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Hemlata Kaushal
Senior Scientist, KVK,
Dr. YS Parmar University of
Horticulture and Forestry,
Nauni, Solan, Himachal
Pradesh, India

Seema Thakur
Senior Scientist, KVK,
Dr. YS Parmar University of
Horticulture and Forestry,
Nauni, Solan, Himachal
Pradesh, India

Rajesh Thakur
Senior Scientist, KVK,
Dr. YS Parmar University of
Horticulture and Forestry,
Nauni, Solan, Himachal
Pradesh, India

Corresponding Author:
Seema Thakur
Senior Scientist, KVK,
Dr. YS Parmar University of
Horticulture and Forestry,
Nauni, Solan, Himachal
Pradesh, India

Effect of different organic and natural liquid manures on growth and yield of leaf lettuce (*Lactuca sativa* L.) under North-Western Himalayan conditions

Hemlata Kaushal, Seema Thakur and Rajesh Thakur

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Abstract

Lettuce is one of the most important leafy vegetables which is gaining importance with the change in food habits and increasing awareness among the people towards their health. There is an increasing demand among consumers for safe and nutritious food that improves physical performance, reduces the risk of diseases, and increases the life span. Organic and natural farming practices eliminate the dependency on agrichemicals; rely on the use of natural products, and aids in improving the environment as well as farm economics in terms of higher yield and net returns. Hence an experiment was conducted during spring season at Horticultural Research & Training Station and KVK, Kandaghat, Solan to investigate the effect of different organic and natural liquid manures on growth and yield of lettuce (*Lactuca sativa*). The results revealed that combined application of (FYM @ 5 t/ha + Ghanjeevamrit @ 0.5 t/ha + Jeevamrit drenching @ 5% + Saptadhanyankur spray @ 3%) recorded higher values for characters like minimum days taken to marketable maturity (40.77), leaf length (21.20 cm), leaf breadth (20.61 cm), plant spread (36.83 cm), plant height (29.37 cm), fresh leaf weight (16.02 g), yield per plant (612.55 g), yield per plot (12.25 kg), yield per hectare (362.88 q), number of leaves (35.51) and benefit cost ratio (5.80).

Keywords: Ghanjeevamrit, Saptadhanyankur, Jeevamrit, FYM, natural liquid manure

Introduction

Lettuce (*Lactuca sativa* L.) is one of the most economically important leafy vegetable crop grown in the world. It occupies the largest production area among salad crops in the world with production continuing to increase on yearly basis. Lettuce is rich in vitamin A and minerals like calcium and iron. Consumption of lettuce helps in lowering blood cholesterol levels, improves insomnia possessing anti-inflammatory, antioxidant, antimicrobial, and anti-cancer properties (Khare, 2004) ^[14]. The health promoting properties of lettuce is attributed to the presence of nutraceutical compounds like bioactive-terpenoids and polyphenols such as carotenoids, phenolic acids, and flavonoids. In India, lettuce is gaining popularity with the change in food habits and increasing awareness among the people towards their health. There is an increasing demand among consumers for safe and nutritious food that improves physical performance, reduces the risk of diseases, and increases the life span (Ogden *et al.* 2007) ^[19].

With the modernization and the growing population the consumption of chemicals namely fertilizers, pesticides, growth regulators, etc., has increased substantially in order to achieve the current demand for food requirements. However, the efficiency of the chemical fertilizers already reached a steady phase due to their indiscriminate and inefficient use. Also the cost of inorganic fertilizers is increasing enormously to an extent that they are not affordable to small and marginal farmers. Hence in this regard, there is a need to identify a suitable substitute in place of chemical fertilizers which are economically cheaper and eco-friendly (Verma *et al.* 2018) ^[34]. The use of manures like Farm Yard Manure, Ghanjeevamrit and natural liquid organic manures like Jeevamrit and Saptadhanyankur plays an important role in sustaining the soil health as well as productivity of the crops. These manures contain small quantities of macronutrients, micronutrients, and growth-promoting substances, when applied to the crop either in form of foliar spray, through drenching in soil or in form of solid manure trigger the necessary plant growth and development, which ultimately led to better

crop yield (Boraiah *et al.* 2017) [2].

Organic and natural farming practices eliminate the dependency on agrichemicals; rely on the use of natural products, and aids in improving the environment as well as farm economics in terms of higher yield and net returns. Organic and natural farming can play an important role in maximizing the profitable production of lettuce with enhanced soil fertility (Uddin *et al.* 1995) [33]. The greater challenge for India is to provide safe and healthy food for the growing population in the country. Despite such an important aspect, work has not been done on the use of organic and natural products in the cultivation of leafy lettuce in summer months. Hence this study was planned to generate information on effect of organic and natural liquid manures on growth and yield of lettuce cultivated in open field conditions.

