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Growth, yield and quality response of organic broccoli to intercrops and crop geometry

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ABSTRACT

A field experiment was conducted to evaluate the efficacy of intercropping and crop geometry in organic production of broccoli (*Brassica oleracea* var. *italica*) during winter season of the year 2013-2014. The experiment was laid out in split plot design replicated thrice with three different organic manures and two spacings as main plot treatments and five intercrops. Among the 30 treatment combinations, application of vermicompost coupled with single row spacing and sole crop of broccoli ($M_2S_1C_1$) reordered the maximum values in terms of number of leaves (28.6), weight of main head (203.3 g), head girth (15.2 cm), number of sprouts per plant (9.9), yield of sprouts per plant (407.6 g), yield of sprouts/ plant (main head + sprouts) per plant (610.9 g), total yield per ha (301.7 q), vitamin A (14.43 mg/100 g) and vitamin C (96.80 mg/100 g) significantly, while plant height (63.9 cm) was recorded maximum in the treatment $M_2S_2C_1$, whereas yield of intercrop per ha (134.9 q) was recorded maximum in the $M_2S_2C_5$ treatment. Amongst the intercropping treatments, broccoli + fenugreek along with vermicompost application following the spacing of 45 x 45 cm ($M_2S_1C_4$) recorded the highest growth and yield attributing characters except number of sprouts per plant, which was found significantly better in the treatment ($M_2S_1C_3$).

Key words: Organic broccoli, intercropping, plant spacing.

INTRODUCTION

Sprouting broccoli (*Brassica oleracea* var. *italica* L.), a member of cole group, is considered as minor vegetable crop. However, its cultivation is now gaining popularity with Indian growers for the last couple of years due to increasing awareness of its high nutritive values and tourist influx. To stabilize crop production and to provide insurance mechanism against aberrant weather situation characterizing rainfed agriculture, intercropping could be a viable agronomic means of risk minimizing farmers profit and subsistence-oriented, energy-efficient and sustainable venture. Growing of two or more different crops on the same piece of land during the same cropping season interacts agronomically by Faroda *et al*. (4). It is well established that plant spacing has significant influence on growth and yield of the broccoli. Optimal plant spacing is important for crop production through efficient utilization of nutrients, water and light by the plants. In general, higher plant population adversely affects the yield per unit area, hampering the vegetative and reproductive growth of plant. Paired row planting (30/60 x 45 cm) may facilitate the growing of intercrops like fenugreek, coriander, beet leaf and radish in broccoli because the space available between rows of main crop is more than available in normal row spacing, *i.e.*, 45 × 45 cm. Moreover, intercropping offers to the farmers an early income from the annual vegetable intercrops before the main crop is harvested (Olubode *et al.*, 8).

Organic vegetable cultivation offers one of the most sustainable farming systems with recurring benefits to only long term soil health, but provides a lasting stability in production by importing better resistance against various biotic and abiotic stresses (Jigme *et al*., 5). Moreover, it provides several social, economic and environmental benefits to the society by way of producing chemical-free safe, nutritive and health protective food for the people, and replacing the dangerous agro-chemicals from the face of earth. Further, the organic manures, can serve as alternative practice in place of fertilizers for improving soil structure, microbial biomass, minimizing global warming and producing quality crop yield.

MATERIALS AND METHODS

The study was conducted at the research farm and laboratory of Department of Vegetable Science, CCS Haryana Agricultural University, Hisar during winter season of the 2013-14. Hot and dry winds during summer and dry severe cold in winter are common features of this region. The experiment was laid out in split plot design replicated thrice

