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Influence of bio-intensive complementary cropping systems on yields and quality parameters of mustard – chickpea intercropping under indo-gangetic plains

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Abstract

An experiment entitled “Evaluation of bio-intensive complementary cropping systems involving Mustard - Chickpea intercropping in Indo-Gangetic plains” was conducted in the field of Department of Soil Conservation and Water Management, C.S.A. University of Agriculture and Technology Kanpur, during rabi season of 2017-18 and 2018-19. To find out the suitable cropping systems on yield attributes i.e. number of pods plant⁻¹, number of seeds pod⁻¹ 1000-seed weight, of chickpea crop. The treatments comprised of T₀ - Mustard alone (45 x 10cm): Flat bed - Conventional method (Control-1), T₁ - Chickpea alone (30 x 10 cm): Flat bed - conventional method (Control-2), T₂ - Mustard + Chickpea (1:1): Additive series (45x10cm) Mustard+1Row of (Chickpea), T₃ - Sowing of Chickpea on ridges-one row on ridges, T₄ - Sowing of Chickpea + Mustard by skipping 1 row of Chickpea, T₅ - Sowing of Chickpea on narrow bed (45 cm): two rows of Chickpea, T₆ - Sowing of Mustard on narrow bed + Chickpea (one side mustard other side chickpea) and T₇ - Broad bed furrow -105 cm (BBF): 3 rows of Chickpea on BB and 1 row of Mustard in furrow in Randomized plot design with 3 replications. Results obtained in regarded to yields and quality parameters showed that the Component crops seed yield qha⁻¹ The mustard yield was obtained higher under Mustard alone (45x 10): Flatbed (Control-1) in first year and second year, 15.13 q/ha and 16.61 q/ha with mean 15.87 q/ha followed by Sowing of Chickpea + Mustard by skipping one row of chickpea as well as under intercropping found second highest 10.93 q/ha in first year and 11.79 in second year 11.36 q/ha. However, the seed yield of intercrops chickpea was obtained highest in Sowing of Chickpea on ridges-one row on ridges of 16.05 q/ha in first year and 17.95 q/ha in second year with average of both year 17.00 q/ha followed by Sowing of Chickpea on narrow bed (45cm): Two row of Chickpea 14.65 q/ha during first year and 16.49 q/ha during second year with average of both year 15.57 q/ha respectively. Highest LER recorded in Mustard + Chickpea (1:1): Additive series during both the years followed by Broad bed furrow -105 cm (BBF): 3 rows of Chickpea on BB and one row of Mustard in furrow and Sowing of Chickpea on ridges-one row on ridges produced second highest LER in first year and Broad bed furrow -105 cm (BBF): 3 rows of Chickpea on BB and one row of Mustard in furrow during second year. Showed that protein content in (%) of chickpea seed. Sowing of chickpea on ridges-one row on ridges methods of treatments content maximum protein recorded in first year (21.15) compare to sowing of Chickpea on narrow bed (45cm): Two row of Chickpea (21.03). However lowest protein content recorded in sowing of Chickpea + Mustard by skipping one row of Chickpea as first year (20.71) percent content in chickpea seed during first year. Oil content in (%) of mustard seed. Maximum oil content recorded in Mustard alone (45x 10): Flatbed (Control-1) 40.39% in mustard seed comparison to Sowing of Mustard on narrow bed + Chickpea (one side mustard other side Chickpea) recorded 39.38% in mustard seed. However, lowest oil content recorded in Sowing of Chickpea + Mustard by skipping one row of Chickpea 39.05% oil content in mustard seed during first year experiment.