Materials and Methods

The experiment was carried out at the Experimental Farm of Horticultural Research & Training Station and KVK, Kandaghat, Solan (H.P.) during 2022. The experimental site is situated at an elevation of 1425 m above mean sea level, about 14 km away from Solan, with 30.9702° N latitude and

77.1054° E longitude, representing mid hill zone of Himachal Pradesh. The layout of experimental field was laid down in Randomized Complete Block Design (RCBD) Factorial with three replications comprising of sixteen treatment combinations of two factors-Factor I: Organic manure (M) and Factor II: Natural liquid manures (L). The detail of treatments combination is given in Table 1. Uniform and healthy seedlings were transplanted in the field in the first week of March in different plots at a spacing of 45 × 30 cm between and within the rows respectively, thus accommodating twenty plants per plot (2.7 m²). Irrigation was done immediately after transplanting and followed on regular basis. All other cultural operations and plant protection measures were adopted to maintain uniform plant population and ideal conditions for proper growth and development of plants. The growth and yield parameters were recorded for five randomly selected plants and the mean values of data obtained were statistically analysed by adopting method as described by Panse and Sukhatme (2000) [21]. The critical differences were calculated at five percent level of significance wherever 'F' test was significant.

Table 1: Details of different treatments under study in the experiment

Treatment No.	Treatment code	Treatment Details
T ₁	M ₀ L ₀	No manure + No liquid manure (Control)
T ₂	M ₀ L ₁	No manure + Jeevamrit drenching @ 5%
T ₃	M ₀ L ₂	No manure + Saptadhanyankur spray @ 3%
T ₄	M ₀ L ₃	No manure + Jeevamrit drenching @ 5% + Saptadhanyankur spray @ 3%
T ₅	M ₁ L ₀	FYM @ 10 t/ha + No liquid manure
T ₆	M ₁ L ₁	FYM @ 10 t/ha + Jeevamrit drenching @ 5%
T ₇	M ₁ L ₂	FYM @ 10 t/ha + Saptadhanyankur spray @ 3%
T ₈	M ₁ L ₃	FYM @ 10 t/ha + Jeevamrit drenching @ 5% + Saptadhanyankur spray @ 3%
T ₉	M ₂ L ₀	Ghanjeevamrit @ 1 t/ha + No liquid manure
T ₁₀	M ₂ L ₁	Ghanjeevamrit @ 1 t/ha + Jeevamrit drenching @ 5%
T ₁₁	M ₂ L ₂	Ghanjeevamrit @ 1 t/ha + Saptadhanyankur spray @ 3%
T ₁₂	M ₂ L ₃	Ghanjeevamrit @ 1 t/ha + Jeevamrit drenching @ 5% + Saptadhanyankur spray @ 3%
T ₁₃	M ₃ L ₀	FYM @ 5 t/ha + Ghanjeevamrit @ 0.5 t/ha + No liquid manure
T ₁₄	M ₃ L ₁	FYM @ 5 t/ha + Ghanjeevamrit @ 0.5 t/ha + Jeevamrit drenching @ 5%
T ₁₅	M ₃ L ₂	FYM @ 5 t/ha + Ghanjeevamrit @ 0.5 t/ha + Saptadhanyankur spray @ 3%
T ₁₆	M ₃ L ₃	FYM @ 5 t/ha + Ghanjeevamrit @ 0.5 t/ha + Jeevamrit drenching @ 5% + Saptadhanyankur spray @ 3%

Factor I: Organic manure (M): M₀-No organic manure, M₁-FYM @ 10 t/ha, M₂-Ghanjeevamrit @ 1 t/ha, M₃-FYM @ 5 t/ha + Ghanjeevamrit @ 0.5 t/ha

Factor II: Natural liquid manure (L): L₀-No liquid manure, L₁-Jeevamrit (drenching @ 5%), L₂-Saptadhanyankur (spray @ 3%), L₃-Jeevamrit + Saptadhanyankur (Drenching @ 5% + spray @ 3%)

Results and Discussion

Application of different levels of organic manures, natural liquid manures and their combinations significantly influenced the various plant growth and yield characters.

Days taken to marketable maturity

Earliness is an important character in lettuce and is economically significant in a way that early maturing varieties fetch higher prices in the market than normal varieties. In plants; earliness is characterized by accelerated passage through the vegetative stages. The cultivation of early maturing varieties results in a more productive use of land, since the same field may yield two or more harvests

per season. Plants under treatment M₃L₃ (FYM @ 5 t/ha + Ghanjeevamrit @ 0.5 t/ha + Jeevamrit drenching @ 5% + Saptadhanyankur spray @ 3%) were found to be earliest in maturity i.e. 40.77 days. While Plants under control treatment took maximum number of days to attain marketable maturity i.e. 48.64 days (Table-2). The reduction in the number of days may be attributed to added supply of nutrients and proliferous root system developed early under balanced nutrient application through varying levels of organic manures and natural liquid manures resulting in better absorption of water and nutrients with improved physical environment. The results are in conformity with Rather *et al.* (2018) [24] & Chatterjee (2015) [4].

