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Direct and Residual Impact of Nutrient Management through Organic and Inorganic Sources on Growth and Yield Attributes in Brinjal–fenugreek Cropping Sequence

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ABSTRACT: A field experiment was conducted at experimental site of Division of Vegetable Science, SKUAST-Kashmir during two consecutive years of 2016 & 2017. The experiment consisted of thirteen treatments which was carried out in Randomized Complete Block Design with three replications. Observations for growth and yield attributes were recorded in the main crop- brinjal as well as in the residual crop- fenugreek. Higher values for days to first fruit picking (53.40), plant height (126.51 cm), number of branches plant^{-1} (7.06), number of fruits plant^{-1} (16.50), fruit length (13.41 cm), fruit diameter (7.96cm), average fruit weight (65.65g), fruit yield plant^{-1} (1.08 kg), fruit yield hectare^{-1} (395.42 q), duration of fruiting (92.16) were recorded in treatment T_9 (50% RFD + 50% PM) for main crop. For residual crop, growth and yield parameters viz., maximum plant height (34.01cm), maximum number of branches plant^{-1} (5.40), minimum harvest days (132.53 days), maximum leaf yield plot^{-1} (4.23kg), maximum leaf yield hectare^{-1} (52.27q) were recorded in treatment T_9 (50% RFD + 50% PM). In view of inconsistent, inadequate information regarding and site specific results of nutrient management through conjugated use of organic and inorganic nutrients, a location specific demonstrative trial was conducted at experimental field of SKUAST-K, Srinagar.

Keywords: Main crop, Brinjal, Residual crop, fenugreek, growth, yield, nutrient management technology, organic and inorganic nutrients.

INTRODUCTION

India is considered as a paradise for horticulture (Saravaiya and Patel, 2005) because of the cultivation of diversity of vegetable crops on large scale. Brinjal is the second major vegetable crop next to tomato. It is also called as eggplant which is native to India (Kiran *et al*., 2010). It is highly productive crop and is popularly known as "poor man's crop". Brinjal is highly nutritious vegetable as it is rich in vitamin A and C and minerals like calcium, magnesium and phosphorus and also possess some medicinal properties (Rajan and Markose, 2002). The medicinal properties possessed by egg plant may include the treatment of diabetes, asthama, cholera, bronchitis and diarrhea, its fruit and leaves are said to lower certain levels of blood cholesterol. It is believed to be a rich source of phenolic compounds that function as an antioxidant and help to prevent cancer, bacterial and viral infection. Fenugreek is an annual herb 30-60 cm tall with light green leaves and three finely toothed oval leaflets. Fenugreek leaves and stem are rich in calcium, iron, carotene and ascorbic acid. Leaves also contain some amount of protein. Fenugreek stimulates digestive process as well as metabolism. It is also used in hypertension and diabetes. Seeds are rich in essential amino acids and trigonelline for which fenugreek is so well known for medicinal uses. Seeds contain steroid "diosgenin" which is used in the preparation of contraceptives (Saini, 2005). Cereal crops are India's mainstay and cereal production is essential for sustaining the livelihood of the rural people. But a key step to the economic development of Indian farmer will be to diversify the cereal based production system. Currently, there is an increasing concern regarding the sustainability of cropping system as productivity has either become stagnant or declined. These crises arise mainly because of decline in the annual average production rates, the green revolution and environmental degradation (Mahajan and Gupta, 2009). Green revolution commenced on a soil which was rich in organic carbon and the crop response to applied fertilizers were spectacular. However, with time, green revolution period culminated into crisis of stagnant agricultural productivity, less income and farmers suicides which showed the importance of shifting towards the diversification of crops. It is a well known fact that optimized crop diversification possess various benefits, not only to growers but also to the ecology, as increasing crop diversity can increase heterogeneity of soil chemical nutrients, soil physical structure, and functional microorganisms at different spatial scales, leading to improved soil health and crop yields Bardgett and van der Putten, (2014); Maron *et al*., (2011). The last decades were recognizable by a growing interest in sustainable farming systems, with a fast-acting progress in its achievement (Warlop, 2016). In this regard ,general dynamic farming strategies developed by innovative growers which are highly diverse (Morel *et al*., 2017) but a common objective followed by these systems is the reduction of risk through an increased cultivated diversity. Diversification of crops from grain to vegetable crops can be helpful for improving agricultural sustainability to provide profitable employment, increase the income and conserve natural resources from further exploitation (Sekhon, 2004). Vegetable crops with their shorter life cycles and broader ecological amplitude than other crops can increase per capita income, health awareness and farmers profit to certain higher level and there can be a distinguishable change in the consumption pattern which is characterized by decline in the share of food grains and increasing share of non-food grains particularly vegetables and fruits in terms of consumption (Vanita *et al*., 2013). Nutrient management plays an important role for sustainable productivity of cropping system. Nutrient management on system basis as compared to individual crop may leads to higher efficiency besides sustainability of system (Hegde and Babu, 2002). Furthermore, inclusion of legume crops within a cropping system, regularly or intermittently, is of great help owing to their soil-ameliorating benefits. The organic carbon content of soil, available nitrogen, phosphorus and potassium contents in soil may increase through legume based rotation as compared to non legume (Dwivedi *et al*., 2003). Also, a sizable quantity is left for the succeeding crop (Prasad, 1996). Deterioration in soil health associated with indiscriminate application of chemical fertilizers which cause leaching and run-off of nutrients may lead to environmental degradation. It necessitates exploitation of organic sources, as they are slow releasing fertilizers for ensuring high level of crop productivity and also protect soil from deterioration, thereby ensuring sustainable vegetable production (Singh, 2006). Moreover, people prefer organic vegetables because of ill effects caused by excessive use of inorganic fertilizers on health (Ibeawuchi *et al*. 2015). Nevertheless, the beneficial effect of organic sources applied in preceding crop was also recorded in succeeding crop (Chattoo *et al*., 2009). Also the increasing cost of chemical fertilizers stresses the need to substitute a part of nutrients through organic sources to make cultivation of brinjal and fenugreek an economically viable preposition. Therefore, an attempt has been made to study the direct and residual impact of nutrient management through organic and inorganic sources on the brinjal-fenugreek cropping system in Kashmir Valley.