Keywords: broad bed furrow (BBF), mustard chickpea - conventional method, narrow bed furrow

Introduction

Mustard (*Brassica juncea* L.) is one of the major edible oil seed crop, maximizing mustard production and productivity is crucial for reducing edible oil import burden for the country. While, chickpea is the main supplier of protein and has a high nutritional value, its production and productivity enhancement is vital for achieving food and nutritional security. Hence, maximizing the productivity of mustard + Chickpea cropping systems is crucial for the country. Chickpea is a self-pollinated legume crop, Pulses are grown in India annually in the area of 29.99 million ha with a production of 25.23 million tones, with the average productivity of meager 841 kg/ha (Agricultural Statistics at a Glance, 2018) [2]. However, the country's demand of pulses by 2020 is to be as huge as 22.3-23.8 million tonnes. Among the potential pulse crops in the country, chickpea (*Cicer arietinum* L.) is a leading pulse crop

which is grown in about 10.56 million hectares area with annual production of 11.23 million tones fetching an average productivity of 1063 kg/ha (Agricultural Statistics at a Glance, 2018) [2]. Chickpea is the second most important crop in the world, it is also grown in 33 countries of the world. Chickpea provides high quality protein for especially vegetarian peoples who's not preferred meat. It is also used for feed of animals and those have a significant role in farming system as a substitute for fallow in cereal rations. Chickpea and mustard is a prominent intercropping system not only in the Indo-Gangetic plains of North India but in the entire Indian sub-continent on dryland conserved moisture conditions. Scientific approach of intercropping of these two crops increases the productivity per unit area per unit time under a situation where two crops are grown in certain proportion and row ratio (Kushwaha *et al.*, 2009) [6].

According to the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) chickpea seeds contain on average- 21.1% protein, 64% total carbohydrates (47% starch, 6% soluble sugar), 5% fat, 6% crude fibre and 3% ash. High mineral content has been reported for phosphorus (340 mg per 100 g), calcium (190 mg per 100 g) and magnesium (140 mg per 100 g), iron (7 mg per 100 g) and zinc (3 mg per 100 g). Recent studies have also shown that they can assist in lowering of cholesterol in the bloodstream (Pittway *et al.*, 2008) [10]. One hundred grams of mature boiled chickpea grain contains 164 calories energy, 2.6 g fat (of which only 0.27 g is saturated), 7.6 g of dietary fibre and 8.9g of protein. Chickpea also provide dietary calcium (49–53 mg per 100 g). Chickpea is used for human consumption as well as animal feed. Intercropping is a crop management system involving the growing of two or more economic dissimilar crop species or varieties in distinct row combinations simultaneously on the same piece of land (Mucheru-Muna *et al.*, 2010) [9]. Moreover, intercropping improves soil fertility through biological nitrogen fixation with the use of legumes, increases soil conservation through greater ground cover than sole cropping and provides better lodging resistance for crops susceptible to lodging than when grown in monoculture. Intercropping allows lower inputs through reduced fertilizer and pesticide requirements, thus minimizing environmental impacts of agriculture and offers financial stability than sole cropping.

Materials and Methods

The study was conducted on *Bio-intensive complementary cropping systems involving Mustard - Chickpea intercropping* at Soil Conservation and Water Management Farm, Chandra Shekhar Azad University of Agriculture & Technology, Kanpur is situated in the alluvial tract of Indo - Gangetic plains in central part of Uttar Pradesh between 25° 26' to 26° 58' North latitude and 79° 31' to 80°34' East longitude at an elevation of 125.9 m above mean sea level. The average annual rainfall is 800 mm, a major portion of which is received during the monsoon season from the last week of June to first week of October. The treatments comprised of T₀ - Mustard alone (45 x10cm): Flat bed - Conventional method

(Control-1), T₁ - Chickpea alone (30 x 10 cm) : Flat bed - Conventional method (Control-2), T₂- Mustard + Chickpea (1:1) : Additive series (45x10cm) Mustard + 1Row of (Chickpea), T₃ - Sowing of Chickpea on ridges-one row on ridges, T₄ - Sowing of Chickpea + Mustard by skipping 1 row of Chickpea, T₅ - Sowing of Chickpea on narrow bed (45 cm): two rows of Chickpea, T₆ - Sowing of Mustard on narrow bed + Chickpea (one side mustard other side chickpea) and T₇ - Broad bed furrow -105 cm (BBF) : 3 rows of Chickpea on BB and 1 row of Mustard in furrow 8 treatments with 3 replications the analysis of variance of the data was worked out on the basis of the Randomized Block Design, as explained by Cochran and Cox (1957) [3].

