Original Research Article

Inter Cropping of Chilli with Coriander and Fenugreek in Prayagraj Agro-climatic Conditions.

ABSTRACT

A field experiment entitled "Inter Cropping of Chilli With Coriander and Fenugreek in Prayagraj Agro-climatic Conditions" was conducted from December, 2021 – March, 2022 at the Horticulture Research Farm, Department of Horticulture, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj. The experiment was laid out in Randomized Block Design (RBD) with three replications and 08 treatments. The experiment consisted of six cropping combinations *viz.*, sole chilli, sole coriander, sole fenugreek, chilli + coriander, chilli+ fenugreek, chilli + coriander + fenugreek. The highest yield (green chilli) was obtained from treatment T_1 (Sole chilli @ 100 % RDF) (13.06 t ha^{-1}). Among the intercropping treatments, the highest chilli yield (12.73 t ha^{-1}) was obtained from treatment T_4 (chilli @ 85% RDF + coriander @15% RDF) whereas the lowest (10.54 t ha^{-1}) was found in treatment T_8 (chilli @ 55 % RDF + coriander @ 22.5 % RDF + fenugreek@ 22.5% RDF). Chilli production was decreased by intercropping, but overall chilli yield rose above solitary chilli due to the contribution of companion crops. The highest chilli along with intercrop yield (150.71 t ha^{-1}), gross return (1101506 Rs. ha^{-1}), net return (817969 Rs. ha^{-1}) and benefit cost ratio (3.88) were obtained from treatment T_8 (chilli @ 55 % RDF + coriander @ 22.5 % RDF + fenugreek@ 20% RDF). Considering the experimental findings, treatment T_8 (chilli @ 55 % RDF + coriander @ 22.5 % RDF + fenugreek@ 20% RDF) found the most suitable combination for higher productivity and economic return under Prayagraj agro-climatic conditions.

1. INTRODUCTION

In terms of acreage and vegetable output, India comes in second. Yet, productivity did not change during the previous ten years. Unbalanced fertilizer application may be one of the causes of this low output. With a balanced application of plant nutrients from various sources, production may be raised. As coriander and fenugreek are heavy feeders, it is necessary to sometimes meet the specific needs of the plant to improve both quality and output. With reincorporation on the same field, the nutrients collected in leaves may be recycled.

Intercropping is a prevalent technique in the agricultural and horticulture sectors, and it plays a significant role in enhancing productivity and yield stability. Intercropping is the simultaneous cultivation of two or more cultivars in the same area to maximise resource utilisation. Intercropping was originally used as a kind of crop insurance in diverse cropping patterns. The intercropping strategy makes better use of resources and increases productivity. Intercropping has several advantages over sole crop culture, including increased efficiency in the use of environmental factors (e.g., light, nutrients, and soil moisture) and labour, reduced adverse effects of various biotic and abiotic stress, increased food diversity, increased

income, insurance against crop failure, and higher return and total productivity per unit area.

In India, Chilli (*Capsicum annum* L.), sometimes referred to as the "king of spices," is widely grown. The largest producer, user, and exporter of chillies worldwide is India. Around 36% of the world's total production of chillies comes from India. Farmers apply fertilizers judiciously to get potential yields, but excess application may lead to leaching losses. Intercropping of chilli with different vegetables offer greater scope to utilize the land and other resources to the maximum extent. Productivity of the system can be enhanced by judicious selection of vegetables differing in duration and growth rhythms, so as to adjust the demand for the above and underground resources (Usha *et. al.,* 2019). It is eaten like a dry, green chilli. With a production of 34.10 lakh tonnes and a productivity of 12 MT/ha, green chilli is grown on 2.87 lakh hectares. 8.30 lakh hectares are used for dry chilli growing, yielding 18.7 lakh tonnes at a productivity of 2.25 MT/ha (*Horticultural Statistics 2016-17*). Red chillies are mostly sourced from India for the global market. 3.48 lakh tonnes and Rs. 3931.70 crores worth of chilli were exported from India in 2015–16, according to Spice India (*http://www.spiceindia.com*). Chilli is generally grown at a wider distance of 0.6 m × 0.45 m, which makes it suitable for intercropping.

