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

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ABSTRACT

A field experiment was carried 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 present experiment consist of five intercropping systems *viz.* sole chickpea, sole mustard, chickpea + mustard (1:1), chickpea + mustard (2:1), chickpea + mustard (3:1) row ratios in replacement series and four liquid manures *viz.* control (no spray of liquid manures), panchagavya 3%, cow urine 10% and vermiwash 10%. Results revealed that among the row arrangements maximum plant height, dry weight of chickpea and mustard both crop were recorded under chickpea + mustard 3:1 row ratio, however sole stand of both crop produced maximum yield attributes. Whereas, among the liquid manures foliar application of panchagavya 3% found to be superior over rest of the liquid manures. In case of quality parameter of chickpea and mustard treatment combination of Chickpea + mustard (3:1) + Foliar application of Panchagavya 3% found best among all treatment combination during all the experimental year as well as in pooled also.

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

Introduction

Chickpea (*Cicer arietinum* L.) is one of the most important pulse crops in India and preferred as an important constituent of Indian vegetarian diet. Indian mustard (*Brassica juncea*) is an annual growing perennial herb and is one of the important oilseed crops that belongs to the family (Brassicaceae) Crucifereae. Indian mustard has 36 chromosomes (2n) and is amphidiploid in nature. Brassica crops is mostly cultivated for edible vegetable oil production. They have a long list of history owing to their cultivation and varied use and has a great contribution in world's agricultural economy. They are widely cultivated as spices as condiments throughout the world both for human consumption and also for livestock feedings. Commonly cultivated species of Indian mustard (Brown mustard) are *B. Juncea* ssp. Integrifolia, *B. Juncea* ssp. *juncea*, *B. Juncea* ssp. *napiformis* and *B. Juncea* ssp. *taisai*. India comes as the third largest country in mustard production after China and Canada. It secures unique position in Indian farming system with an impressive acreage next to food seeds. Intercropping is the technique of growing two or more crops simultaneously in the same area. The most common benefit of intercropping is the ability to produce more yield on a given plot of land while using the natural resources more effectively by combining crops with different rooting abilities, canopy structures, heights and nutrient requirements based on how well the component

crops utilize their complementary growth resources.

Optimum plant geometry is one of the important factors for higher production, by efficient utilization of under ground resources and also harvesting as much as solar radiation and in turn better photosynthesis. It is a cost effective technique that modifies the crop canopy structure and microclimate, enhances crop competitiveness in weed suppression, improves the resource use efficiency and maximizes crop productivity. Success of an intercropping system will depend not only on proper choice of the component crops but also on spatial arrangement of plants. Intercropping of chickpea and mustard in spatial row arrangements is one of the most important factors for getting better yield advantage. Chickpea and mustard both the crops differ with respect to their morphological features *viz.*, plant height, leaf size, root system, photosynthetic ability, nutrient requirements etc. Hence, these crops will utilise the resources *viz.*, water and nutrient at different depths and at different layers, which will help to maintain the nutrient and water balance in the effective crop root zone and advantage of having pulse in the mixture will help to maintain the fertility status of soil by biological nitrogen fixation, which ultimately helps to increase the higher dry matter, higher yield and higher harvest of solar radiations. Mustard is taller plant with broader crop canopy shows the greater competing ability than chickpea accommodating more rows of mustard in between the chickpea cause shading effect, which affect the photosynthesis ultimately hamper growth and yield of chickpea. Hence, judging appropriate row arrangement in such a way that a tall plant for high light intensities at top and a compact chickpea for lower intensities at bottom without much shading effect can lead to efficient use of light as in multi-storey cropping for higher yields. Panchagavya is an organic product made up of five different cow products *viz.*, cow dung, cow urine, cow milk, cow curd and cow ghee. It contains macro and micro nutrients along with various amino acids, growth regulators, vitamins and beneficial microorganism which are responsible to play the role of promoting growth and also provides immunity to plant system (Das *et al*., 2023).