MATERIAL AND METHODS

The experiment was laid out for two consecutive years of 2016 and 2017 at Experimental Field of Division of Vegetable Science, Sher-e-Kashmir University of Agricultural Sciences and Technology, Shalimar, Kashmir. The experiment was laid out in Randomized Complete Block Design with three replications comprising thirteen treatments viz., T_1 (FYM @ 38t ha^{-1}), T_2 (VC @ 8t ha^{-1}), T_3 (PM @ 8t ha^{-1}), T_4 (SM @ 25t ha^{-1}), T_5 (DW @ 20t ha^{-1}), T_6 (7.5t FYM+ 1.5t VC+ 1.5t PM+ 5t SM + 4t DW ha^{-1}), T_7 (50% RFD + 50% FYM), T_8 (50% RFD + 50% VC), T_9 (50% RFD + 50% PM), T_{10} (50% RFD + 50% SM), T_{11} (50% RFD + 50% DW), T_{12} (RFD) and T_{13} (Control). Thirty nine (39) plots of 3.00m × 2.70 m size were prepared as per layout specifications to accommodate 30 plants $plot^{-1}$ in brinjal and 270 plants $plot^{-1}$ in fenugreek planted in rows with 6 plants per row in brinjal and 27 plants per row in fenugreek. Organic manures were incorporated to each plot 3-4 days before transplanting. Half dose of nitrogen, full dose of phosphorous and potash at the rate of 75 kg N ha^{-1} and 120 kg ha^{-1} each of P_2O_5 and K_2O through urea, single super phosphate and muriate of potash, respectively was applied as per the treatment detail as basal dose just before transplanting of seedlings. The remaining half dose of nitrogen was applied as top dressing after 45 days of transplanting. No fertilizers and manures were applied in fenugreek. It was grown as residual crop. Healthy and vigorous seedlings of uniform size were transplanted in well prepared plots in the evening hours to prevent excessive transpiration at spacing of 60 cm × 45 cm during two consecutive years 2016 and 2017, respectively. After transplanting, the seedlings were watered immediately with rose cane. Light irrigation was given as and when required throughout the growing season after crop establishment. Then, gap filling was done up to 7 days after transplanting for maintaining required plant population. Observations on various aspects like growth and yield attributes of main crop –brinjal and residual crop-fenugreek were then recorded.

