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To workout the role of organic manures and bio-fertilizers on soil properties

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Abstract
A field experiment was conducted during Rabi 2016-17 at Experimental Farm of Division of Vegetable Science SKUAST-K Shalimar Campus to work out the role of organic manures and bio-fertilizers on soil properties. The experiment was laid out in RCBD with inorganic fertilizers, three types of both organic manures and bio-fertilizers constituting 13 treatments combinations in all. Maximum available nitrogen, phosphorus and potassium were recorded in T_1 (120 kg N ha^{-1} + 90 kg P ha^{-1}+ 60 kg K ha^{-1}).

Keywords: bio-fertilizers, organic manures, vermicompost, soil properties

Introduction
Lettuce (*Lactuca sativa* L.), is an annual plant of Asteraceae family. It is a self-pollinated annual plant. The quantity and quality of this crop is affected by many factors and the most important factor is fertilizers. As a result of which, growers are making heavy use of chemicals (fertilizers and pesticides) without any consideration to soil and human health. The increased use of chemicals under intensive cultivation has not only contaminated the ground and surface water but has also disturbed the harmony existing among the soil, plant and microbial population (Bahadur *et al.*, 2006) [1]. Organic farming is appreciated by vegetable consumers as it enhances quality of the produce. Organic manure plays a direct role in plant growth as a source of all necessary macro and micronutrients in available forms during mineralization and improves physical and chemical properties of soils (Chaterjee *et al*., 2005) [2]. Organic manures can be used to promote the healthy population of beneficial organisms in the soil. Bio-fertilizers, on the other hand, are cost-effective and renewable source of plant nutrients. Organic inputs alone will not meet the nutritional needs of crops because they contain a comparatively less quantity of nutrients compared to inorganic fertilizers, the need to integrate the two forms in order to achieve better crop yields. The interaction between organic matter, biofertilizers and inorganic fertilizers may lead to either an increase or decrease in nutrients in soil depending on the nutrient and plant material.

Materials and Methods
The present investigation was carried out at Experimental Farm, Division of Vegetable Science, SKUAST-Kashmir, Shalimar campus, during Rabi 2016-17. The experimental material consisted of one cultivar named LS-2 of lettuce crop, chemical fertilizers (Urea, Diammonium Phosphate, and Muriate of Potash), organic manures viz. farm yard manure (FYM), vermicompost (VC), sheep manure (SM) and three types of biofertilizers namely *Azotobacter*, Phosphorus Solubilising Bacteria and Potassium Solubilising Bacteria. All of these Biofertilizers were procured from Biofertilizer Labarotory, Faculty of Agriculture, Wadura, SKUAST-K. The treatment combination T_1 [120 kg N ha^{-1} + 90 kg P ha^{-1}+ 60 kg K ha^{-1} (RFD)], T_2 [Farmyard manure (24 t ha^{-1})], T_3 [Vermicompost (8 t ha^{-1})], T_4 [Sheep Manure (17 t ha^{-1})], T_5 [60 kg N ha^{-1} + 45 kg P ha^{-1}+ 30 kg K ha^{-1}+ Farmyard manure (12 t ha^{-1})], T_6 [60 kg N ha^{-1} + 45 kg P ha^{-1}+ 30 kg K ha^{-1}+ Vermicompost (4 t ha^{-1})], T_7 (60 kg N ha^{-1} + 45 kg P ha^{-1}+ 30 kg K ha^{-1}+ Sheep Manure (8.5 t ha^{-1}) and T_8 (60 kg N ha^{-1} + 45 kg P ha^{-1}+ 30 kg K ha^{-1}+ Farmyard manure (12 t ha^{-1}). Biofertilizers were applied as seedling root dip treatment (@ 7.5 l ha^{-1}) before transplanting of seedlings in the experimental field. All chemical fertilizers and organic manures were incorporated in the experimental field at the time of land preparation. Full dose of P and K along with half dose of N was given as a basal dose and thoroughly mixed with soil. The remaining half dose of N was applied as two splits, first 30 days after transplanting and second 45 days after transplanting. Experimental data of Soil pH, organic carbon, available nitrogen, available phosphorus (kg P ha^{-1}) and available potassium was subjected to statistical analysis as per the standard statistical procedure given by Gomez

and Gomez (1984) [5]. Levels of significance used for 'F' and 'T' tests were P = 0.05 as given by Fisher (1970) [4]. The initial status of experimental site with respect to above characteristics is given in Table 1.