Keeping the above points in view, the present experiment was carried out at Crop Research Farm, Department of Agronomy, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj (Uttar Pradesh), India.

Materials and Methods

A field study were carried out during winter (*rabi*) season 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. Present study carried out with 20 treatment combinations, which consisted of five intercropping systems *viz.* sole chickpea (I_1), sole mustard (I_2), chickpea + mustard (1:1) ((I_3), chickpea + mustard (2:1) (I_4) and chickpea + mustard (3:1) (I_5) row ratios in replacement series and four liquid manures *viz.* control (no spray) (L_1), panchagavya 3% (L_2), cow urine 10% (L_3) and vermiwash 10% (L_4). Sole cropping of chickpea and mustard were kept for comparison. Thus, 20 treatment combinations were tested in split plot design, which were replicated thrice in which intercropping system were kept in main plot and liquid manures in sub-plots and experiment consisted of total 60 plots. The soil of experimental plot was sandy loam in texture having soil pH (7.7 and 7.2), low organic carbon (0.46 and 0.47%) and nitrogen (118 and 120 kg/ha), medium phosphorus (26.5 and 28 kg/ha) and high in potassium (312 and 316 kg/ha) during two consecutive years, respectively. The gross plot size was 4 m × 4 m (16 m^2). Field preparation included one deep ploughing by 2 cross harrowing followed by planking. The seed rate of chickpea is 80 kg/ha and formustard is 6 kg/ha were considered for sowing of crop during study. The crop was sown on 05/11/2018 and 05/11/2019 with using Pusa-362 and Varuna variety for chickpea and mustard, respectively. A common spacing of 45 cm × 10 cm was adopted for all intercrop and sole crop treatments for sowing. The recommended dose of fertilizer for chickpea is 20 kg N, 40 kg P_2O_5 and 20 kg K_2O and for mustard 80 kg N, 40 kg P_2O_5 and 40 kg K_2O per hectare were applied through urea, single super phosphate and muriate of potash in sole crop only. In intercropping combinations, seed rate and fertilizers were calculated according to number of row arrangement. Foliar application of liquid manures were applied at branching and flowering stage on both crop. Crop was raised under irrigated condition and a total of two irrigations were applied atcritical growth stages. Crop protection measures were followed as and when required. Both chickpea and mustard were harvested manually at about 10 cm above the ground level and were kept for sun drying for some days in field and after threshing the bundles from each plot, the grains were cleaned, dried and weighed. The data were subjected to analysis of variance (ANOVA) in split-plot design for various observations (Gomez and Gomez, 1984). The results were presented at 5 % level of significance (P=0.05) and critical difference (CD) values were calculated to compare the various treatments means.

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 75 DAS were depicted in Table 1.

Plant height of chickpea (cm)

Plant height of chickpea was not significantly influenced by intercropping systems (Table 1). However, maximum plant height (31.32, 31.57 and 31.34 cm) was recorded in the chickpea + mustard 3:1 row ratio of intercropping system at 75 DAS and minimum plant height (30.07, 30.19 and 30.13) were recorded under sole treatment of chickpea. However, significant impact of liquid manures on plant height of chickpea at 75 DAS by foliar application of panchgavya @ 3% showed highest plant height (33.65, 33.48 and 33.65 cm) of chickpea which was statistically at par (31.83, 32.17 and 31.83 cm) with foliar application of vermiwash @ 10%. Increase in growth attributes due to the presence of macro and micro nutrients in panchgavya also, different microflora aid in increased plant height. Presence of naturally occurring beneficial microorganisms predominantly yeasts, actinomycetes, bacteria, photosynthetic bactria 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)

Plant dry weight of chickpea was not significantly influenced by intercropping systems (Table 1). However, maximum dry weight (3.48, 3.62 and 3.55 g/plant) was recorded in the chickpea + mustard 3:1 row ratio of intercropping system at 75 DAS and minimum dry weight (3.01, 3.15 and 3.08 g/plant) were recorded under sole treatment of chickpea. However, significant impact of liquid manures on dry weight of chickpea at 75 DAS by foliar application of panchgavya @ 3% showed highest dry weight (4.07, 4.17 and 4.12 g/plant) of chickpea which statistically at par (3.38, 3.53 g/plant) with foliar application of vermiwash @10%.