Leaf length

Among different treatments M₃ L₃ (FYM @ 5 t/ha + Ghanjeevamrit @ 0.5 t/ha + Jeevamrit drenching @ 5% + Saptadhanyankur spray @ 3%) recorded maximum average leaf length i.e. 21.20 cm. The minimum average leaf length was recorded under control treatment (T₁) i.e. 12.77 cm. Increase in length of leaves might be due to the application of organic manures. The positive influence of natural

manures on the growth and yield characters of lettuce crop might be due to the release of the balanced nutrients contained in the organic nutrient sources especially nitrogen. This ensures favourable condition for the elongation of lettuce plant as well as availability of other macro and trace elements and improvement in soil physical structure such as water holding capacity. The leaf proliferation and expansion in leafy vegetables is attributed to organic soil amendments. These results were in agreement with the findings of Masarirambi *et al.* (2010) ^[16] and Sarhan *et al.* (2012) ^[25].

Leaf breadth

Plants recorded maximum average leaf breadth (20.61 cm) in treatment M₃L₃ (FYM @ 5 t/ha + Ghanjeevamrit @ 0.5 t/ha + Jeevamrit drenching @ 5% + Saptadhanyankur spray @ 3%) whereas minimum average leaf breadth was recorded in control i.e. 11.10 cm (Table-2). Average Leaf breadth was significantly influenced by combined effect of

different organic manures and natural liquid manures. This might be due to the continuous nutrient availability to the plants by the use of organics and natural liquid manures. This was found to be in accordance with findings of Hasan and Solaiman (2013) ^[11], Sevinc *et al.* (2018) ^[26] & Caliskan *et al.* (2014) ^[3].

Plant spread

The maximum increase in plant spread was recorded in treatment M₃L₃ (FYM @ 5 t/ha + Ghanjeevamrit @ 0.5 t/ha + Jeevamrit drenching @ 5% + Saptadhanyankur spray @ 3%) i.e. 36.83 cm and the minimum increase in plant spread i.e. 31.11 cm was recorded under control. The increase in leaf length due to the increased uptake of nutrients might be the reason for increased plant spread. This is found to be in accordance with findings of Manoj *et al.* (2013) ^[15], Rather *et al.* (2018) ^[24] and Dolma and Gupta (2011) ^[7].

Table 2: Effect of different organic and natural liquid manures on days taken to marketable maturity, leaf length, leaf breadth, plant spread and plant height

Treatments	Days taken to marketable maturity	Leaf length (cm)	Leaf breadth (cm)	Plant spread (cm)	Plant height (cm)
M ₀ (No manure)	46.24	14.95	12.22	32.77	20.26
M ₁ (FYM @ 10 t/ha)	44.93	15.56	15.48	33.47	22.04
M ₂ (Ghanjeevamrit @ 1 t/ha)	45.71	16.03	15.28	33.79	24.45
M ₃ (FYM @ 5 t/ha + Ghanjeevamrit @ 0.5 t/ha)	43.58	19.26	17.57	36.04	26.18
CD(0.05)	1.19	1.01	1.42	0.85	1.10
L ₀ (No liquid manure)	47.44	14.47	13.19	33.19	21.02
L ₁ (Jeevamrit drenching @ 5%)	45.92	16.12	14.75	34.43	22.88
L ₂ (Saptadhanyankur spray @ 3%)	44.73	16.06	15.82	33.97	22.79
L ₃ (Jeevamrit drenching @ 5% + Saptadhanyankur spray @ 3%)	42.37	19.16	16.79	34.47	26.23
CD(0.05)	1.19	1.01	1.42	0.85	1.10
M ₀ L ₀ (Control)	48.64	12.77	11.10	31.11	18.49
M ₀ L ₁ (No manure + Jeevamrit drenching @ 5%)	47.75	14.70	12.33	32.93	20.34
M ₀ L ₂ (No manure + Saptadhanyankur spray @ 3%)	45.88	15.24	13.64	32.74	20.43
M ₀ L ₃ (No manure + Jeevamrit drenching @ 5% + Saptadhanyankur spray @ 3%)	42.70	17.07	11.81	34.28	21.77
M ₁ L ₀ (FYM @ 10 t/ha + No liquid manure)	46.96	13.24	15.07	31.97	19.87
M ₁ L ₁ (FYM @ 10 t/ha + Jeevamrit drenching @ 5%)	47.14	14.73	13.63	34.16	21.21
M ₁ L ₂ (FYM @ 10 t/ha + Saptadhanyankur spray @ 3%)	43.68	13.62	14.32	33.72	19.37
M ₁ L ₃ (FYM @ 10 t/ha + Jeevamrit drenching @ 5% + Saptadhanyankur spray @ 3%)	41.95	20.67	18.91	34.04	27.72
M ₂ L ₀ (Ghanjeevamrit @ 1 t/ha + No liquid manure)	48.23	14.31	11.67	34.67	22.45
M ₂ L ₁ (Ghanjeevamrit @ 1 t/ha + Jeevamrit drenching @ 5%)	43.73	16.22	16.52	34.23	25.01
M ₂ L ₂ (Ghanjeevamrit @ 1 t/ha + Saptadhanyankur spray @ 3%)	46.79	15.88	17.09	33.54	24.27
M ₂ L ₃ (Ghanjeevamrit @ 1 t/ha + Jeevamrit drenching @ 5% + Saptadhanyankur spray @ 3%)	44.08	17.71	15.84	32.72	26.06
M ₃ L ₀ (FYM @ 5 t/ha + Ghanjeevamrit @ 0.5 t/ha + No liquid manure)	45.93	17.55	14.92	35.00	23.29
M ₃ L ₁ (FYM @ 5 t/ha + Ghanjeevamrit @ 0.5 t/ha + Jeevamrit drenching @ 5%)	45.06	18.81	16.51	36.40	24.96
M ₃ L ₂ (FYM @ 5 t/ha + Ghanjeevamrit @ 0.5 t/ha + Saptadhanyankur spray @ 3%)	42.56	19.48	18.23	35.90	27.10
M ₃ L ₃ (FYM @ 5 t/ha + Ghanjeevamrit @ 0.5 t/ha + Jeevamrit drenching @ 5% + Saptadhanyankur spray @ 3%)	40.77	21.20	20.61	36.83	29.37
Overall Mean	45.12	16.45	15.14	34.01	23.23
CD (0.05)	2.38	2.03	2.84	1.70	2.19