Results and Discussion

Yield

Component crops seed yield

The mustard yield was obtained higher under Mustard alone (45x 10): Flatbed (Control-1) in first year and second year, 15.13 q/ha and 16.61 q/ha with mean 15.87 q/ha followed by Sowing of Chickpea + Mustard by skipping one row of chickpea as well as under intercropping found second highest 10.93 q/ha in first year and 11.79 in second year 11.36 q/ha with mean while lowest recorded under Broad bed furrow - 105 cm (BBF): 3 rows of Chickpea on BB and one row of Mustard in furrow 7.15 q/ha in first year and 8.99 q/ha in second year with mean 8.07 q/ha (Table 1).

The seed yield of intercrops chickpea was obtained highest in Sowing of Chickpea on ridges-one row on ridges of 16.05 q/ha in first year and 17.95 q/ha in second year with average of both year 17.00 q/ha followed by Sowing of Chickpea on narrow bed (45cm): Two row of Chickpea 14.65 q/ha during first year and 16.49 q/ha during second year with average of both year 15.57 q/ha respectively. However, minimum yield recorded in intercropping system of Sowing of Chickpea + Mustard by skipping one row of Chickpea i.e., 4.95 q/ha in first year & 5.91 q/ha in second year with average yield 5.43 q/ha during both year (Table 1), respectively. Similar results were reported Das *et al.* (2017) [4], Ramrao *et al.* (2017) [11] and Singh *et al.* (2019) [12].

Chickpea equivalent seed yield (q/ha)

Effect of different cropping system showed significantly variation chickpea equivalent seed yield was recorded significantly highest of 16.27 q/ha in first year and 18.50 q/ha in second year with average 17.39 q/ha under Mustard + Chickpea (1:1): Additive series followed by Sowing of Chickpea on ridges-one row on ridges 16.05 q/ha in first year and 18.13 q/ha recorded under Broad bed furrow -105 cm (BBF): 3 rows of Chickpea on BB and one row of Mustard in furrow second year with average 17.04 q/ha. Among the different cropping system average data Mustard + Chickpea (1:1): Additive series gain higher equivalent yield as compared to others cropping system, respectively. While in intercropping systems was recorded minimum in Mustard alone (45x10): Flatbed (Control-1) 13.75 q/ha in first year and 15.10 q/ha

Table 1: Effect of bio-intensive complementary cropping systems involving Mustard- Chickpea intercropping on Yield attributes interval during both the year of Chickpea crop

Treatment	Component crops seed yield (q ha ⁻¹)			Chickpea equivalent seed yield (q ha ⁻¹)			Land equivalent ratio (LER)		
	2017-18	2018-19	Mean	2018-19	2017-18	Mean	2017-18	2018-19	Mean
Applied different methods									
T ₁ - Chickpea alone (30x 10): Flatbed (Control-2)	(15.13)	(16.61)	(15.87)	13.75	15.10	14.43	1.00	1.00	1.00
T ₂ - Mustard + Chickpea (1:1): Additive series	14.11	15.42	14.76	14.11	15.42	14.77	1.00	1.00	1.00
T ₃ - Sowing of Chickpea on ridges-one row on ridges	7.58 (9.57)	9.41 (10.0)	8.49 (9.78)	16.27	18.50	17.39	1.17	1.21	1.19
T ₄ - Sowing of Chickpea + Mustard by skipping one row of Chickpea	16.05	17.95	17.00	16.05	17.95	17.00	1.14	1.16	1.15
T ₅ - Sowing of Chickpea on narrow bed (45cm): Two row of Chickpea	4.95 (10.93)	5.91 (11.79)	5.43 (11.36)	14.89	16.63	15.76	1.08	1.09	1.09
T ₆ - Sowing of Mustard on narrow bed + Chickpea (one side mustard other side Chickpea)	14.65	16.49	15.57	14.65	16.49	15.57	1.04	1.07	1.06
T ₇ - Broad bed furrow -105 cm (BBF): 3 rows of Chickpea on BB and one row of Mustard in furrow	6.83 (9.65)	8.60 (9.89)	7.71 (9.77)	15.60	17.59	16.60	1.12	1.15	1.14
SE ±(d)	-	-	-	0.63	0.50	-	0.04	0.03	-
CD (P=0.05)	-	-	-	1.37	1.09	-	0.10	0.07	-