Table 1: Physico-chemical properties of soil of experimental site.

Particulars	Initial Status	Rating	Methods employed
Soil pH	7.12	Normal	1:2.5 soil water suspension using pH meter (Jackson,1973) [7]
Organic carbon (%)	1.09	Medium	Wet digestion method Walkley and Black's rapid titration method (1934) [14]
Available nitrogen (kg N ha^{-1})	210.50	Low	Alkalinepotassiumpermanganatemethod (Subbiah and Asija,1956) [11]
Available Phosphorus (kg P ha^{-1})	22.75	Medium	Olsen's method of extraction with 0.5 *N*, $NaHCO_3$ (Olsen *et al.* 1954) [9]. Using Systronics Spectro-photometer.
Available Potassium (kg K ha^{-1})	205.20	Medium	Ammonium acetate extraction (Jackson, 1967) [7]

The chemical composition of organic manures which were used for experiment are given in the Table 2.

Table 2: Chemical composition of organic manures used in the experiment.

Organic manure	Percent Nitrogen	Percent Phosphorus	Percent Potassium
Farmyard Manure	0.5	0.15	0.5
Sheep Manure	0.7	0.4	0.3
Vermicompost	2.0	1.03	0.8

Result and Discussion

Soil chemical characteristics

The data (Table-3) regarding soil chemical characteristics viz. pH and organic carbon as influenced by various nutritional treatments after the harvest of lettuce crop. The data indicates that the application of vermicompost along with inorganic fertilizers and biofertilizers (50% RFD + vermicompost @ 4 t ha^{-1} + biofertilizers) noticed lower pH (6.65). The decrease in soil pH could be attributed to the production of organic acids like lactic acid, formic acid and oxalic acid. Carbonic acid produced during decomposition of vermicompost could have narrowed down the C/N ratio and hence leads to more decomposition, more microbial population, enhanced biological conservation and higher build-up of organic carbon. Similar findings were reported by Mujiyati and Supriyadi (2009) [8], Esteffanous *et al.* (2003) [3], Perumal *et al.* (2003) [10] and Walia and Kler (2005).

Table 3: Role of inorganic fertilizers, organic manures and biofertilizers on soil ph and organic carbon.

Treatment	Treatment combination	pH	Organic carbon (%)
T_1	120 kg N ha^{-1} + 90 kg P ha^{-1}+ 60 kg K ha^{-1} (RFD)	6.84	0.95
T_2	Farmyard manure (@ 24 t/ha.)	7.02	0.94
T_3	Vermicompost (@ 8 t/ha.)	6.96	1.08
T_4	Sheep manure (@ 17 t/ha.)	7.00	0.93
T_5	60 kg N ha^{-1} + 45 kg P ha^{-1}+ 30 kg K ha^{-1}+ FYM(12 t ha^{-1})	6.80	1.04
T_6	60 kg N ha^{-1} + 45 kg P ha^{-1}+ 30 kg K ha^{-1}+ Vermicompost (4 t ha^{-1})	6.79	1.15
T_7	60 kg N ha^{-1} + 45 kg P ha^{-1}+ 30 kg K ha^{-1}+ Sheep manure(8.5t ha^{-1})	6.74	0.99
T_8	60 kg N ha^{-1} + 45 kg P ha^{-1}+ 30 kg K ha^{-1}+ FYM(12 t ha^{-1})+Biofertilizers @ 7.5 l ha^{-1}	6.66	1.07
T_9	60 kg N ha^{-1} + 45 kg P ha^{-1}+ 30 kg K ha^{-1}+ Vermicompost (4 t ha^{-1}) + Biofertilizers @ 7.5 l ha^{-1}	6.65	1.15
T_{10}	60 kg N ha^{-1} + 45 kg P ha^{-1}+ 30 kg K ha^{-1}+ Sheep manure(8.5t ha^{-1})+Biofertilizers @ 7.5 l ha^{-1}	6.67	1.06
T_{11}	120 kg N ha^{-1} + 90 kg P ha^{-1}+ 60 kg K ha^{-1} + Biofertilizers @7.5 l ha^{-1}	6.73	1.04
T_{12}	60 kg N ha^{-1} + 45 kg P ha^{-1}+ 30 kg K ha^{-1}+ Biofertilizers @ 7.5 l ha^{-1}	6.75	0.86
T_{13}	Control	7.15	0.63
C D (P=0.05)		N.S	N.S