Plant height

Maximum plant height was recorded in the treatment M₃L₃ (FYM @ 5 t/ha + Ghanjeevamrit @ 0.5 t/ha + Jeevamritdrenching @ 5% + Saptadhanyankur spray @ 3%) on the other hand minimum plant height (18.49 cm) was recorded in control treatment (M₀L₀). It may be due to the reason that organic manure enhanced soil aggregation,

aeration, water holding capacity and amended the root system by flow of nutrients, which in combination created favourable conditions for root respiration, nutrient absorption by the roots and hence growth in plant height. Similar finding for plant height had been reported by Taha *et al.* (2017) ^[32], Ansari (2008) ^[1], Sharma and Aggarwal (2019) ^[27], Devan (2013) ^[6] & Pant *et al.* 2009 ^[22].

Fresh leaf weight

Fresh leaf weight is an important yield contributing character and has a direct effect on the final plant yield. Application of M₃L₃ (FYM @ 5 t/ha + Ghanjeevamrit @ 0.5 t/ha + Jeevamrit drenching @ 5% + Saptadhanyankur spray @ 3%) recorded the maximum fresh leaf weight i.e. 16.02 g while the minimum fresh leaf weight was recorded in control treatment (M₀L₀) i.e. 9.87 g (Table-3). This might be due to the fact that organic manures, natural liquid manures and their interaction enhances the role of leaves in photosynthesis, energy storage, cell division and cell enlargement. Similar results have been reported by Singh (2004) [30], Durak *et al.* (2017) [8], Frasetya *et al.* (2019) [9], and Sharma *et al.* (2002) [28].

Dry leaf weight

Dry leaf weight is an important character which helps to determine the fiber and total dry matter in the plant leaf. Leaf dry weight tended to increase by increasing dose of organic manures and by application of different liquid manures; however this increment was not significant. Application of organic manure, natural liquid manure and

their interaction with each other had non-significant influence on this character.

Number of leaves per plant

Plants under treatment M₃L₃ (FYM @ 5 t/ha + Ghanjeevamrit @ 0.5 t/ha + Jeevamrit drenching @ 5% + Saptadhanyankur spray @ 3%) produced the maximum number of leaves (35.51). On the other hand minimum number of leaves were recorded in control treatment (M₀L₀) i.e. 26.73. The increase in growth parameters like leaf number was due to the fact that organic and natural liquid manures besides supplying N, P and K also improved the soil condition which improved the source to sink relationship. The unavailable sources of elemental nitrogen, bound phosphates, micronutrients, and decomposed plant residues were made available into the most absorbable form to facilitate the plants to absorb the nutrients. This lead to an increase in the growth attributes of plants due to natural liquid manure application. The results were in conformity with those reported by Islam *et al.* (2012) [13], Moreira *et al.* (2014) [18], Rather *et al.* (2018) [24], Michael *et al.* (2012) [17] and Siddappa (2015) [29].