Coriander (*Coriandrum sativum)* belongs to family Apiaceae/Umbellifereae. It is a strong odoriferous, hardy annual plant. It has slender, erect, hollow stem with white flowers in a compound umbel. The globular coriander fruit is brownish-yellow in colour with straight and curving ridges. The flavor resembles a mixture of caraway, cumin, sage and lemon peel. The aroma and taste are due to essential oil content which is used for flavoring baked goods, condiments, confectionaries, ice-cream mixes, chewing gums, alcoholic and nonalcoholic beverages. India is the largest producer of coriander in the world. It is mainly cultivated in Rajasthan, Madhya Pradesh and Andhra Pradesh with scattered patches in Tamil Nadu, Orissa, Karnataka, Utter Pradesh and Bihar.

Fenugreek (*Trigonella foenum-graecum* L.), is an annual plant in the family Fabaceae, with leaves consisting of three smalls obviate to oblong leaflets. It is cultivated worldwide as a semiarid crop. Its seeds and leaves are common ingredients in dishes from the Indian subcontinent, and have been used as a culinary ingredient since ancient times. Its use as a food ingredient in small quantities is safe. Although sold as a dietary supplement, there is no clinical evidence that fenugreek has therapeutic properties. Commonly used in traditional medicine, fenugreek can increase the risk of serious adverse effects, including allergic reactions. India is a major producer of fenugreek, and over 80% of India's output is from Rajasthan. Fenugreek is used as a herb (dried or fresh leaves), spice (seeds), and vegetable (fresh leaves, sprouts, and micro greens). Stolen is the chemical responsible for the distinctive maple syrup smell of fenugreek. Cuboid-shaped, yellow- to amber-coloured fenugreek seeds are frequently encountered in the cuisines of the Indian subcontinent, used both whole and powdered in the preparation of pickles, vegetable dishes, dal, and spice mixes such as panch phoron and sambar powder. They are often roasted to reduce inherent bitterness and to enhance flavour. In India is often cultivated as a cover crop in citrus-fruit groves to take advantage of their leguminous nature. It is a multipurpose crop grown during winter season for seed, vegetable and condiment purposes in various parts of the country.

2. MATERIALS AND METHODS

The experiment was conducted at Horticulture Research Farm, Department of Horticulture, Naini Agricultural Institute,

Sam Higginbottom University of Agriculture, Technology & Sciences, Prayagraj (U.P.) during December, 2021 – March, 2022. One cultivar of each crop was tried in Randomized Block Design (RBD) with three replications and eight treatment combinations viz. **T_1** Sole Chilli @100% RDF, **T_2** Sole Coriander @100% RDF, **T_3** Sole Fenugreek @100% RDF, **T_4** Chilli @ 85% RDF + Coriander @15% RDF, **T_5** Chilli @ 85% RDF+ Fenugreek @15% RDF, **T_6** Chilli @70% RDF + Coriander @30% RDF, **T_7** Chilli @ 70% RDF + Fenugreek @ 30% RDF, **T_8** Chilli @ 55 % RDF + Coriander @ 22.5 % RDF + Fenugreek @ 22.5 % RDF. Chilli cv. Dankal , Coriander cv. Co-1 , Fenugreek cv. Krishna these three varieties were used for the experiment. Farm Yard Manure 20 t/ha for chilli, 10 t/ha for coriander and 20-25 t/ha for fenugreek were applied at the time of field preparation. Nitrogen was supplied through the application of urea and DAP; phosphorus was supplied only through DAP, and potassium was supplied through MOP at various stages of crop growth. In each plot fertilizers were applied as per above- mentioned treatment combination and thoroughly mixed in the soil with the help of khurpi. Thirty days old healthy seedlings of chilli having 4-5 leaves with a height of 15-18 cm were selected and transplanted at the experimental plot and given light irrigation. At each observation, three plants from each plot were randomly selected for chilli and tagged, and for carrot and radish, five plants of each plot were randomly selected at the time of harvesting. The observations were recorded from these plants. The data were subjected to analysis of variance and mean separation was assessed by critical difference (CD) at 5% probability. Data was analyzed using OPSTAT software.