The plant height of 10 tagged plants from each plot was taken at final harvest. The height was measured from ground level to highest growing point and the mean was calculated and expressed in centimeters (the main crop as well as the residual crop). At the final picking, the total number of branches of 10 tagged plants in each plot was counted and the average was worked out (the main crop well as the residual crop). Number of days taken by the crop from the date of transplanting to the first fruit picking in each treatment were counted and the average was worked out. Total number of fruits harvested at different pickings from 10 tagged plants in each treatment was added and average was obtained to work out the fruit number plant^{-1}. The length of 10 randomly taken fruits at marketable stage was measured in centimeters, excluding the pedicel length and the average was worked out. The width of brinjal fruits from 10 randomly selected fruits at marketable stage of each treatment was measured by Vernier Calliper at middle portion of the fruit at harvest and the average was calculated and expressed in centimeters. Total fresh weight of fruits at each picking (main crop) and plants at green leafy stage (residual crop) from each treatment for 10 tagged plants was added to work out total weight of fruits (main crop) and green plants (residual crop) for 10 plants. From ten plants in a plot the yield plant^{-1} was estimated in kilograms (for main as well as residual crop).Depending on the number of plants in a plot, the yield plant^{-1} (kg) was converted into yield per plot-^{1} for each treatment. The yield plot^{-1} (kg) was converted into quintals ha^{-1} for each treatment. Number of days taken by the crop from the date of first fruit picking to final picking in each treatment were counted and the average was worked out (main crop and residual crop).

RESULTS AND DISCUSSIONS

A. Growth attributes of brinjal (main crop) in cropping sequence

The experimental findings presented in Table 1 depicted significant impact of treatments on growth aspects of brinjal viz., plant height and number of branches per plant. Among 13 treatments under study, treatment T_9 (50% RFD+ 50% PM) had the maximum plant height and number of branches during both consecutive kharif seasons of 2016 and 2017. From pooled data, it can be seen that treatment T_9 recorded 126.51 cm plant height and 7.06 number of branches per plant which was superior to all other treatments under study. It is apparent from the data that among sole organic applications, treatment T_6 (integration of all manures) recorded maximum plant height of 116.93 cm and 6.08 number of branches per plant. The better efficiency of organic manure application in conjugation with inorganic fertilizers might be due to the fact that organic manures might have supplied the micronutrients in an desired range which is optimum to the plant, thus improving the metabolic activity in the early growth phase which might have encouraged the overall growth (Prativa and Bhattarai, 2011). Overall vegetative parameters were influenced due to application of nutrient through combination of organic manure and inorganic fertilizers which proved beneficial for improving growth of brinjal crop as reported by (Palia *et al.*, 2021)

Superiority of poultry manure over farm yard manure, sheep manure, vermicompost and dal weed in improvement of growth characters of brinjal can be attributed to its richness in nutrients, quick mineralization, increased availability of nitrogen and other plant nutrients. Besides this, poultry manure contains uric acid having 60 percent nitrogen, which gets rapidly changed to ammonical form and is readily available to plants. In addition to the above mentioned qualities, it is an excellent source of organic matter and is rich in growth promoting substances, thus resulting in better growth, whether used as sole application or in combination with inorganic sources as reported by Aunburani and Manivannan (2002). (Kiraci, 2018) used cow manure, sheep manure, poultry manure, seaweed, and conventional applications to assess the effect on growth and quality of carrots. The findings revealed that poultry manure application gave the highest yield whereas, control application gave the lowest .

Table 1: Influence of nutrient management through organic manures and inorganic fertilizers on plant height (cm) and number of branches per plant.

	Treatment combinations	Plant height (cm)			Number of branches plant $^{-1}$		
		Kharif 2016	Kharif 2017	Pooled data	Kharif 2016	Kharif 2017	Pooled data
T_1	**Farmyard manure**	104.60	109.93	107.26	5.80	5.81	5.80
T_2	**Vermicompost(VC)**	103.86	107.03	105.45	5.89	6.03	5.96
T_3	**Poultry manure (PM)**	110.30	113.00	111.65	5.91	6.13	6.02
T_4	**Sheep manure(SM)**	99.30	102.93	101.11	5.13	5.56	5.35
T_5	**Dal weed (DW)**	95.46	99.00	97.23	5.40	5.33	5.36
T_6	**Integration(all organic manures)**	114.80	119.06	116.93	6.10	6.06	6.08
T_7	**50%RFD+50%FYM**	110.56	115.03	112.80	6.69	6.66	6.68
T_8	**50%RFD+50%VC**	118.36	123.03	120.70	6.60	6.86	6.73
T_9	**50%RFD+50%PM**	125.03	128.00	**126.51**	6.96	7.16	**7.06**
T_{10}	**50%RFD+50%SM**	104.90	107.93	106.41	5.50	5.86	5.68
T_{11}	**50%RFD+50%DW**	98.56	102.06	100.31	5.48	5.46	5.47
T_{12}	**RFD**	122.70	125.10	123.90	6.00	6.50	6.25
T_{13}	**Control**	91.60	94.10	92.85	4.60	4.76	4.68
	C.D	**2.34**	**1.89**	**1.46**	**0.23**	**0.36**	**0.21**