Panchagavya as liquid manures contains N, P, K, S, Fe and Zn. Thus, balanced nutrition might have resulted in better development and robust growth panchagavya is also known to contain beneficial microorganisms such as azospirillum, azotobacter, phosphobacteria and pseudomonas besides lactobacillus, which promotes the plant growth. Similar findings of results were also noticed by Chongre *et al*. (2019).

Mustard growth attributes

The data pertaining to plant height and dry weight of mustard among intercropping systems and liquid manures at 75 DAS were presented in Table 1.

Plant height of mustard (cm)

Plant height of mustard was not significantly influenced by intercropping systems (Table 1). However, maximum plant height (142.84, 144.56 and 143.7 cm) was recorded in the chickpea + mustard 3:1 row ratio of intercropping system and minimum plant height (30.07, 30.19 and 30.13) were recorded under sole treatment of chickpea at 75 DAS. However, significant impact of liquid manures on plant height of chickpea by foliar application of panchgavya @ 3% showed highest plant height (33.65, 33.48 and 33.65 cm) of chickpea. Which statistically at par (31.83, 32.17 and 31.83 cm) with foliar application of vermiwash @10% at 75 DAS. Increase plant height may be due increased protein synthesis and growth regulators such as IAA and GA3, in Panchgavya may enhance cell division, cell multiplication and cell enlargement, which favours increased intermodal length. The lower plant height was observed in control may be due to indadequate nutrient supply during the crop growth stages. Similar results also reported by Tiwari *et al.* (2020).

Plant dry weight (g/plant)

Dry weight of mustard was not significantly influenced by intercropping systems (Table 1). However, maximum dry weight (14.92, 15.21 and 15.07 g/plant) was recorded in the chickpea + mustard 3:1 row ratios of intercropping system, which was statistically at par with Chickpea + mustard (2:1) during the second year and in pooled data. Whereas, significant impact of liquid manures on dry weight of mustard by foliar application of panchgavya @ 3% showed highest dry weight (18.05, 18.68 and 18.36 g/plant) of mustard. However, folair application of vermiwash @10% found at par (18.05, 18.68 and 18.36) value with panchgavya @ 3% at 75 DAS. The panchagavaya is considered to be the most effective bio-enhancer, which might have enhance photosynthesis and portioning of photosynthates to various metabolic sink and resultant more growth and yield components. Similar findings were reported by Patel *et al.* (2018).

Yield attributes chickpea and mustard

The data pertaining to seeds/pod and protein content (%) of chickpea, seeds/silique of mustard and oil content (%) of mustard among intercropping systems and liquid manures were depicted in Table 2.