3. RESULTS AND DISCUSSION

3.1 Effect of Intercrops on Green Chilli Yield and Quality on Application of Different level of RDF

It was clearly observed that the intercrops had significantly shown influence on growth and yield of chilli.

3.2 Growth, Yield and Quality Characters of Chilli

The growth, yield, and quality traits of chilli considerably varied depending on the treatment, as shown in Table 1. In terms of growth parameters, the maximum plant height of chilli (70.12 cm) was found in T1 (Sole Chilli @100% RDF) and the minimum plant height (61.20 cm) was recorded in T6 (Chilli @70% RDF + Coriander @30% RDF). Kaur and Sharma, [2] reported that increasing the nitrogen level helped in increasing the plant height. Similarly the highest number of branches plant^{-1} (15.12), maximum leaf area at the time of harvesting (40.55 cm2), lowest number of days taken for 50% flowering (24.43 days), minimum number of days taken to 1st harvest (45.96 days) was recorded in T1 (Sole Chilli @ 100% RDF) while the lowest number of branches plant^{-1} (11.89), minimum leaf area at the time of harvesting (33.74 cm^2), highest number of days taken for 50% flowering (36.33 days), maximum number of days taken to 1st harvest (56.42 days) was recorded in T8 (Chilli @ 55 % RDF + Coriander @ 22.5 % RDF + Fenugreek @ 22.5 % RDF). When it comes to yield parameters, the maximum fruit length (8.25 cm) was recorded in T1 (Sole Chilli @100% RDF) while the minimum fruit length (8.05 cm) was recorded in T8 (Chilli @ 55 % RDF + Coriander @ 22.5 % RDF + Fenugreek @ 22.5 % RDF). Correspondingly the maximum fruit girth (3.64 cm), the maximum average fruit weight (5.13 g), maximum number of fruit plant^{-1} (75.99), highest fruit yield plant^{-1} (396.51 g),

maximum fruit yield hectare^{-1} (13.06 t) was recorded in T1 (Sole chilli @ 100% RDF) while the minimum fruit girth (3.44 cm), the minimum average fruit weight (4.92 g), minimum number of fruit plant^{-1} (64.27), lowest fruit yield plant^{-1} (316.25 g), minimum fruit yield hectare^{-1} (10.54 t) was recorded in T8 (Chilli @ 55 % RDF + Coriander @ 22.5 % RDF + Fenugreek @ 22.5 % RDF). Similarly, Tumbare and Niikam, 2004 reported impact of intercropping on main crop. Likewise, the maximum TSS value (8.15 ºBrix) was observed in T1 (Sole chilli @ 100% RDF) while the minimum TSS value (7.05 ºBrix) was observed in T8 (Chilli @ 55 % RDF + Coriander @ 22.5 % RDF + Fenugreek @ 22.5 % RDF). Intercrops significantly reduced the yield of main crop as compared to sole cropping.

3.3 Yield and Quality Characters of Coriander

Yield and quality characteristics of coriander were significantly differed in different treatments and are mentioned in Table 2. In terms of yield parameters, the maximum plant height (97.22 cm) was recorded in T2 (Sole Coriander @100% RDF) and the minimum plant height (86.13 cm) was recorded in T8 (Chilli @ 55 % RDF + Coriander @ 22.5 % RDF + Fenugreek @ 22.5 % RDF). Uniformly the maximum number of branches per plant (28.69), the maximum number of leaves per plant (75.42), the maximum leaf yield per plant (17.48 g), the maximum leaf yield per plot (166.11 kg) was recorded in T2 (Sole Coriander @100% RDF) while the minimum number of branches per plant (22.17), the minimum number of leaves per plant (62.51), the minimum leaf yield per plant (13.20 g), the minimum leaf yield per plot (155.34 kg) was recorded in T8 (Chilli @ 55 % RDF + Coriander @ 22.5 % RDF + Fenugreek @ 22.5 % RDF). Likewise, the maximum TSS value (6.20 ºBrix) was observed in T2 (Sole Coriander @100% RDF)the minimum TSS value (4.62 ºBrix) was observed in T8 (Chilli @ 55 % RDF + Coriander @ 22.5 % RDF + Fenugreek @ 22.5 % RDF). For growth, yield and quality parameters, sole cropping pattern of each crop showed best result compared to intercropping combination but when it comes to overall yield, intercropping showed maximum result.