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with three different organic manure, *viz*., FYM (M_1), vermicompost (M_2) and poultry manure (M_3) and two spacings, *viz*., single row-S_1 (45 × 45 cm) and paired row-S_2 (30/60 × 45 cm) as main plot treatments and five intercrops, *viz.* broccoli-CBH-1 (C_1), beet leaf-HS-23 (C_2), coriander-Hisar Bhumit (C_3), fenugreek-Hisar Suwarna (C_4) and radish-HS-1 (C_5) including sole crop of broccoli as sub-plot treatments, thus making a total of 30 treatment combinations. The FYM, vermicompost and poultry manure was applied at the rate of 8.0, 5.0 and 5.0 t/ha, respectively. The available N, P and K contents (%) in the organic manures in FYM (0.5, 0.3 and 0.3), vermicompost (1.5, 1.2 and 1.1) and poultry manure (1.1, 0.8 and 0.8) were estimated before experimentation. The available N content and available phosphorus and potassium contents were estimated using standard procedures. The seeds of intercrops were sown between the rows of broccoli after five days of transplanting. The intercrops, *viz*., coriander, fenugreek and *palak* were harvested between 25 to 35 days after sowing and radish was harvested 40 to 45 days after sowing. The harvesting of head and sprouts from 55 days after transplanting and onwards when the heads and buds are compact and unopened. Mean values of the parameters in each replication were statistically analyzed in Split Plot Design using the software of CCS HAU, Hisar website *http://hau.ernet.in/opstat.html* for analysis of variance and test of significance.

RESULTS AND DISCISSION

Results of study revealed that the individual effect of treatments like organic manure, crop geometry and intercropping of different crops in between the rows of broccoli showed significant effects on growth, yield and quality of broccoli, while crop geometry did not show significant effect on carotene content (Table 1). The maximum plant height (57.52 cm), number of leaves (26.0), weight of main head (188.2 g), girth of main head (13.4 cm), number of sprouts per plant (7.0), yield of sprouts per plant (376.4 g), total yield (main head + sprouts) per plant (564.6 g), total yield per hectare (278.8 q/ha) of broccoli, total yield of intercrops (58.1 q/ha), vitamin A (13.42 mg/100 g) and vitamin C (86.00 mg/100 g) was found to be the highest with the application of vermicompost. The application of vermicompost was found more effective due to better aeration and water holding capacity, which might have increased the nutrient use efficiency, supply of micronutrients and availability of major nutrients due to favourable soil conditions. The

Table 1. Influence of organic manures, crop geometry and intercrops on growth, yield and quality parameters of broccoli and total yield of intercrops.

Treatment	PH	NL	WMH	GMH	NS	YS	TYPP	TYPH	TYI	Vit A	Vit C
Manure (M)											
FYM (M_1)	49.10	20.4	159.6	10.3	4.2	320.2	479.9	237.0	44.8	10.39	73.72
Vermicompost (M_2)	53.11	23.1	184.9	12.1	6.0	370.6	555.5	274.3	54.2	13.82	86.00
Poultry manure (M_3)	51.21	21.8	174.8	11.8	5.2	350.4	525.2	259.4	48.8	13.02	80.49
CD at 5%	0.22	0.3	4.3	0.2	0.4	8.6	12.9	6.4	2.9	0.62	0.10
Spacing (S)											
45 cm × 45 cm (S_1)	48.94	22.3	176.9	11.9	5.5	354.7	531.6	262.5	38.0	12.50	81.78
30/60 cm × 45 cm (S_2)	53.34	21.2	169.3	10.9	4.6	339.4	508.7	251.2	60.5	12.32	78.36
CD at 5%	0.18	0.2	3.5	0.2	0.3	7.0	10.5	5.2	2.4	NS	0.09
Intercrop (C)											
Broccoli (C_1)	59.36	24.9	184.3	13.6	7.9	369.6	554.0	273.6	0.0	12.86	87.45
Beet leaf (C_2)	51.16	20.5	173.4	10.2	4.4	347.7	521.1	257.4	58.0	12.32	77.48
Coriander (C_3)	50.18	22.3	174.2	11.7	5.4	349.4	523.7	258.6	22.3	12.36	79.18
Fenugreek (C_4)	51.13	22.7	176.0	11.6	5.3	353.0	529.2	261.3	54.0	12.45	79.46
Radish (C_5)	43.86	18.4	157.3	9.9	2.9	315.6	473.0	233.5	112.0	12.06	76.79
Mean (M,S,C)	51.14	21.8	173.0	11.4	5.2	347.1	520.2	256.9	49.3	12.40	80.07
CD at 5%	59.36	0.2	0.2	0.2	0.1	0.4	0.6	0.3	2.8	0.12	0.12