Number of seeds/plant

The number of seeds/pod of chickpea remained

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 75 DAS						Mustard at 75 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	30.07	30.19	30.13	3.01	3.15	3.08	-	-	-	-	-	-
Sole mustard	-	-	-	-	-	-	140.12	141.87	140.99	13.26	13.55	13.40
Chickpea + mustard (1:1)	30.58	30.81	30.70	3.12	3.34	3.23	141.24	142.54	141.89	13.72	14.21	13.96
Chickpea + mustard (2:1)	31.07	31.17	31.12	3.31	3.45	3.38	142.67	143.81	143.23	13.59	14.87	14.73
Chickpea + mustard (3:1)	31.32	31.57	31.44	3.48	3.62	3.55	142.84	144.56	143.70	14.92	15.21	15.07
F-test	NS	NS	NS	NS	NS	NS	NS	NS	NS	S	S	S
SEm±	0.90	0.66	0.61	0.25	0.20	0.17	1.26	2.03	1.57	0.25	0.27	0.21
CD (P=0.05)	-	-	-	-	-	-	-	-	-	0.86	0.94	0.74
Factor : B Liquid manures (Sub Plot)												
Control	27.78	28.28	27.78	2.37	2.51	2.44	134.20	136.14	135.17	10.79	10.98	10.88
Panchagavya 3%	33.65	33.48	33.65	4.07	4.17	4.12	146.97	148.44	147.70	18.05	18.68	18.36
Cow urine 10%	29.77	29.80	29.77	3.09	3.21	3.15	141.58	142.95	142.27	12.55	12.86	12.71
Vermiwash 10%	31.83	32.17	31.83	3.38	3.68	3.53	144.12	145.24	144.68	15.11	15.31	15.21
F-test	S	S	S	S	S	S	S	S	S	S	S	S
SEm±	0.81	0.88	0.81	0.24	0.22	0.20	1.78	1.49	1.31	0.49	0.39	0.43
CD (P=0.05)	2.35	2.58	2.35	0.70	0.30	0.59	5.21	4.35	3.82	1.42	1.14	1.26

unaffected due intercropping system. However, maximum number of seeds/pod (1.45, 1.51 and 1.48) was recorded in sole treatment of chickpea. However, significant impact of liquid manures on number of seeds/ pod of chickpea by foliar application of panchgavya @ 3% showed the maximum number of seeds/pods (1.67, 1.77 and 1.72) of chickpea, which was statistically at par (1.40 and 1.47) with foliar application of vermiwash @ 10% during the first and second year data, respectively. However in pooled data none of the treatment showed at par value. It may be due to nutrient present in panchagavya *i.e.* macro-nutrients NPK and micro-nutrients, which are required for the growth and development of plants. Besides this, the presence of various amino acids, vitamins, growth regulators like auxins, gibberellins, cytokinins and also beneficial micro-organisms like *pseudomomas*, *azotobacter* and *phosphobacteria* which influenced yield attributing characters like number of pods per plant, number of seeds per pod, seed index and increased the field stand. Findings were reported by Gunasekar *et al.* (2018).

Yield attributes of mustard

Number of seeds/siliqua

The number of seeds/siliqua of mustard was not significant influenced by intercropping system. However maximum number of seeds/siliqua (14.63, 14.90 and 14.77) was under sole treatment of mustard. However, significant impact of liquid manures on number of seeds/siliqua of mustard by foliar application of panchgavya @ 3% shows maximum number of seed/siliqua (15.72, 15.90 and 15.81) of mustard. Whereas, folair application of vermiwash @10 % found to be at par (15.10, 15.33 and 15.22) with foliar application of panchgavya @ 3%.

Reduction of yield attributes might be due to intensified interspecific competition for light and utilization of available resources offered by intercrops, resulting in etiolated growth and poor pod setting. Similar results were in accordance with reports made by Deepak *et al*. (2023).

The action of the growth regulator in the

Table 2 : Yield parameters and quality of chickpea and mustard areinfluenced by different row ratio of chickpea and mustard intercropping system and liquid manures.