A. Yield attributes of brinjal (main crop) in cropping sequence

It is clear from the data presented in Table 2 that days to first fruit picking and number of fruits per plant were significantly influenced by the application of various organic manures, inorganic fertilizers and their combination. Among integration of organic sources with inorganic fertilizers, minimum days to first fruit picking were observed in treatment T_9 (50% RFD + 50% PM) during both consecutive seasons of 2016 and 2017 as evident from pooled data also recording the value of 53.40 days followed by treatment T_8 (50% RFD + 50% VC). Among organic treatments, treatment T_6 (integration of organic manures) recorded 58.50 days to first fruit picking. Similarly, maximum number of fruits per plant were observed in treatment T_9 (50% RFD+ 50% PM) which recorded 16.50 number of fruits per plant followed by treatment T_8 (50% RFD + 50% VC). Among organic treatments, treatment T_6 (integration of organic manures) recorded 14.85 number of fruits per plant followed by treatment T_3 (PM) which were significantly superior to all sole treatments. It is apparent that integration of organic and inorganic source of nutrients supplied readily available nutrients for initial requirement through inorganic fertilizers at low pace as long term availability through mineralization of organic sources at a constant level resulted in early improved growth which in turn minimized days to first fruit picking (Choudhary *et al.*, 2011). Furthermore, the presence of increased microbial activity might have improved the availability of soil phosphorus and nitrogen which ultimately had enhanced the uptake of nitrogen in plant leading to increased chlorophyll content and photosynthate accumulation which hastened the process of fruit development (Adil *et al.*, 2015). The increased number of fruits per plant might be due to increased NPK uptake which resulted in more vegetative growth in terms of height and number of branches and in turn increases number of fruits per plant. Further, the conjunctive application of chemical and organic fertilizers increased the solubilisation effect of plant nutrients which might have the increased uptake of NPK which reflected positively on fruit number. Similar findings have been presented by Prativa and Bhattarai (2011). The improved plant growth led to better carbohydrate build up which increased the plant fruit yield and their quality components (Paul *et al*., 2017)

Table 2: Influence of nutrient management through organic manures and inorganic fertilizers on days to first fruit picking and number of fruits per plant.

	Treatment combinations	Days to first fruit picking			Number of fruits plant^{-1}		
		Kharif 2016	Kharif 2017	Pooled data	Kharif 2016	Kharif 2017	Pooled data
T_1	**Farmyard manure**	61.16	64	62.58	12.83	12.35	12.59
T_2	**Vermicompost (VC)**	60.33	63	61.66	13.59	13.50	13.54
T_3	**Poultry manure (PM)**	58.00	61.00	59.50	14.40	14.10	14.25
T_4	**Sheep manure(SM)**	61.83	65.00	63.41	11.73	11.60	11.66
T_5	**Dal weed (DW)**	63.16	66.00	64.58	10.76	10.93	10.85
T_6	**Integration (all organic manures)**	57.00	60.00	58.50	14.80	14.90	14.85
T_7	**50%RFD+50%FYM**	56.33	59.00	57.66	14.63	15.00	14.81
T_8	**50%RFD+50%VC**	54.00	57.00	55.50	15.29	15.52	15.40
T_9	**50%RFD+50%PM**	51.80	55.00	**53.40**	16.53	16.46	**16.50**
T_{10}	**50%RFD+50%SM**	59.00	62.00	60.50	12.98	13.00	12.99
T_{11}	**50%RFD+50%DW**	61.03	64.00	62.51	12.36	12.43	12.40
T_{12}	**RFD**	55.00	58.00	56.50	14.99	15.00	14.99
T_{13}	**Control**	64.86	68.00	66.43	8.22	8.51	8.36
	C.D	**1.53**	**2.76**	**1.53**	**0.33**	**0.53**	**0.30**