Table 3: Effect of different organic and natural liquid manures on fresh leaf weight (g), dry leaf weight (g)

Treatments	Fresh leaf weight (g)	Dry leaf weight (g)	Number of leaves per plant
M ₀ (No manure)	11.00	0.81	29.67
M ₁ (FYM @ 10 t/ha)	11.13	0.82	32.11
M ₂ (Ghanjeevamrit @ 1 t/ha)	12.58	0.94	29.78
M ₃ (FYM @ 5 t/ha + Ghanjeevamrit @ 0.5 t/ha)	13.54	0.95	32.30
CD(0.05)	1.00	NS	1.09
L ₀ (No liquid manure)	10.89	0.85	29.80
L ₁ (Jeevamrit drenching @ 5%)	12.46	0.89	31.11
L ₂ (Saptadhanyankur spray @ 3%)	11.66	0.91	30.58
L ₃ (Jeevamrit drenching @ 5% + Saptadhanyankur spray @ 3%)	13.25	0.88	32.36
CD(0.05)	1.00	NS	1.09
M ₀ L ₀ (Control)	9.87	0.74	26.73
M ₀ L ₁ (No manure + Jeevamrit drenching @ 5%)	10.58	0.80	32.13
M ₀ L ₂ (No manure + Saptadhanyankur spray @ 3%)	11.40	0.83	31.07
M ₀ L ₃ (No manure + Jeevamrit drenching @ 5% + Saptadhanyankur spray @ 3%)	12.14	0.85	28.75
M ₁ L ₀ (FYM @ 10 t/ha + No liquid manure)	9.98	0.84	31.99
M ₁ L ₁ (FYM @ 10 t/ha + Jeevamrit drenching @ 5%)	13.00	0.82	30.69
M ₁ L ₂ (FYM @ 10 t/ha + Saptadhanyankur spray @ 3%)	10.53	0.83	32.24
M ₁ L ₃ (FYM @ 10 t/ha + Jeevamrit drenching @ 5% + Saptadhanyankur spray @ 3%)	11.02	0.79	33.51
M ₂ L ₀ (Ghanjeevamrit @ 1 t/ha + No liquid manure)	13.39	0.95	27.77
M ₂ L ₁ (Ghanjeevamrit @ 1 t/ha + Jeevamrit drenching @ 5%)	11.65	1.01	31.21
M ₂ L ₂ (Ghanjeevamrit @ 1 t/ha + Saptadhanyankur spray @ 3%)	11.48	0.98	28.47
M ₂ L ₃ (Ghanjeevamrit @ 1 t/ha + Jeevamrit drenching @ 5% + Saptadhanyankur spray @ 3%)	13.80	0.84	31.69
M ₃ L ₀ (FYM @ 5 t/ha + Ghanjeevamrit @ 0.5 t/ha + No liquid manure)	10.32	0.85	32.72
M ₃ L ₁ (FYM @ 5 t/ha + Ghanjeevamrit @ 0.5 t/ha + Jeevamrit drenching @ 5%)	14.60	0.91	30.41
M ₃ L ₂ (FYM @ 5 t/ha + Ghanjeevamrit @ 0.5 t/ha + Saptadhanyankur spray @ 3%)	13.22	0.99	30.56
M ₃ L ₃ (FYM @ 5 t/ha + Ghanjeevamrit @ 0.5 t/ha + Jeevamrit drenching @ 5% + Saptadhanyankur spray @ 3%)	16.02	1.04	35.51
Overall Mean	12.06	0.9	30.97
CD(0.05)	1.99	NS	2.17

Yield (per plant, per plot, per hectare)

Yield is the most important parameter that determines the success of crop production. Lettuce crop reacts positively to the application of organic manures. Plants supplied with optimum level of nutrients in form of organic manures exhibits maximum vegetative growth which ultimately leads to the higher plant yield. Plants under treatment M₃L₃ noticed the highest lettuce yield (612.55g) per plant, yield per plot (12.25 kg) and yield per hectare (362.88 q) (Table-4). Whereas, the lowest yield (407.10 g) per plant, yield per plot (8.14 kg) and yield per hectare (241.17 q) was recorded with control treatment (M₀L₀). The combined

application of organic and natural liquid manures enhances the growth and yield attributing parameters due to the slow release of nutrients throughout the growing period of crop and also improves the soil physico-chemical and mineralogical properties which in turn increase the fertility status of the soil. Hence, these organic manures and natural liquid manures are efficient natural substitutes for obtaining higher yield besides improving the nutrient status of the soil. Similar findings have been reported by Palekar (2006) [20], Devakumar *et al.* (2008) [5], Singh *et al.* (2012) [31] and Ghuman and Sur (2006) [10].

Table 4: Effect of different organic and natural liquid manures on yield of lettuce per plant (g), yield per plot (kg) and yield per hectare (q).