PH = plant height (cm), NL = No. of leaves, WMH = Wt. of main head (g), GMH = Girth of main head (cm), NS = No. of sprouts, YS = Yield of sprouts (g/plant), TYPP = Total yield per plant (g), TYPH = Total yield per ha (q), TYI = Total yield of intercrop (q/ha), Vit A = Vitamin A (mg/100 g) and Vit C = Vitamin C (mg/100 g).

results indicated that the treatments receiving high doses of nutrients resulted in hastening of different reproductive growth phases of broccoli, whereas, the commencement of different reproductive phases were drastically delayed in case of plants receiving low rate of nutrients or no nutrients. A promotional effect of nitrogen on carotene content might be attributed to the fact that it is the main constituent of all amino acids, protein and lipids that while acting as a structural compound of the chloroplast might in turns helped to produce more carotene. On the other hand, this might be due to the fact that vermicompost supplied the most important nutrients responsible for enhancing the ascorbic acid content (Chaudhary *et al*., 2; Kumar *et al*., 6). These results are in accordance to those of (Chaterjee *et al*., 1).

The crop geometry on broccoli crop had shown a significant effect on growth and yield attributes. The maximum number of leaves (22.3), weight of main head (176.9 g), girth of main head (11.9 cm), number of sprouts per plant (5.5), yield of sprouts per plant (354.7 g), total yield (main head + sprouts) per plant (531.6 g), total yield per hectare (262.5 q), vitamin A per 100 g (12.50 mg) and vitamin C per 100 g (81.78 mg) of broccoli was observed in normal spacing due to less competition for growing space and light. However, the maximum plant height (53.34 cm) and total yield of intercrops per ha (60.5 q) was recorded in paired row planting (30/60 × 45 cm) due to closer spacing that supported erect growth as compared to normal spacing. There was no significant effect of crop geometry on carotene contents, hence, suitable spacing to increase the carotene content could not be suggested. Earlier, Singh *et al*. (11) suggested that closer spacing of broccoli tended to produce taller plant than widely spaced plant. This might be due to competition of solar energy couple with shallow root system and higher plant height at closer spacing. Rakesh *et al.* (9) recorded significant results in respect to different growth parameters of broccoli on different spacings.

Result of the study revealed that the plant growth, yield and quality were significantly influenced in different treatment combination. The growing of sole crop of broccoli recorded maximum plant height (59.36 cm), number of leaves (24.9), weight of main head (184.3 g), girth of main head (13.6 g), number of sprouts per plant (7.9), yield of sprouts per plant (369.6) g, total yield per plant (554.0 g), total yield per hectare (273.6 q), vitamin A per 100 g (12.86 mg) and vitamin C per 100 g (87.45 mg) of broccoli. However, amongst the intercropping pattern, the maximum height (51.16 cm) of broccoli plants was recorded with growing of beet leaf (C_2), which was statistically at par in the treatment C_4. This was due to fast and vigorous growth of beet leaf that resulted in erect growth of broccoli plants. The maximum girth of main head (11.7 cm) and number of sprouts (5.4) was recorded in the treatment C_3, which was statistically at par in the treatment C_4. Whereas, all other growth, yield and quality parameters was recorded highest with fenugreek that may be due to fixing of atmospheric nitrogen and small canopy growth of fenugreek, which was statistically at par in the treatment C_3 and C_2. However, the intercropping of radish had adverse effect on growth, yield and quality of broccoli due to intense competition for light, space, nutrients and moisture. These results are in conformity with those of Yadav *et al*. (14).