Nutrient availability

The data presented in Table 4. Regarding soil available-N, P and K revealed significant variation Maximum availability of nitrogen (272.06 kg ha^{-1}), phosphorus (27.19 kg ha^{-1}) and potassium (162.73 kg ha^{-1}) were observed with the application of 120 N kg ha^{-1}+ 90 P kg ha^{-1}+ 60 K kg ha^{-1}. The decrease in available nitrogen, phosphorus and potassium compared to T_1 (RFD) could be attributed to the increased removal by the crop for its growth and development. Maximum available nitrogen after crop harvest was recorded in T_1 (120 N kg ha^{-1} + 90 P kg ha^{-1}+ 60 K kg ha^{-1}), which might be due to less uptake by the crop. The readily available form of nitrogen, phosphorus and potassium supplied through application of chemical fertilizers might have led to increased level of these nutrients after harvest of the crop.

The maximum nutrient availability after crop harvest in T_1 (RFD) might also be due to low yield recorded as compared to the treatments where it was integrated with organic fertilizers. The maximum growth and yield of the crop recorded by integration of chemical fertilizers with organic fertilizers might also be due to highest uptake by crop in these treatments, due to which the availability of nutrients after harvest had reduced. These results are in conformity with Wani (1983) [16], Talib (1984) [12] and Talib and Verma (1990) [13].

Table 4: Influence of inorganic fertilizers, organic manures and biofertilizers on nutrient availability and leaf yield of Lettuce cv. LS-2.

Treatment	Treatment combination	Available N (kg ha^{-1})	Available P (kg ha^{-1})	Available K (kg ha^{-1})
T_1	120 kg N ha^{-1} + 90 kg P ha^{-1}+ 60 kg K ha^{-1} (RFD)	272.06	27.19	162.73
T_2	Farmyard manure (@ 24 t/ha.)	246.87	18.23	146.91
T_3	Vermicompost (@ 8 t/ha.)	248.93	19.11	148.22
T_4	Sheep manure (@ 17 t/ha.)	247.55	18.85	147.78

T_5	60 kg N ha^{-1} + 45 kg P ha^{-1}+ 30 kg K ha^{-1}+ FYM(12 t ha^{-1})	251.53	21.22	155.21
T_6	60 kg N ha^{-1} + 45 kg P ha^{-1}+ 30 kg K ha^{-1}+ Vermicompost (4 t ha^{-1})	253.22	22.46	157.91
T_7	60 kg N ha^{-1} + 45 kg P ha^{-1}+ 30 kg K ha^{-1}+ Sheep manure(8.5t ha^{-1})	252.09	21.97	156.19
T_8	60 kg N ha^{-1} + 45 kg P ha^{-1}+ 30 kg K ha^{-1}+ FYM(12 t ha^{-1})+Biofertilizers @ 7.5 l ha^{-1}	258.32	23.01	158.09
T_9	60 kg N ha^{-1} + 45 kg P ha^{-1}+ 30 kg K ha^{-1}+ Vermicompost (4 t ha^{-1}) + Biofertilizers @ 7.5 l ha^{-1}	260.11	24.22	159.13
T_{10}	60 kg N ha^{-1} + 45 kg P ha^{-1}+ 30 kg K ha^{-1}+ Sheep manure(8.5t ha^{-1})+Biofertilizers @ 7.5 l ha^{-1}	259.92	23.81	158.27
T_{11}	120 kg N ha^{-1} + 90 kg P ha^{-1}+ 60 kg K ha^{-1} + Biofertilizers @7.5 l ha^{-1}	269.23	26.11	160.11
T_{12}	60 kg N ha^{-1} + 45 kg P ha^{-1}+ 30 kg K ha^{-1}+ Biofertilizers @ 7.5 l ha^{-1}	225.58	17.82	141.22
T_{13}	Control	168.21	13.14	125.17
C D (P=0.05)	0.25	4.25	1.41	0.46

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