Treatments	Yield per plant (g)	Yield per plot (kg)	Yield per hectare (q)
M ₀ (No manure)	456.50	9.13	270.43
M ₁ (FYM @ 10 t/ha)	509.25	10.18	301.68
M ₂ (Ghanjeevamrit @ 1 t/ha)	471.87	9.44	279.53
M ₃ (FYM @ 5 t/ha + Ghanjeevamrit @ 0.5 t/ha)	532.44	10.65	315.42
CD(0.05)	21.34	0.43	12.64
L ₀ (No liquid manure)	447.04	8.94	264.83
L ₁ (Jeevamrit drenching @ 5%)	502.55	10.05	297.71
L ₂ (Saptadhanyankur spray @ 3%)	478.97	9.58	283.74
L ₃ (Jeevamrit drenching @ 5% + Saptadhanyankur spray @ 3%)	541.50	10.83	320.78
CD(0.05)	21.34	0.43	12.64
M ₀ L ₀ (Control)	407.10	8.14	241.17
M ₀ L ₁ (No manure + Jeevamrit drenching @ 5%)	459.97	9.20	272.49
M ₀ L ₂ (No manure + Saptadhanyankur spray @ 3%)	431.32	8.63	255.52
M ₀ L ₃ (No manure + Jeevamrit drenching @ 5% + Saptadhanyankur spray @ 3%)	527.61	10.55	312.56
M ₁ L ₀ (FYM @ 10 t/ha + No liquid manure)	468.94	9.38	277.80
M ₁ L ₁ (FYM @ 10 t/ha + Jeevamrit drenching @ 5%)	509.99	10.20	302.12
M ₁ L ₂ (FYM @ 10 t/ha + Saptadhanyankur spray @ 3%)	505.91	10.12	299.70
M ₁ L ₃ (FYM @ 10 t/ha + Jeevamrit drenching @ 5% + Saptadhanyankur spray @ 3%)	552.16	11.04	327.10
M ₂ L ₀ (Ghanjeevamrit @ 1 t/ha + No liquid manure)	458.17	9.16	271.42
M ₂ L ₁ (Ghanjeevamrit @ 1 t/ha + Jeevamrit drenching @ 5%)	514.87	10.30	305.01
M ₂ L ₂ (Ghanjeevamrit @ 1 t/ha + Saptadhanyankur spray @ 3%)	440.76	8.82	261.10
M ₂ L ₃ (Ghanjeevamrit @ 1 t/ha + Jeevamrit drenching @ 5% + Saptadhanyankur spray @ 3%)	473.67	9.48	280.60
M ₃ L ₀ (FYM @ 5 t/ha + Ghanjeevamrit @ 0.5 t/ha + No liquid manure)	453.96	9.08	268.93
M ₃ L ₁ (FYM @ 5 t/ha + Ghanjeevamrit @ 0.5 t/ha + Jeevamrit drenching @ 5%)	525.38	10.51	311.23
M ₃ L ₂ (FYM @ 5 t/ha + Ghanjeevamrit @ 0.5 t/ha + Saptadhanyankur spray @ 3%)	537.88	10.76	318.64
M ₃ L ₃ (FYM @ 5 t/ha + Ghanjeevamrit @ 0.5 t/ha + Jeevamrit drenching @ 5% + Saptadhanyankur spray @ 3%)	612.55	12.25	362.88
Overall Mean	492.52	9.85	291.77
CD (0.05)	42.67	0.85	25.28

Benefit Cost ratio: Among different treatments net returns were highest (₹ 928431.78 ha⁻¹) in M₃L₃ (FYM @ 5 t/ha + Ghanjeevamrit @ 0.5 t/ha + Jeevamrit drenching @ 5% + Saptadhanyankur spray @ 3%) whereas lowest net returns (₹ 601254.04 ha⁻¹) were calculated in control treatment (M₀L₀). Similarly, maximum gross income per hectare (₹ 1088629.78) was recorded under M₃L₃ while minimum gross income (₹ 723504.04) was obtained under control treatment (Table-5). Maximum B:C ratio (5.80) was recorded in M₃L₃ (FYM @ 5 t/ha + Ghanjeevamrit @ 0.5 t/ha + Jeevamrit drenching @ 5% + Saptadhanyankur spray @ 3%) whereas minimum B:C ratio (4.52) was recorded in M₁L₀ (FYM @ 10 t/ha + No natural liquid manure). Higher net return under

M₃L₃ (FYM @ 5 t/ha + Ghanjeevamrit @ 0.5 t/ha + Jeevamrit drenching @ 5% + Saptadhanyankur spray @ 3%) could be due to the higher yield of lettuce plant obtained under this treatment. Excellent vegetative growth and good soil conditions resulted in higher yield which ultimately led to the increase in economic yield, total gross income, net returns and benefit cost ratio despite of increase in expenditure. These results were in conformity with those obtained by Hashem and Abd-Elrahman (2016) [12] on the benefits of applying natural organic manures and their combination. Also, the results were in confirmation with those obtained by Patil *et al.* (2013) [23] on lettuce plants.