The interaction between organic manure, crop geometry and intercrop remarkably influenced the growth, yield and quality parameters of broccoli and yield of intercrops (Tables 2-5). The treatment $M_2S_1C_1$ was found superior in respect to all growth, yield and quality parameters of broccoli in different treatment combination. Application of vermicompost coupled with paired row spacing of 30/60 in × 45 cm having sole broccoli crop recorded higher plant height (63.78 cm) followed by $M_3S_2C_1$ (62.28 cm). However, application of vermicompost with a spacing of 45 cm × 45 cm with sole crop of broccoli recorded maximum number of leaves (28.6), weight of main head (203.3 g), maximum head girth (15.2 cm), number of sprouts per plant (9.9), yield of sprouts per plant (407.6 g), total yield (main head + sprouts) per plant (610.9 g), total yield per ha (301.7 q), vitamin A per 100 g (14.43 mg) and vitamin C per 100 g (96.80 mg) of broccoli. Amongst the intercropping pattern, best results were observed in the treatment $M_2S_1C_4$ except plant height, which was superior in the treatment $M_2S_2C_4$ (57.87 cm). Amongst the intercrop treatments, broccoli + fenugreek along with vermicompost application following the spacing of 45 cm × 45 cm ($M_2S_1C_4$) recorded highest growth, yield and quality traits except number of sprouts per plant (6.7), which was found in the treatment ($M_2S_1C_3$). There were non-significant difference in between $M_2S_2C_2$ and $M_3S_2C_3$, $M_2S_2C_2$ and $M_3S_2C_4$ and, $M_3S_2C_3$ and $M_3S_2C_4$ for total yield per ha.

Application of organic based nutrients mainly biogas slurry + FYM, vermicompost + FYM and vermicompost alone recorded the maximum fruit size and more number of fruits per plant in different vegetable crops. These findings clearly indicated that vermicompost played a significant role for enhancing the growth of broccoli. Improvement in plant growth attributes with the application of vermicompost might be due to better photosynthesis, energy storage, cell division and cell enlargement, moisture holding

Table 2. Interaction effect of organic manures, crop geometry and intercrops on plant height, number of leaves and weight of main head.

Intercrop	Plant height (cm)											
	M_1			M_2			M_3			Mean for plant spacing		Mean for organic manures
	S_1	S_2	Mean	S_1	S_2	Mean	S_1	S_2	Mean	S_1	S_2	
C_1	54.20	59.97	57.09	58.68	63.78	61.23	57.25	62.28	59.77	56.71	62.01	59.36
C_2	47.08	51.08	49.08	50.38	55.93	53.16	49.50	52.98	51.24	48.99	53.33	51.16
C_3	46.05	50.32	48.19	49.73	54.03	51.88	48.58	52.38	50.48	48.12	52.24	50.18
C_4	46.90	50.87	48.89	49.33	57.87	53.60	47.98	53.82	50.90	48.07	54.19	51.13
C_5	41.08	43.42	42.25	44.65	46.73	45.69	42.62	44.68	43.65	42.78	44.94	43.86
Mean	47.06	51.13	49.10	50.55	55.67	53.11	49.19	53.23	51.21	*48.93*	*53.34*	51.14
CD at 5% for interaction : Manure × spacing = 0.31, Manure × intercrop = 0.50, Spacing × intercrop = 0.58, Manure × spacing × intercrop = 1.02												
Intercrop	No. of leaves											
C_1	23.2	22.1	22.7	28.6	25.4	27.0	26.4	24.0	25.2	26.1	23.8	25.0
C_2	20.0	19.7	19.9	23.1	21.2	22.2	19.6	19.4	19.5	20.9	20.1	20.5
C_3	19.8	21.1	20.5	23.5	23.6	23.6	23.0	22.6	22.8	22.1	22.4	22.3
C_4	21.5	22.1	21.8	24.5	24.1	24.3	22.1	22.1	22.1	22.7	22.8	22.7
C_5	18.7	16.0	17.4	20.1	17.0	18.6	21.1	17.5	19.3	20.0	16.8	18.4
Mean	20.6	20.2	20.4	24.0	22.3	23.1	22.4	21.1	21.8	*22.3*	*21.2*	21.8
CD at 5% for interaction : Manure × spacing = 0.4, Manure × intercrop = 0.4, Spacing × intercrop = 0.3, Manure × spacing × intercrop = 0.5												
Intercrop	Main head wt. (g)											
C_1	173.7	168.7	171.2	203.3	193.7	198.5	186.9	179.9	183.4	188.0	180.8	184.4
C_2	160.4	154.3	157.4	188.0	184.8	186.4	183.1	170.0	176.6	177.2	169.7	173.4
C_3	161.7	156.0	158.9	189.0	184.1	186.6	181.9	172.9	177.4	177.5	171.0	174.3
C_4	164.0	158.4	161.2	192.3	185.0	188.7	184.2	172.5	178.4	180.2	172.0	176.1
C_5	153.7	145.7	149.7	169.0	159.3	164.2	162.4	154.1	158.3	161.7	153.0	157.4
Mean	162.7	156.6	159.7	188.3	181.4	184.9	179.7	169.9	174.8	*176.9*	*169.3*	173.1
CD at 5% for interaction : Manure × spacing = NS, Manures × intercrop = 0.4, Spacing × intercrop = 0.3, Manures × spacing × intercrop = 0.5												