3.4 Yield and Quality Characters of Fenugreek

Yield and quality characteristics of radish were significantly differed in different treatments and are mentioned in Table 3. In terms of yield parameters, the maximum plant height (94.10 cm)was recorded in T3 (Sole Fenugreek @100% RDF) and the minimum plant height (77.43 cm) was recorded in T8 (Chilli @ 55 % RDF + Coriander @ 22.5 % RDF + Fenugreek @ 22.5 % RDF). Uniformly the maximum number of branches per plant (26.69), the maximum number of leaves per plant (73.42), the maximum leaf yield per plant (15.48 g), the maximum leaf yield per plot (414.52 kg) was recorded in T3 (Sole Fenugreek @100% RDF) while the minimum number of branches per plant (20.17), the minimum number of leaves per plant (60.51), the minimum leaf yield per plant (11.20 g), the minimum leaf yield per plot (311.72 kg) was recorded in T8 (Chilli @ 55 % RDF + Coriander @ 22.5 % RDF + Fenugreek @ 22.5 % RDF) . Likewise, the maximum TSS value (6.15 ºBrix) was observed in T3 (Sole Fenugreek @ 100% RDF) while the minimum TSS value (4.57 ºBrix) was observed in T8 (Chilli @ 55 % RDF + Coriander @ 22.5 % RDF + Fenugreek @ 22.5 % RDF). Similar findings were obtained by (Lebauer and Treseder, 2008).

3.5 COST BENEFIT ANALYSIS

Considering all the economics of different treatment and intercropping combination in chilli, the net return (Rs. 817969/ha) was maximum in T8 (Chilli @ 55 % RDF + Coriander @ 22.5 % RDF + Fenugreek @ 22.5 % RDF). followed by (Rs. 799168/ha) was observed in T6 (Chilli @70% RDF + Coriander @30% RDF) while the minimum net return (Rs. 74626) was observed in T1 (Sole Chilli @ 100% RDF) (Table 4). Although the cost of cultivation of sole chilli, sole coriander and sole fenugreek was comparatively lower as compared to intercropping combinations but due to the additional yield of the intercropping vegetables the profitability of intercropping was increasedover sole cropping. Ijoyah and Dzer reported that the more the combined yields the more the economic return of the intercropping compared to sole cropping. Innazent *et al.,* reported that chilli + amaranth intercropping system provided maximum biological return. The highest benefit cost ratio (BCR) (3.88) was recorded in T8 (Chilli @ 55 % RDF + Coriander @ 22.5 % RDF + Fenugreek @ 22.5 % RDF) followed by (3.82) was observed in T6 (Chilli @70% RDF + Coriander @30% RDF) while the minimum benefit cost ratio (1.40) was observed in T1 (Sole Chilli @ 100% RDF). Similarly, Patil *et al.,* observed that turmeric and chilli intercropping combination increased the economics without affecting the growth and yield of main crop turmeric. Kadir *et al.*,observed that chilli and groundnut intercropping systems increased yield, economic and nutritional value. Besides this, many researchers also indicated that intercropping practice gets a higher economic return than the sole cropping practice (Suresha et al.,2007 ; Alom *et al.,* 2008 ; Farhad *et al.,* (2014); Begum *et al.,* Khatun *etal.,*

Table 1. Growth, yield and quality of chilli as influenced by chilli, coriander and fenugreek intercropping