Perusal of Table 3 indicates significant influence of various treatments on average fruit length and average fruit diameter. It is apparent from the data that integration of organic manures with chemical fertilizers in equal proportions (50:50) exhibited an increase in fruit length and fruit diameter over sole application of organic manures and RFD. Among 13 treatments under study, treatment T_9 (50% RFD+ 50% PM) recorded maximum fruit length and maximum fruit diameter during Kharif seasons of 2016 and 2017, depicting 14.5 percent and 14 percent increase over treatment T_{12} (RFD) which was superior to all other treatments under study. Pooled analysis also showed superiority of treatment T_9 (50% RFD + 50% PM), recording a fruit length of 13.41 cm and fruit diameter of 7.96 cm. Among organic applications, treatment T_6 (integration of all manures) was found significantly superior to all other sole applications of organic manures which recorded average fruit length of 11.19 cm and average fruit diameter of 6.26 cm. The better efficiency resulted from combined application of organic manures with inorganic fertilizers might be due to the fact that organic manures might have helped in enhancing the metabolic activity to the plant in the early growth phase as it might have supplied the micronutrients in an optimum range which in turn must have encouraged the overall growth and fruit development (Prativa and Bhattarai, 2011). It was further reported that integrated nutrient management exhibited a significant influence on growth and yield attributes over the sole application of chemical fertilizers due to accelerated mobility of photosynthates from source to sink as well as improved soil structure which had favourably impacted the yield attributes (Nisar *et al.*, 2019). It is also known that addition of organic manures improved the soil structure as it provides the binding substance to soil aggregates which might lead to the increased cation exchange capacity and water holding capacity of soil, which helped to improve the efficiencies of applied fertilizers that reflected positively on growth and development of fruits Choudhary *et al.,* (2011); Isaac and Verghese (2016). The application of organic manures decrease the bulk density of soil makes it porous and increases its water holding capacity which might had favoured in increasing the diameter of fruit. Similar findings were reported by Yadav and Vijayakumari (2003).

Table 3: Influence of nutrient management through organic manures and inorganic fertilizers on average fruit length (cm) and average fruit diameter (cm).

	Treatment combinations	Average fruit length (cm)			Average fruit diameter(cm)		
		Kharif 2016	Kharif 2017	Pooled data	Kharif 2016	Kharif 2017	Pooled data
T_1	Farmyard manure	10.09	10.40	10.24	4.59	5.00	4.79
T_2	Vermicompost(VC)	10.3	10.53	10.41	5.20	5.50	5.35
T_3	Poultry manure (PM)	10.60	11.10	10.85	5.19	5.70	5.44
T_4	Sheep manure(SM)	9.99	10.26	10.13	4.19	4.40	4.29
T_5	Dal weed (DW)	9.20	9.73	9.46	4.00	4.20	4.10
T_6	Integration(all organic manures)	10.99	11.40	11.19	6.19	6.33	6.26
T_7	50%RFD+50%FYM	10.99	11.30	11.14	5.50	5.70	5.60
T_8	50%RFD+50%VC	12.50	12.80	12.65	7.49	7.53	7.51
T_9	50%RFD+50%PM	13.29	13.53	**13.41**	7.69	8.23	**7.96**
T_{10}	50%RFD+50%SM	10.79	11.40	11.09	4.99	5.16	5.08
T_{11}	50%RFD+50%DW	9.50	10.00	9.75	4.39	4.80	4.59
T_{12}	RFD	11.60	11.83	11.71	6.80	7.16	6.98
T_{13}	Control	8.49	9.03	8.76	4.00	4.13	4.06
	C.D	**0.32**	**0.27**	**0.20**	**0.25**	**0.28**	**0.18**

The data from Table 4 shows the conjugation of organic sources with inorganic sources of nutrients exhibited superiority over other treatments under study. It was found that treatment T_9 (50% RFD+ 50% PM) recorded maximum average fruit weight and fruit yield per plant during both consecutive years of 2016 and 2017. Pooled analysis also showed that treatment T_9, recorded average fruit weight of 65.65g and fruit yield per plant of 1.08 kg. It can be clearly seen from the data that among organic applications, treatment T_6 (integration of all manures) was found to be significantly superior to other sole organic applications. The increased fruit weight might be due to optimum supply of nitrogen all over the growing season which promoted flowering and fruiting and supply of food material which contributed to increased fruit weight and fruit yield per plant (Rabindra Kumar and Srivastava 2006).

Table 4: Influence of nutrient management through organic manures and inorganic fertilizers on average fruit weight (g) and fruit yield per plant (kg).

	Treatment combinations	Average fruit weight (g)			Fruit yield plant^{-1} (kg)		
		Kharif 2016	Kharif 2017	Pooled data	Kharif 2016	Kharif 2017	Pooled data
T_1	Farmyard manure	54.33	56.81	55.57	0.69	0.70	0.69
T_2	Vermicompost(VC)	54.51	56.71	55.61	0.74	0.76	0.75
T_3	Poultry manure (PM)	56.39	58.56	57.47	0.81	0.82	0.81
T_4	Sheep manure(SM)	49.87	56.37	53.12	0.58	0.65	0.61
T_5	Dal weed (DW)	50.34	52.88	51.61	0.54	0.57	0.55
T_6	Integration(all organic manures)	57.17	58.88	58.03	0.84	0.87	0.85
T_7	50%RFD+50%FYM	56.93	58.93	57.93	0.83	0.88	0.85
T_8	50%RFD+50%VC	64.52	65.30	64.91	0.98	1.01	1.00
T_9	50%RFD+50%PM	64.52	65.79	**65.65**	1.08	1.08	**1.08**
T_{10}	50%RFD+50%SM	55.97	55.38	55.67	0.72	0.72	0.72
T_{11}	50%RFD+50%DW	51.20	52.28	51.74	0.63	0.65	0.64
T_{12}	RFD	61.34	61.55	61.44	0.92	0.92	0.92
T_{13}	Control	34.84	35.80	35.34	0.28	0.30	0.29
	C.D	**3.03**	**3.33**	**2.19**	**0.033**	**0.022**	**0.019**