capacity, supply of micronutrients and availability of major nutrients due to favourable soil condition (Uddin *et al.*, 13). Poultry manure also enhanced the vegetative growth of broccoli. It might be due to the fact that poultry manure contains uric acid having 60 per cent nitrogen. The uric acid rapidly changes to ammonia form causing its immediate and efficient utilization for better plant growth and development These results were supported by (Chaterjee *et al*., 1). These results are in partial conformity with the findings of (Choudhary *et al.*, 2; Kumar *et al*., 6; Mohapatra *et al*., 7; Rakesh *et al.*, 9; Singh *et al*., 10; Singh *et al*., 11; Yadav *et al.*, 14). Similar observations due to organic manures with respect to quality attributes of broccoli were reported by (Chaterjee *et al*., 1; Damir and Polat, 3) in broccoli. Based on the experimental results, it may be concluded that the application of vermicompost coupled with paired row spacing of 30/60 cm × 45 cm + fenugreek intercropped with broccoli improved the growth, yield and quality of broccoli and yield of intercrops.

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Table 3. Interaction effect of organic manures, crop geometry and intercrop on girth of head, number of sprouts and yield of sprouts of broccoli at final harvest of heads.

Intercrop	Girth of head (cm)											
	M_1			M_2			M_3			Mean for plant spacing		Mean for organic manures
	S_1	S_2	Mean	S_1	S_2	Mean	S_1	S_2	Mean	S_1	S_2	
C_1	12.9	12.1	12.5	15.2	14.2	14.7	14.2	13.4	13.8	14.1	13.2	13.7
C_2	10.1	8.6	9.4	11.2	10.1	10.7	10.7	10.4	10.6	10.7	9.7	10.2
C_3	11.3	9.2	10.3	12.7	11.8	12.3	13.1	12.1	12.6	12.4	11.0	11.7
C_4	11.3	9.3	10.3	13.1	12.1	12.6	11.8	12.2	12.0	12.1	11.2	11.6
C_5	10.0	8.5	9.3	10.1	10.2	10.2	10.8	9.7	10.3	10.3	9.5	9.9
Mean	11.1	9.5	10.3	12.5	11.7	12.1	12.1	11.6	11.8	*11.9*	*10.9*	11.4
CD at 5% for interaction : Manure × spacing = 0.4, Manure × intercrop = 0.5, Spacing × intercrop = NS, Manure × spacing × intercrop = 0.7												
Intercrop	No. of sprouts per plant											
C_1	6.2	5.6	5.9	9.9	8.7	9.3	8.9	7.9	8.4	8.3	7.4	7.9
C_2	4.0	3.8	3.9	5.1	4.5	4.8	4.3	3.7	4.0	4.5	4.0	4.2
C_3	5.1	4.6	4.9	6.7	5.5	6.1	6.1	4.1	5.1	6.0	4.7	5.4
C_4	5.2	4.4	4.8	6.5	5.9	6.2	6.0	4.4	5.2	5.9	4.9	5.4
C_5	1.8	1.1	1.5	4.1	3.4	3.8	3.6	2.9	3.3	3.2	2.5	2.8
Mean	4.5	3.9	4.2	6.5	5.6	6.0	5.8	4.6	5.2	*5.6*	*4.7*	5.1
CD at 5% for interaction : Manure × spacing = 0.3, Manure × intercrop = 0.2, Spacing × intercrop = 0.2, Manure × spacing × intercrop = 0.3												
Intercrop	Yield of sprouts per plant (g)(main head + sprouts)											
C_1	348.2	338.2	343.2	407.6	388.3	398.0	374.6	360.6	367.6	376.8	362.4	369.6
C_2	321.6	309.4	315.5	376.9	370.5	373.7	367.0	340.8	353.9	355.2	340.2	347.7