Table 2: Effect of bio-intensive complementary cropping systems involving Mustard- Chickpea intercropping on Days to flowering, pod formation and at maturity during 2017-18 of Chickpea crop

Treatment	Protein content (%)			Oil content (%)		
	2017-18	2018-19	Mean	2017-18	2018-19	Mean
Applied different methods						
T ₀ . Mustard alone (45x 10) : Flatbed (Control-1)	-	-	-	40.39	40.42	40.41
T ₁ . Chickpea alone (30x 10): Flatbed (Control-2)	20.89	20.92	20.50	-	-	-
T ₂ - Mustard + Chickpea (1:1): Additive series	20.75	20.78	20.76	39.25	39.29	39.27
T ₃ - Sowing of Chickpea on ridges-one row on ridges	21.15	21.19	21.17	-	-	-
T ₄ - Sowing of Chickpea + Mustard by skipping one row of Chickpea	20.71	20.74	20.72	39.05	39.10	39.08
T ₅ - Sowing of Chickpea on narrow bed (45cm): Two row of Chickpea	21.03	21.08	21.06	-	-	-
T ₆ - Sowing of Mustard on narrow bed + Chickpea (one side mustard other side Chickpea)	20.75	20.79	20.77	39.38	39.42	39.40
T ₇ - Broad bed furrow -105 cm (BBF): 3 rows of Chickpea on BB and one row of Mustard in furrow	20.81	20.84	20.82	39.15	39.20	39.18
SE ±(d)	0.07	0.09	-	0.07	0.08	-
CD (P=0.05)	0.16	0.20	-	0.16	0.21	-

In second year with average value 14.43 q/ha, respectively (Table-1). The results clearly indicate that significant variation in term of chickpea equivalent seed yield different cropping system have been proved superior under Mustard + Chickpea (1:1): Additive series during both year of experiment. Among the lowest chickpea equivalent seed yield registered in Mustard alone (45x10): Flatbed (Control-1) during both the year. Similar reported by Lal (2012)^[7], Wasu *et al.* (2013)^[16], Zafarani (2014)^[17] and Das *et al.* (2017)^[4].

Land equivalent ratio (LER)

Mustard + Chickpea (1:1): Additive series at par Broad bed furrow -105 cm (BBF): 3 rows of Chickpea on BB and one row of Mustard in furrow showed same response sowing of Chickpea on ridges-one row on ridges. Highest LER recorded in Mustard + Chickpea (1:1): Additive series during both the years followed by Broad bed furrow -105 cm (BBF): 3 rows of Chickpea on BB and one row of Mustard in furrow and Sowing of Chickpea on ridges-one row on ridges produced second highest LER in first year and Broad bed furrow -105 cm (BBF): 3 rows of Chickpea on BB and one row of Mustard in furrow during second year. Where lowest recorded under sole cropping system. There was marked variation in terms of LER occurred in different cropping system during 2017-18 and 2018-19. Mustard + Chickpea (1:1): Additive series observed significantly higher LER over flatbed methods during both year experiments (Table-1). Similar results reported by Mandal *et al.* (1994)^[8], Upasani (1994)^[14] and Singh *et al.* (2019)^[12].