Treatments	Plant height (cm)	No. of branches plant^{-1}	Leaf area at harvest (cm^2)	Days taken for 50% flowering	Days taken to 1st harvest	Avg. fruit length (cm)	Avg. fruit girth (cm)	Avg. fruit weight (g)	Avg. no of fruit plant^{-1}	Avg. fruit yield plant^{-1} (g)	Avg. yield hectare^{-1} (t)	TSS (^{o}Brix)
T_1	70.12	15.12	40.55	24.43	45.96	8.25	3.64	5.13	75.99	396.51	13.06	8.15
T_4	63.51	15.08	35.5	31.21	52.04	8.23	3.55	5.11	72.64	378.33	12.73	7.90
T_5	61.22	12.33	34.14	31.64	55.21	8.13	3.53	5.02	68.11	340.95	11.35	7.85
T_6	61.2	14.01	35.12	26.30	52.45	8.17	3.53	5.10	73.81	378.18	12.65	7.70
T_7	65.84	13.25	35.23	31.98	54.71	8.15	3.51	5.10	69.12	350.51	11.65	7.84
T_8	65.71	11.89	33.74	36.33	56.42	8.05	3.44	4.92	64.27	316.25	10.54	7.05
SE(d)±	0.37	0.06	0.45	0.20	0.25	0.03	0.05	0.04	0.27	0.94	0.03	0.04
CD 0.05	0.92	0.52	1.52	0.51	0.78	0.07	0.12	0.1	0.85	2.73	0.06	0.11

T_1 Sole Chilli @100% RDF, **T_4** Chilli @ 85% RDF + Coriander @15% RDF, **T_5** Chilli @ 85% RDF+ Fenugreek @15% RDF, **T_6** Chilli @70% RDF + Coriander @30% RDF, **T_7** Chilli @ 70% RDF + Fenugreek @ 30% RDF, **T_8** Chilli @ 60%RDF+Coriander@20%RDF+Fenugreeek @20%RDF.

Table 2. Yield and quality of coriander as influenced by chilli, coriander and fenugreek intercropping

Treatments	Plant Height (cm)	Number of Branches per plant	Number of leaves per plant	Leaf yield per plant (g)	Leaf yield per plot (kg)	TSS (°Brix)	Ascorbic acid mg/100g
T_2	97.22	28.69	75.42	17.48	166.11	6.2	208.87
T_4	90.9	24.92	62.75	14.53	159.94	5.3	190.54
T_6	93.13	25.21	63.75	15.4	162.42	5.51	197.35
T_8	86.13	22.17	62.51	13.2	155.34	4.62	151.25
SE(d)±	4.77	2.46	2.46	0.64	0.16	0.03	0.99
CD 0.05	2.03	2.13	2.13	1.60	0.49	0.85	2.49

T_2 Sole Coriander @100% RDF, **T_4** Chilli @ 85% RDF + Corinader @ 15 % RDF, **T_6** Chilli @70% RDF + Coriander @30% RDF, **T_8** Chilli @ 55 % RDF + Coriander @ 22.5 % RDF + Fenugreek @ 22.5 % RDF.

Table 3. Yield and quality of fenugreek as influenced by chilli, coriander and fenugreek intercropping

Treatments	Plant Height (cm)	Number of Branches per plant	Number of leaves per plant	Leaf yield per plant (g)	Leaf yield per plot (kg)	TSS (°Brix)	Ascorbic acid mg/100g
T_3	94.1	26.69	73.42	15.48	414.52	6.15	203.87
T_5	81.03	22.92	60.75	12.53	343.72	5.25	185.54
T_7	87.41	23.21	61.75	13.40	364.52	5.46	192.35
T_8	77.43	20.17	60.51	11.20	311.72	4.57	146.25
SE(d)±	2.18	2.44	2.44	0.62	4.52	0.32	0.97
CD 0.05	5.44	2.11	2.11	1.58	11.32	0.83	2.47

T_3 Sole Fenugreek @100% RDF, **T_5** Chilli @ 85% RDF+ Fenugreek @15% RDF, **T_7** Chilli @ 70% RDF + Fenugreek @ 30% RDF, **T_8** Chilli @ 55%RDF+Coriander @ 22.5 % RDF + Fenugreek @ 22.5 % RDF.