C_3	324.2	312.9	318.6	378.9	369.1	374.0	364.6	346.6	355.6	355.9	342.9	349.4
C_4	328.9	317.5	323.2	385.6	370.9	378.3	369.3	345.8	357.6	361.3	344.7	353.0
C_5	308.2	292.2	300.2	338.9	319.5	329.2	325.6	309.0	317.3	324.2	306.9	315.6
Mean	326.2	314.0	320.1	377.6	363.7	370.6	360.2	340.6	350.4	*354.7*	*339.4*	347.0
CD at 5% for interaction : Manure × spacing = NS, Manure × intercrop = 0.7, Spacing × intercrop = 0.6, Manures × spacing × intercrops = 1.0												

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Table 4. Interaction effect of organic manures, crop geometry and intercrops on total yield per plant, total yield per hectare and total yield of intercrops.

Intercrop	Total yield per plant (g)											
	M_1			M_2			M_3			Mean for plant spacing		Mean for organic manures
	S_1	S_2	Mean	S_1	S_2	Mean	S_1	S_2	Mean	S_1	S_2	
C_1	521.9	506.9	514.4	610.9	582.0	596.5	561.5	540.5	551.0	564.8	543.1	554.0
C_2	482.0	463.7	472.9	564.9	555.3	560.1	550.1	510.8	530.5	532.3	509.9	521.1
C_3	486.1	468.9	477.5	568.0	553.2	560.6	546.5	519.5	533.0	533.5	513.9	523.7
C_4	492.9	476.3	484.6	578.2	555.9	567.1	553.5	518.3	535.9	541.5	516.8	529.2
C_5	462.0	438.0	450.0	508.1	478.8	493.5	488.0	463.1	475.6	486.0	460.0	473.0
Mean	489.0	470.8	479.9	566.0	545.0	555.5	539.9	510.4	525.2	*531.6*	*508.7*	520.2
CD at 5% for interaction : Manure × spacing = NS, Manure × intercrop = 1.1, Spacing × intercrop = 0.9, Manure × spacing × intercrop = 1.6												
Intercrop	Total yield (q/ha)											
C_1	257.7	250.3	254.0	301.7	287.4	294.6	277.3	266.9	272.1	278.9	268.2	273.6
C_2	238.0	229.0	233.5	279.0	274.2	276.6	271.6	252.2	261.9	262.9	251.8	257.3
C_3	240.1	231.6	235.9	280.5	273.2	276.9	269.9	256.5	263.2	263.5	253.8	258.6
C_4	243.4	235.2	239.3	285.5	274.5	280.0	273.3	255.9	264.6	267.4	255.2	261.3
C_5	228.2	216.3	222.3	250.9	236.4	243.7	241.0	228.7	234.9	240.0	227.1	233.6
Mean	241.5	232.5	237.0	279.5	269.1	274.3	266.6	252.0	259.3	*262.5*	*251.2*	256.9
CD at 5% for interaction : Manure × spacing = NS, Manure × intercrop = 0.6, Spacing × intercrop = 0.5, Manure × spacing × intercrop = 0.8												
Intercrop	Total yield of intercrops (q/ha)											
C_1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C_2	35.1	75.1	55.1	45.3	84.2	64.8	36.6	73.3	55.0	39.0	77.5	58.3
C_3	15.9	27.3	21.6	15.3	34.0	24.7	13.4	29.1	21.3	14.9	30.1	22.5
C_4	37.9	58.8	48.4	38.5	79.3	58.9	35.3	74.0	54.7	37.2	70.7	54.0
C_5	89.7	110.9	100.3	110.1	134.9	122.5	99.7	126.5	113.1	99.8	124.1	112.0
Mean	35.7	54.4	45.1	41.8	66.5	54.2	37.0	60.6	48.8	*38.2*	*60.5*	49.3
CD at 5% for interaction : Manure × spacing = 2.6, Manure × intercrop = 4.8, Spacing × intercrop = 3.9, Manure × spacing × intercrop = 6.8												