Table 5: Effect of different organic and natural liquid manures on economics of lettuce production

Sr. No.	Treatments	Yield (q/ha)	Gross income (₹/ha)	Cost of cultivation (₹/ha)	Net Return (₹/ha)	B:C Ratio
T ₁	M ₀ L ₀	241.17	723504.04	122250	601254.04	4.92
T ₂	M ₀ L ₁	272.49	817458.68	134175	683283.68	5.09
T ₃	M ₀ L ₂	255.52	766547.83	129683	636864.83	4.91
T ₄	M ₀ L ₃	312.56	937668.49	141608	796060.49	5.62
T ₅	M ₁ L ₀	277.80	833400.17	150850	682550.17	4.52
T ₆	M ₁ L ₁	302.12	906360.15	162775	743585.15	4.57
T ₇	M ₁ L ₂	299.70	899109.18	158283	740826.18	4.68
T ₈	M ₁ L ₃	327.10	981292.83	170208	811084.83	4.77
T ₉	M ₂ L ₀	271.42	814253.80	127230	687023.80	5.40
T ₁₀	M ₂ L ₁	305.01	915032.89	139155	775877.89	5.58
T ₁₁	M ₂ L ₂	261.10	783312.75	134663	648649.75	4.82
T ₁₂	M ₂ L ₃	280.60	841812.25	146588	695224.25	4.74
T ₁₃	M ₃ L ₀	268.93	806777.71	140840	665937.71	4.73
T ₁₄	M ₃ L ₁	311.24	933705.34	152765	780940.34	5.11
T ₁₅	M ₃ L ₂	318.64	955926.26	148273	807653.26	5.45
T ₁₆	M ₃ L ₃	362.88	1088629.78	160198	928431.78	5.80
CD (0.05)				25.28		

Conclusion

The present study revealed that the integrated application of FYM @ 5 t/ha + Ghanjeevamrit @ 0.5 t/ha + Jeevamrit drenching @ 5% + Saptadhanyankur spray @ 3% (M3L3) proved most effective among all treatments for enhancing growth and yield attributes of leafy lettuce. This treatment also recorded the highest economic returns, including gross income (₹ 10,88,629.78), net returns (₹ 9,28,431.78), and benefit-cost ratio (5.80). It may thus be concluded that the combined use of these organic inputs can be recommended for sustainable and commercially viable lettuce production under open field conditions.