Quality parameters

Protein content in seed of chickpea (%)

The data of different cropping system sowing methods showed that protein content in (%) of chickpea seed (Table 2). Sowing of chickpea on ridges-one row on ridges methods of treatments content maximum protein recorded in first year (21.15) compare to sowing of Chickpea on narrow bed (45cm): Two row of Chickpea (21.03). However lowest protein content recorded in sowing of Chickpea + Mustard by skipping one row of Chickpea as first year (20.71) percent content in chickpea seed during first year. Effect of different cropping system sowing methods also varied remarkably in respect of protein content in seed of chickpea. Significantly higher protein content recorded in sowing of chickpea on ridges-one row on ridges methods of treatments second year (21.19) followed by sowing of Chickpea on narrow bed (45cm): Two row of Chickpea (21.08) percent. However lowest protein content in sowing of Chickpea + Mustard by skipping one row of Chickpea treatment in second year (20.74) percent respectively during both the years. Similar results were reported by Chaudhary *et al.* (2002) and Deo and Khaldelwal (2009)^[6].

Oil content in seed of mustard (%)

Response of different cropping system showed that oil content in (%) of mustard seed (Table 2). Maximum oil content recorded in Mustard alone (45x 10): Flatbed (Control-1) 40.39% in mustard seed comparison to Sowing of Mustard on narrow bed + Chickpea (one side mustard other side

Chickpea) recorded 39.38% in mustard seed. However, lowest oil content recorded in Sowing of Chickpea + Mustard by skipping one row of Chickpea 39.05% oil content in mustard seed during first year experiment Effect of different cropping system also varied remarkably in respect of oil content in seed of mustard higher oil content recorded in Mustard alone (45x 10): Flatbed (Control-1) 40.42% in mustard seed second highest recorded 39.42% in Sowing of Mustard on narrow bed + Chickpea (one side mustard other side Chickpea). However, lowest oil content in Sowing of Chickpea + Mustard by skipping one row of Chickpea 39.10% during second years of experiment. Similarly, among different cropping system also showed marked variation in respect of oil content in seed of mustard. Significantly higher oil content was recorded under Mustard alone (45x 10): Flatbed (Control-1). However, lowest oil content was observed in Sowing of Chickpea + Mustard by skipping one row of Chickpea during both the year of experiment. Similar results reported by Chaudhary *et al.* (2002) and Deo and Khaldelwal (2009)^[6].

Conclusion

The results obtained during course of investigation, it is recommended that the cropping systems on yields chickpea + mustard *i.e.* Component yields, equivalent seed yield and Land equivalent ratio (LER). Quality parameters *i.e.* protein content (%) and oil content (%) in chickpea + mustard are as under.

- **The mustard yield was obtained higher under Mustard alone (45x 10):** Flatbed (Control-1) followed by Sowing of Chickpea + Mustard by skipping one row of chickpea as well as under intercropping found second highest. However, the seed yield of intercrops chickpea was obtained highest in Sowing of Chickpea on ridges-one row on ridges followed by Sowing of Chickpea on narrow bed (45cm): Two row of Chickpea respectively.
- **In case of LER highest recorded in Mustard + Chickpea (1:1):** Additive series during both the years followed by Broad bed furrow -105 cm (BBF): 3 rows of Chickpea on BB and one row of Mustard in furrow and Sowing of Chickpea on ridges-one row on ridges produced second highest LER in first year and Broad bed furrow -105 cm (BBF): 3 rows of Chickpea on BB and one row of Mustard.
- **Sowing of chickpea on ridges-one row on ridges methods of treatments contain maximum protein content recorded sowing of Chickpea on narrow bed (45cm):** Two row of Chickpea. However lowest protein content recorded in sowing of Chickpea + Mustard by skipping one row of Chickpea as in chickpea.
- **Maximum oil content was recorded in Mustard alone (45x 10):** Flatbed (Control-1) 40.39% in mustard seed comparison to Sowing of Mustard on narrow bed + Chickpea (one side mustard other side Chickpea) recorded 39.38% in mustard seed. However, lowest oil content recorded in Sowing of Chickpea + Mustard by skipping one row of Chickpea 39.05% oil content in mustard seed during first year experiment.

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