Table 4. Economics of intercropping of coriander and fenugreek with chilli per hectare

Treatments	Gross return (Rs. /ha)	Cost of cultivation (Rs. /ha)	Net return (Rs. /ha)	B:C Ratio
T_1	261845	187219	74626	1.40
T_2	499080	188137	310943	2.65
T_3	641475	176467	465008	3.64
T_4	617193	240808	376386	2.56
T_5	764350	229949	534401	3.32
T_6	630202	241462	388740	2.61
T_7	776441	230398	546043	3.37
T_8	1101506	283537	817969	3.88

T_1 Sole Chilli @100% RDF, **T_2** Sole Coriander @100% RDF, **T_3** Sole Fenugreek @100% RDF, **T_4** Chilli @ 85% RDF + Coriander @15% RDF, **T_5** Chilli @ 85% RDF+ Fenugreek @15% RDF, **T_6** Chilli @70% RDF + Coriander @30% RDF, **T_7** Chilli @ 70% RDF + Fenugreek @ 30% RDF, **T_8** Chilli @ 55 % RDF + Coriander @ 22.5 % RDF+ Fenugreek @ 22.5 % RDF.

4. CONCLUSION

From the study it was concluded that cultivation of coriander as intercrop with chilli as main crop was found as best option among the intercropping with nutrient combination thus best result was obtained in T4 (Chilli @ 85% RDF + Coriander @ 15% RDF) in terms of vegetative growth, quality and quantity parameters for main crop as well as for intercrop. The highest net return of Rs. 314847/ha and the best B:C ratio of 2.15 was obtained in T8 (Chilli @ 55%RDF+Coriander @22.5%RDF+Fenugreek@22.5%RDF) due to addition of yield of two different intercrops. Hence the treatment T8 (Chilli @ 55 % RDF + Coriander @ 22.5 % RDF + Fenugreek @ 22.5 % RDF) is best suited for the farmers of Prayagraj Agro-climatic Conditions in terms of overall production, land use efficiency and net return.

5. REFERENCES

Alom MS, Paul NK, Quayyum M A. **(2008)** Performance of hybrid maize (*Zea mays* L.) under intercropping systems with mungbean in different planting methods. *SAARC J. Agric*.;6: 73-82.

Begum SA, Zaman MS, Khan ASMMR. (2015) Intercropping of root crops with chilli in charlands of Mymensingh. Progressive Agriculture.26:109-114.

Bose, T. K. Kabir, J. Das, P. and Joy, P. P. (2000), Tropical Horticulture, Volume-1 Naya Prokash, Calcuta. Pp. 145.

Farhad ISM, Chowdhury MMU, Bhowal SK, Choudhury AK, Khan AS. (2014) Chilli–garlic intercropping system in coastal saline area. App. Sci. Report. PSCI Publications. 2(2):47-50.

Ijoyah MO and Dzer DM. (2012) Yield performance of okra (Abelmoschus esculentus L. Moench) and maize (Zea mays L.) as affected by time of planting maize in Makurdi. Nigeria. ISRN Agron. 2012;7.

Innazent A, Anitha S, Thomas CG, Prameela KP, Beena (2018) VI. Biological efficiency of chilli + amaranth intercropping system under fertigation. Journal of Tropical Agriculture. 2018;56(2): 201-205

Kadir M, Rahman J, Riad MI, Alam MK (2021). Intercropping chilli with groundnut in char land. Tropical Agroecosystem (TAEC). 2021;2(2):79-81.

Khatun MF, Islam MS, Ali MA, Ali MO, Ahmed QM. (2020) Intercropping Garlic (*Allium sativum* L.) with Chilli (*Capsicum annum* L.) in the Haor area of Kishoreganj. Bangladesh *Agron. J.* 23(1):75- 81.

Mangla, N., S., Srivastava, R., and Yadav, Indranil (2021) Study of different varietis of carrot and its benefits for human health: A review , *Journal of Pharmacognosy and Phytochemistry* 10(1): 1293-1299.

Patil PM, Chougala DC, Adarsh HS. (2020) Turmeric + chilli Intercropping: Way towards doubling farmers income. International Journal of Science and Research. 2020;10(5):655-657.

Soniya T, Kamalakannan S, Maheswari TU, Sudhagar R. (2021) Effect of intercropping on growth and yield of tomato (*Solanum lycopersicum* L.). *Annals of Plant and Soil Research*. 23(1):36-41.

Suresha BA, Allolli TB, Patil MG, Desai BK, Hussain S A. (2007) Yield and economics of chilli based intercropping system. Karnataka J. Agric. Sci.;20(4):807- 809.