Treatments	Chickpea			Mustard			Chickpea			Mustard		
	Number of seeds/ pods			Number of seeds/ siliqua			Protein Content (%)			Oil Content (%)		
	2018	2019	Pooled	2018	2019	Pooled	2018	2019	Pooled	2018	2019	Pooled
Factor : AIntercropping systems (Row ratio)												
Sole chickpea	1.45	1.51	1.48	-	-	-	20.37	20.23	20.30	-	-	-
Sole mustard	-	-	-	14.63	14.90	14.77	-	-	-	38.78	38.98	38.88
Chickpea + mustard (1:1)	1.28	1.35	1.32	13.78	13.97	13.88	20.44	20.34	20.39	38.99	39.14	39.06
Chickpea + mustard (2:1)	1.33	1.42	1.38	13.92	14.18	14.05	20.59	20.51	20.55	39.10	39.26	39.18
Chickpea + mustard (3:1)	1.40	1.47	1.43	14.20	14.48	14.34	20.66	20.77	20.72	39.29	39.42	39.36
F-test	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	S	NS
SEm±	0.09	0.09	0.08	0.64	0.41	0.30	0.17	0.18	0.16	0.17	0.04	0.10
CD (P=0.05)	-	-	-	-	-	-	-	-	-	-	0.13	-
Factor : B Liquid manures												
Control	1.15	1.22	1.18	11.85	12.07	11.96	19.79	19.76	19.78	38.03	38.21	38.12
Panchagavya 3%	1.67	1.77	1.72	15.72	15.90	15.81	21.60	21.64	21.62	40.04	40.18	40.11
Cow urine 10%	1.25	1.30	1.28	13.87	14.23	14.05	20.17	20.07	20.12	38.64	38.83	38.73
Vermiwash 10%	1.40	1.47	1.43	15.10	15.33	15.22	20.50	20.38	20.44	39.45	39.57	39.51
F-test	S	S	S	S	S	S	S	S	S	S	S	S
SEm±	0.10	0.11	0.07	0.56	0.44	0.29	0.20	0.18	0.16	0.15	0.04	0.08
CD (P = 0.05)	0.29	0.32	0.20	1.62	1.29	0.85	0.57	0.53	0.47	0.44	0.11	0.23

plant system then assisted in stimulating the necessary growth and development of the plant, which in turn results in better yield attributes. Similar findings also reported by Das *et al.* (2023).

Quality parameter

Protein content in chcikpea

Data pertaining to quality aspescts of chickpea and mustard are presented in Table 2. Protein content of chickpea not influenced significantly under different intercropping treatments, whereas significant variation noticed among different liquid manure treatments. However, highest protein content (20.66, 20.77 and 20.72) was recorded under treatment combination of Chickpea + mustard (3:1) among the different row ratios of intercropping system and minimum protein content (20.37, 20.23 and 20.30). Whereas, among the liquid organic manures significantly highest protein content (21.60, 21.64 and 21.62) under foliar application of panchgavya @ 3% and none of the treatment found at par value. In foliar spray, nutrients and growth stimulants might be transferred more easily to the various plant portions, which could improve yield qualities. Since, panchagavya contains IAA and GA in smaller amounts, foliar spraying of this plant could have stimulated the plant system, increasing the production of a growth regulator in the cell system. Similar findings also reported by Das *et al.* (2023). This might be due to the increased and decreased of nitrogen content in grain because protein content was directly related to nitrogen content in plant. Similar line were also based on the findings of Bahadur *et al.* (2016).

Oil content in mustard

Oil content of mustard data showed significant variation during second year of experiment and non significant variation during the first year and in pooled data. Maximum oil content (39.29 and 39.36%) under the treatment combination of Chickpea + mustard (3:1) row ratios of intercropping system during the first year of experiment and in pooled data, respectively. Whereas as minimum oil content (38.78 and 38.88 %) under sole crop mustard during first year of experiment and in pooled

data of experiment. However, significant variation noticed in case of oil content during the second year of data, significantly maximum (39.42%) under the treatment combination of Chickpea + mustard (3:1) among the different row ratios of intercropping system and none of the treatment recorded at par value. Oil content differ significantly among different liquid manures variation. However significantly maximum (40.04, 40.18 and 40.11) oil content recorded through foliar application of Panchagavya 3%, however none of treatments showed at par value during the all experimental year as well as in pooled data. Oil yield is complex important character determine by interaction between genetic and environmental factor and has a direct dependence on seed yield and oil content. Results are also under the findings of Bahadur *et al.* (2016).

Conclusion

On the basis of two year of study it is concluded that chickpea sown with 3 : 1 row ratio along with foliar application of panchgavya 3% at branching and flowering stage was found to be beneficial.

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