Perusal of data in Table 5 shows that among 13 treatments under study, treatment T_9 (50% RFD+ 50% PM) recorded maximum fruit yield per plot as well as per hectare during both consecutive seasons of 2016 and 2017 which is also evident from pooled data recording maximum fruit yield of 32.60 per plot and maximum fruit yield of 395.42 per hectare. Among sole application of organic treatments, treatment T_6 (integration of all manures) recorded fruit yield of 25.65 g per plot and fruit yield of 316.51 per hectare which was found superior to all other sole applications of organic manures. The yield being a dependent character is determined by yield attributing characters like the number of fruits per plant and fruit weight. The response of brinjal to integrated sources were found to be spectacular as compared to sole application of nutrients Zainub *et al*., (2016); Barman *et al.*, (2017). The organic sources ameliorated the phosphorus availability which played a distinguishing role in energy conservation and transfer. The balanced nitrogen supply all over the growing cycle of the crop reduced leaf senescence and escalated the assimilate demand of plant sinks which increased the yield of crop. Further, improvement in vegetative growth and balanced C/N ratio due to organic manures might have increased the synthesis of carbohydrates which boosted fruit yield of the crop Choudhary *et al*., (2011); Vijaya and Seethalakshmi (2011). Another study showed that combined application of NPK and poultry manure based compost gave highest yield due to low carbon to nitrogen ratio of poultry manure and the effect of decomposition which lead to early release of plant nutrient in the soil and ultimately increased the yield of crop due to low carbon to nitrogen ratio of poultry manure and the effect of decomposition which lead to early release of plant nutrient in the soil (Muhammad *et al*., 2018).

Table 5: Influence of nutrient management through organic manures and inorganic fertilizers on fruit yield per plot (kg) and fruit yield per hectare (q).

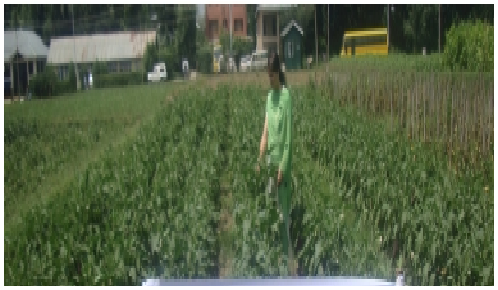
	Treatment combinations	Fruit yield plot^{-1} (kg)			Fruit yield hectare^{-1} (q)		
		Kharif 2016	Kharif 2017	Pooled data	Kharif 2016	Kharif 2017	Pooled data
T_1	Farmyard manure	20.70	21.00	20.85	255.43	259.14	257.28
T_2	Vermicompost(VC)	22.20	22.80	22.50	273.94	281.35	277.17
T_3	Poultry manure (PM)	24.30	24.60	24.45	299.86	303.56	301.71
T_4	Sheep manure(SM)	17.40	19.50	18.45	214.71	240.63	227.67
T_5	Dal weed (DW)	16.20	17.10	16.65	199.90	211.01	205.45
T_6	Integration(all organic manures)	25.20	26.10	25.65	310.96	322.07	316.51
T_7	50%RFD+50%FYM	24.90	26.40	25.65	307.26	325.77	316.52
T_8	50%RFD+50%VC	29.53	30.42	29.97	364.50	375.46	369.98
T_9	50%RFD+50%PM	32.59	32.62	**32.60**	391.45	399.40	**395.42**
T_{10}	50%RFD+50%SM	21.03	21.60	21.31	259.65	266.65	263.15
T_{11}	50%RFD+50%DW	18.93	19.50	19.21	233.72	240.73	237.23
T_{12}	RFD	27.53	27.70	27.61	339.55	341.97	340.76
T_{13}	Control	8.42	9.01	8.71	103.65	111.06	107.35
	C.D	**0.30**	**0.65**	**0.34**	**3.68**	**8.04**	**4.30**

The data presented in Table 6 revealed about conjugated use of different organic sources with recommended fertilizer dose in equal proportions (50:50) exhibited an increase in duration of fruiting. Among 13 treatments under study, treatment T_9 (50% RFD+ 50% PM) recorded maximum duration of fruiting during both kharif seasons of 2016 and 2017 which is clearly evident from pooled data analysis as well recording 92.16 days which was superior to all other treatments.