References

1. Ansari AA. Effect of vermicompost and vermiwash on the productivity of spinach (*Spinacia oleracea*), onion (*Allium cepa*) and potato (*Solanum tuberosum*). World J Agric Sci. 2008;4:554-557.
2. Boraiah B, Devakumar N, Shubha S, Palanna KB. Effect of panchagavya, jeevamrutha and cow urine on beneficial microorganisms and yield of capsicum (*Capsicum annuum* L. var. *grossum*). Int J Curr Microbiol Appl Sci. 2017;6:3226-3234.
3. Caliskan S, Yetisir H, Karanlik S. Combined use of green manure and farmyard manure allows better nutrition of organic lettuce. Not Bot Horti Agrobot Cluj Napoca. 2014;42:248-254.
4. Chatterjee R. Influence of nutrient sources on growth, yield and economics of lettuce production under foothills of eastern Himalayan region. Emir J Food Agric. 2015;27:460-462.
5. Devakumar N, Rao GGE, Shubha S, Khan I, Nagaraj, Gowda SB. Activities of Organic Farming Research Centre. Navile, Shimoga: University of Agricultural Sciences, Bangalore; 2008.
6. Devan E. Influence of vermiwash and plant growth regulators on the exomorphological characters of *Abelmoschus esculentus* (Linn.) Moench. Afr J Basic Appl Sci. 2013;5:82-90.
7. Dolma T, Gupta AJ. Evaluation of lettuce genotypes for growth and yield attributes in Kashmir Valley. Indian J Plant Genet Resour. 2011;24:62-66.
8. Durak AÖA, İbrahim KK, Rabia I, Fırat EK. The effects of vermicompost on yield and some growth parameters of lettuce. Turk J Agric Food Sci Technol. 2017;5:1566-1570.
9. Frasetya B, Harisman K, Maulid S, Ginandjar S. The effect of vermicompost application on the growth of lettuce plant (*Lactuca sativa* L.). J Phys Conf Ser. 2019;1402:1-5.
10. Ghuman BS, Sur HS. Effect of manuring on soil properties and yield of rain-fed wheat. J Indian Soc Soil Sci. 2006;55:6-11.
11. Hasan MR, Solaiman HM. Efficacy of organic and inorganic fertilizer on the growth of *Brassica oleracea* L. (cabbage). Int J Agric Crop Sci. 2012;5:34-43.
12. Hashem FA, Abd-Elrahman SH. Soil chemical characteristics and growth of broccoli and cauliflower plants as affected by liquid organic fertilizers and irrigation water levels. Glob J Adv Res. 2016;3:881-895.
13. Islam SMD, Ahmed A, Mahmud S, Tusher TR, Khanom S. Effects of organic fertilizer on the growth and yield of lettuce (*Lactuca sativa* L.) used as vegetables. Int J Agric Sci Res. 2012;2:116-128.
14. Khare CP. Indian herbal remedies: Rational western therapy, ayurvedic, and other traditional usage. Germany: Springer Science & Business Media; 2004.
15. Manoj K, Bikash D, Prasad KK, Kumar P. Effect of integrated nutrient management on growth and yield of broccoli (*Brassica oleracea* var. *italica*) under Jharkhand conditions. Veg Sci. 2013;40:117-120.
16. Masarirambi MT, Hlawe MM, Oseni OT, Sibiya TE. Effects of organic fertilizers on growth, yield, quality and sensory evaluation of red lettuce (*Lactuca sativa* L.) Veneza Roxa. Agric Biol J N Am. 2010;1:1319-1324.
17. Michael TM, Bekhumusa M, Mbokazi KP, Tajudeen OO. Effects of kraal manure, chicken manure and inorganic fertilizer on growth and yield of lettuce (*Lactuca sativa* L. var. Commander) in a semi-arid environment. Horticulture Department, University of Swaziland; 2012. p. 58-62.
18. Moreira MA, Santos CAP, Lucas AAT, Bianchini FG, de Souza IM, Viegas PRA. Lettuce production according to different sources of organic matter and soil cover. Int J Agric Sci. 2014;5:99-105.
19. Ogden CL, Carroll MD, McDowell MA, Flegal KM. Obesity among adults in the United States. NCHS Data Brief No. 1. Hyattsville (MD): National Center for Health Statistics; 2007.
20. Palekar S. Shoonya Bandovalada Naisargika Krushi. Bangalore: Agri Prakashana; 2006.
21. Panse VG, Sukhatme PV. Statistical methods for agricultural workers. New Delhi: Indian Council of Agricultural Research; 2000. p. 157-165.
22. Pant AP, Radovich TJK, Hue NV, Talcott ST, Krennek KA. Vermicompost extracts influence growth, mineral nutrients, phytonutrients and antioxidant activity in pak choi (*Brassica rapa* cv. Bonsai, Chinensis Group) grown under vermicompost and chemical fertilizer. J Sci Food Agric. 2009;89:2383-2392.
23. Patil T, Singh M, Khanna M, Singh DK, Hasan M. Response of lettuce (*Lactuca sativa* L.) to trickle irrigation under different irrigation intervals, N application rate and crop geometry. Indian J Agric Econ. 2013;68:573-582.
24. Rather AM, Jabeen N, Bhat TA, Parray EA, Hajam MA, Wani MA, et al. Effect of organic manures and bio-fertilizers on growth and yield of lettuce. Pharma Innov J. 2018;7:75-77.
25. Sarhan TZ. Effect of biofertilizer and different levels of nitrogen (urea) on growth, yield and quality of lettuce (*Lactuca sativa* L.) Ramadi cultivar. J Agric Sci Technol. 2012;2:137-141.
26. Sevinc A, Funda EA, Solmaz Y, Caktu E, Adiloglu A. Effect of vermicompost on the growth and yield of lettuce plant (*Lactuca sativa* L. var. *crispa*). Int J Plant Soil Sci. 2018;21:1-5.
27. Sharma J, Agarwal S. Impact of organic fertilizers on growth, yield and quality of spinach. Indian J Plant Sci. 2019;39:37-43.
28. Sharma SK, Sharma R, Korla BN. Effect of nitrogen and phosphorus on the growth and seed yield of sprouting broccoli cv. Green Head. Hort J. 2002;15:87-90.

29. Siddappa. Use of jeevamrutha and farm yard manure on growth and yield of field bean (*Dolichos lablab* L.) [MSc (Agri) thesis]. Bangalore: University of Agricultural Sciences; 2015.
30. Singh AK. Effect of nitrogen and phosphorus on growth and curd yield of cauliflower var. Snowball-16 under cold arid region of Ladakh. Haryana J Horti Sci. 2004;33:127-129.
31. Singh G, Sekhon HS, Harpreeth K. Effect of farmyard manure, vermicompost and chemical nutrients on growth and yields of chickpea (*Cicer arietinum* L.). Int J Agric Res. 2012;7:93-99.
32. Taha AA, El-Shazly MM, Ali NMM. Impact of nitrogen and organic fertilization on nutrients uptake by lettuce plants. J Soil Sci Agric Eng Mansoura Univ. 2017;8:341-346.
33. Uddin MJ, Ali MS, Hossain MA, Ahmed MU, Haque MM. Effect of boron on grain set, yield and some other parameters of wheat cultivars. Bangladesh J Agric Sci. 1995;2:179-184.
34. Verma S, Babu A, Patel A, Singh SK, Pradhan SS, Verma SK. Significance of vermiwash on crop production: A review. J Pharmacogn Phytochem. 2018;7:297-310