Manures. *Curr. J. Appl. Sci. Tech*., **39(48)**, 206-215.

Tripathy, S., Meena S.L., Dhar S., Paul S. and Singh S. (2023). Effect of row ratios and organic nutrient management on productivity and economics of Indian mustard (*Brassica juncea*) + chickpea (*Cicer arietinum*) intercropping system. *Indian J. Agricult. Sci*., **93(10)**, 1067-1072.

Yadav, J.K. Sharma M., Yadav R. and Yadav S.K. (2017). Effect of different organic manures on growth and yield of chickpea (*Cicer arietinum* L.). *J. Pharmacog. Phytochem*., **6(5)**, 1857-1860.