Pooled data also revealed significance of treatment T_6 (integration of all manures) recording 82.31 days of fruiting which was significantly superior to all sole application of organic manures. Duration of fruiting was higher with treatments receiving organic manures either in integration with chemical fertilizers or organic manures alone indicating the influence of organic manures in extending the fruiting period as reported by Anuburani and Manivanan (2002) in brinjal.

Table 6: Influence of nutrient management through organic manures and inorganic fertilizers on duration of fruiting.

	Treatment combinations	Duration of fruiting (days)		
		Kharif 2016	Kharif 2017	Pooled data
T_1	Farmyard manure	70.33	75.06	72.70
T_2	Vermicompost(VC)	75.00	80.10	77.55
T_3	Poultry manure (PM)	76.00	80.93	78.46
T_4	Sheep manure(SM)	70.00	75.00	72.50
T_5	Dal weed (DW)	65.66	70.96	68.31
T_6	Integration(all organic manures)	79.66	84.96	82.31
T_7	50%RFD+50%FYM	79.66	84.00	81.83
T_8	50%RFD+50%VC	82.66	87.93	85.30
T_9	50%RFD+50%PM	90.33	94.00	**92.16**
T_{10}	50%RFD+50%SM	73.33	77.90	75.61
T_{11}	50%RFD+50%DW	71.00	71.00	71.00
T_{12}	RFD	75.66	81.90	78.78
T_{13}	Control	63.33	68.06	65.70
	C.D	3.87	1.81	2.08



B. Residual influence of nutrient management through organic manures and inorganic fertilizers on fenugreek

Perusal of data in Table 7 revealed significant variation in plant height and number of branches in residual crop fenugreek. Among various treatments, conjugation of organic with inorganic sources exhibited better residual effect over sole application of organic manures and RFD. Among 13 treatments under study, treatment T_9 (50% RFD+ 50% PM) which received nutrients through poultry manure and inorganic fertilizers on equivalent basis (50 : 50) had the maximum plant height and number of branches per plant during both rabi seasons of 2016 and 2017 which is evident from pooled data also recording values of 34.01 cm for plant height and 5.40 number of branches per plant which was higher than all other treatments. While lowest values were recorded with control which received no inputs. The increased growth and vigour of the succeeding crop was due to the residual nutrients leading to better development which in turn increased the yield of succeeding crop as reported by Choudhary *et al*., (2011). It can be seen from the data presented in Table 8 that treatment T_9 (50% RFD+ 50% PM) exhibited a superior residual effect in reducing number of days to harvesting as compared to sole application of organic sources as well as RFD during both consecutive seasons. Pooled data also revealed significance of treatment T_9 recording 132.53 days to harvest, which was found to be superior to all other treatments under study. The results implies that there were sufficient residual nutrients available to the crop which resulted in its rapid growth. Referring to data in Table 9 revealed maximum leaf yield per plot and leaf yield per hectare was observed in treatment T_9 (50% RFD+ 50% PM) recording 4.23 kg leaf yield per plot and 52.27 kg leaf yield per hectare which was found to be significantly superior to all other treatments. The marked influence of nutrient management of preceding crop on the growth and yield of unfertilized succeeding crop might be due to balanced and continued supply of nutrients which enhanced their availability and with their effective involvement in root and shoot growth exhibited better plant growth which consequently led to higher yield of succeeding crop as reported by Parihar *et al*., (2009).

Table 7: Residual influence of nutrient management through organic manures and inorganic fertilizers on plant height (cm) and number of branches per plant.

	Treatment combinations	Plant height (cm)			Number of branches plant^{-1}		
		Rabi 2016	Rabi 2017	Pooled data	Rabi 2016	Rabi 2017	Pooled data
T_1	Farmyard manure	24.23	25.70	24.96	3.52	3.80	3.66
T_2	Vermicompost(VC)	25.53	27.10	26.31	3.60	4.30	3.95
T_3	Poultry manure (PM)	26.46	28.00	27.23	3.90	4.50	4.20
T_4	Sheep manure(SM)	21.53	22.96	22.25	3.33	3.40	3.36
T_5	Dal weed (DW)	19.03	20.53	19.78	3.11	3.20	3.15
T_6	Integration(all organic manures)	27.60	29.36	28.48	4.71	4.03	4.37
T_7	50%RFD+50%FYM	28.96	30.26	29.61	4.31	4.80	4.55
T_8	50%RFD+50%VC	31.13	32.46	31.80	4.91	5.00	4.95
T_9	50%RFD+50%PM	33.43	34.60	**34.01**	5.31	5.50	**5.40**
T_{10}	50%RFD+50%SM	22.66	24.16	23.41	3.40	3.60	3.50
T_{11}	50%RFD+50%DW	21.03	22.33	21.68	3.21	3.50	3.35
T_{12}	RFD	19.02	18.95	18.98	3.04	3.01	3.02
T_{13}	Control	17.03	17.40	17.21	2.95	2.90	2.92
	C.D	**0.97**	**2.91**	**1.49**	**0.27**	**0.50**	**0.28**