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Table 5. Interaction effect of organic manures, crop geometry and intercrops on quality parameters.

Intercrop	Vitamin A content (mg/100 g)											
	M_1			M_2			M_3			Mean for plant spacing		Mean for organic manures
	S_1	S_2	Mean	S_1	S_2	Mean	S_1	S_2	Mean	S_1	S_2	
C_1	10.63	10.63	10.63	14.43	14.33	14.38	13.63	13.47	13.55	12.90	12.81	12.85
C_2	10.20	10.07	10.14	13.77	13.63	13.70	13.27	12.97	13.12	12.41	12.22	12.32
C_3	10.43	10.60	10.52	13.97	13.37	13.67	12.87	12.93	12.90	12.42	12.30	12.36
C_4	10.77	10.37	10.57	14.03	13.63	13.83	12.93	12.97	12.95	12.58	12.32	12.45
C_5	10.01	10.07	10.04	13.67	13.33	13.50	12.67	12.47	12.57	12.12	11.96	12.04
Mean	10.41	10.35	10.38	13.97	13.66	13.82	13.07	12.96	13.02	*12.49*	*12.32*	12.40
CD at 5% for interaction : Manure × spacing = NS, Manure × intercrop = 0.21, Spacing × intercrop = NS, Manure × spacing × intercrop = 0.29												
Intercrops	Vitamin C content (mg/ 100 g)											
C_1	81.30	79.00	80.15	96.80	91.60	94.20	89.50	86.50	88.00	89.20	85.70	87.45
C_2	73.03	69.30	71.17	85.40	81.53	83.47	78.30	77.30	77.80	78.91	76.04	77.48
C_3	75.50	71.13	73.32	87.30	82.00	84.65	80.53	78.60	79.57	81.11	77.24	79.18
C_4	75.70	71.70	73.70	86.60	82.67	84.64	81.10	79.00	80.05	81.13	77.79	79.46
C_5	72.53	68.00	70.27	85.07	81.03	83.05	78.00	76.10	77.05	78.53	75.04	76.79
Mean	75.61	71.83	73.72	88.23	83.77	86.00	81.49	79.50	80.49	*81.78*	*78.36*	80.07
CD at 5% for interaction : Manure × spacing = 0.14, Manure × intercrop = 0.03, Spacing × intercrop = 0.02, Manure × spacing × intercrop = 1.02												

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