Table 8: Residual influence of nutrient management through organic manures and inorganic fertilizers on days to harvesting.

	Treatment combinations	Days to harvesting		
		Rabi 2016	Rabi 2017	Pooled data
T_1	Farmyard manure	160.00	154.66	157.33
T_2	Vermicompost (VC)	157.00	152.16	154.58
T_3	Poultry manure (PM)	155.33	151.06	153.20
T_4	Sheep manure(SM)	164.00	158.90	161.45
T_5	Dal Weed (DW)	168.00	162.86	165.43
T_6	Integration(all organic manures)	147.00	142.13	144.56
T_7	50%RFD+50%FYM	144.00	139.10	141.55
T_8	50%RFD+50%VC	140.00	130.93	135.46
T_9	50%RFD+50%PM	135.00	130.06	**132.53**
T_{10}	50%RFD+50%SM	162.00	157.13	159.56
T_{11}	50%RFD+50%DW	166.00	160.10	163.05
T_{12}	RFD	164.02	164.80	164.41
T_{13}	Control	170.00	168.06	169.03
	C.D	**3.74**	**4.22**	**2.75**

Table 9: Residual influence of nutrient management through organic manures and inorganic fertilizers on leaf yield per plot (kg) and leaf yield per hectare (q).

	Treatment combinations	Leaf yield plot^{-1} (kg)			Leaf yield hectare^{-1} (q)		
		Rabi 2016	Rabi 2017	Pooled data	Rabi 2016	Rabi 2017	Pooled data
T_1	Farmyard manure	2.79	3.25	3.02	34.50	40.14	37.32
T_2	Vermicompost(VC)	3.00	3.37	3.18	37.05	41.62	39.34
T_3	Poultry manure (PM)	3.23	3.60	3.41	39.85	44.46	42.15
T_4	Sheep manure(SM)	2.63	3.04	2.83	32.45	37.51	34.98
T_5	Dal weed (DW)	2.50	2.91	2.70	30.84	35.91	33.37
T_6	Integration (all organic manures)	3.40	3.75	3.57	42.03	46.27	44.15
T_7	50%RFD+50%FYM	3.60	4.02	3.81	44.46	49.64	47.05
T_8	50%RFD+50%VC	3.69	4.11	3.90	45.62	50.75	48.18
T_9	50%RFD+50%PM	4.02	4.44	**4.23**	49.68	54.86	**52.27**
T_{10}	50%RFD+50%SM	2.82	3.25	3.04	34.87	40.14	37.50
T_{11}	50%RFD+50%DW	2.60	3.03	2.81	32.08	37.42	34.75
T_{12}	RFD	2.35	2.75	2.55	29.07	33.93	31.50
T_{13}	Control	1.69	1.52	1.61	20.93	18.83	19.88
	C.D	**0.078**	**0.117**	**0.068**	**0.93**	**1.44**	**0.83**

CONCLUSION

It is concluded that Brinjal-fenugreek cropping system is well fitted under Kashmir conditions. Among treatments under study, treatment T_9 (50% RFD + 50% PM) was found to be the best treatment over rest of the treatments with respect to improvement in growth and yield attributes of main crop brinjal as well as in residual crop fenugreek. For harvesting sustainable and quality yield in brinjal, a grower can adopt following nutrient schedule:-50% RFD+50% PM, 50% RFD+50% VC. A grower can raise fenugreek as residual crop in brinjal-fenugreek cropping sequence by adopting following nutrient schedule: - 50% RFD+50% PM - 50% RFD+50% VC.

FUTURE SCOPE

No single set of recommendations on plant nutrient application are appropriate for the diverse agricultural environments and economic conditions that exist. Successful INM adoption programs thus must enhance farmers' capacity to learn and break free from the conventional fix of one-way technology transfer from researcher to farmer. Farmers also need to participate in the development of these technologies and become knowledgeable about managing soil fertility and capturing the opportunities offered by their diverse environments.

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