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Effect of integrated nutrient management on availability of nutrients, uptake and yield of pea (*Pisum Sativum* L.)

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Abstract
A field experiment was conducted during 2014-15 and 2015-16 at the experimental farm of Department of Soil Science and Water Management, Dr. Y.S. Parmar University of Horticulture and Forestry, Nauni-Solan, Himachal Pradeh. To study the effect of integrated nutrient management on availability of nutrients, uptake and yield of pea (*Pisum Sativum* L.). The experiment was laid out in randomized block design with nine treatments and three replications. The experiments were conducted for two years in pea and tomato cropping sequence where in, recommended dose of fertilizer was substituted with organic at three levels (10, 20 and 30 per cent). The higher rates of fertilizer in the tune of 10, 20 and 30 per cent over recommended dose has also been tried to arrive at concrete and conclusive results. These results revealed that application of 130% NPKM (50:50 of FYM and VC as per N content) resulted significantly highest available N (410.36 kg/ha), P (71.50 kg/ha) and K (308.81 kg/ha) and organic carbon (12.57 g kg^{-1}). The pod yield of pea (162.27q/ha) was maximun in T_3 (80% NPKM + 20% N through FYM and VC (50:50)+PGPR) treatment and uptake was also highest in the same treatment (T_3) as compare to other treatments.

Keywords: Organic carbon, available nutrients, yield of pea and Nutrient uptake

Introduction
Pea (*Pisum sativum* L.) belongs to family Fabaceae, is a nitrogen fixing leguminous plant. It is an important vegetable crop in many parts of the world including arid and semi-arid regions. In India, it is grown mainly as a winter vegetable in the plains of north and central parts and as a summer vegetable in the hilly regions of the country, occupying an area of 442 thousand hectare with annual production of 4239 thousand metric tones. In Himachal Pradesh, it occupies an area of 23.67 thousand hectare with annual production of 280.23 thousand metric tones (NHB, 2013) [15]. Himachal Pradesh has rich biodiversity and varied agro climatic conditions which are highly suitable for growing diverse vegetables round the year. Amongst the vegetables grown in these regions, the demand for garden pea for its green pod is gaining importance in farming community. Among various factors that affect the growth and yield of garden pea, soil fertility and cultural practices including management play a crucial role. Thus, the required productivity and sustainability can be achieved by integrating several optimum nutrient management practices (Singh and Biswas 2000) [18]. 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) [3] However, their average yield is low due to unbalanced fertilizers use of sub-optimal doses of nutrients in an unbalanced proportion led to sever depletion of nutrients reserve in Indian soils, causing multiple nutrient deficiencies and decline in crop productivity. No single source of plant nutrients i.e chemical fertilizers, organic manure, crop residues or biofertlizers can meet the entire nutrient demand of crops in intensive agriculture. The integrated plant nutrient supply, envisaging conjuctive use of fertilizers and other nutrient sources of organic and biological origin is an ideal approach to maintain soil health, increase productivity.

Material and Methods
A field experiment was conducted during 2014-15 and 2015-16 at the experimental farm of Department of Soil Science and Water Management, Dr. Y.S. Parmar University of

Horticulture and Forestry, Nauni- Solan, H.P.). It is located at 30° 52' N latitude and 77° 11' E longitude and elevation of 1175 m above mean sea level having average slope of 7-8 percent. The experimental soil having pH (6.67), EC (0.38 dS m^{-1}), Organic Carbon (10.98 g kg^{-1}). With regard to soil fertility status Available N (351.78 kg ha^{-1}), Available P (56.89 kg ha^{-1}) and Available K (257.69 kg ha^{-1}). The experiment was laid out in Randomized Block Design with nine treatments and three replications viz. T_1-Absolute control, T_2- 70% NPKM + 30% N through FYM and VC (50:50), T_3 -80% NPKM + 20% N through FYM and VC (50:50), T_4 -90% NPKM +10% N through FYM and VC (50:50), T_5- 100% NPK + 100% FYM, T_6 -100% NPK +100% VC (equivalent to FYM as per N content), T_7 -110% NPKM (50:50 of FYM and VC as per N content), T_8 -120% NPKM (50:50 of FYM and VC as per N content) and T_9 - 130% NPKM (50:50 of FYM and VC as per N content). The recommended dose (100% RDN) of inorganic fertilizer was 100 kg ha^{-1} N, 375 kg ha^{-1} P_2O_5 and 100 kg ha^{-1} K_2O to the pea crop. In these treatments NPK was applied uniformly N applied according to the treatments. The two organic sources used for the study viz. FYM and vermicompost, respectively. Pea variety used was Azad Pea-1 were sown in well prepared raised nursery beds two month before transplanting with the spacing of 60x10 cm. The full dose of FYM, Vermicompost, P, K fertilizers and 1/3 dose of N were applied at the time of field preparation as a basal dose. The rest of 1/3 dose of N was applied after one month of transplanting and the remaining N was applied after two month of transplanting. Vermiwash (1:8), and Biopesticides were used in experiment at 10 days interval during experiment for proper management of crop. Plant samples collected at final harvest (Piper, 1966) [16]. Pod yield was recorded treatment wise at each harvest. Soil samples collected at harvest of the crop and were analyzed for available N, P_2O_5 and K_2O.

Result and Discussion

Soil properties

Application of organic manure has significant effect on Ph, EC and organic carbon of soil Table 1. pH and EC has non significant effect, whereas the organic carbon is influenced by different INM treatments. Application of 130% NPKM (50:50 of FYM and VC as per N content) produced significantly maximum organic carbon (12.57g kg^{-1}) may be due to the incorporation of organic material in the soil and increase in number and activity of micro organisms and better regulation of organic carbon dynamics in soils. An increase in the soil organic matter leads to an improvement in the nutrient status of the soil. These results are in consonance with those of Choudhary *et al.* 2005 [7] and Choudhary *et al.* 2014 [6] are also in agreement with the above findings. Available nutrients in soil and nutrient content in Pea plant and nutrient are furnished in Table 2. Application of 130% NPKM (50:50 of FYM and VC as per N content) i.e T_9 registered significantly highest nitrogen was recorded under T_9 (410.36 kg ha^{-1}) which was statistically at par with T_8 (408.13 kg ha^{-1}) and T_3 (404.14 kg ha^{-1}) whereas, highest available phosphorus was recorded in T_9 (71.50 kg ha^{-1}) which is statistically at par with T_8 (71.05 kg ha^{-1}), T_3 (69.52 kg ha^{-1}), T_7 (68.66 kg ha^{-1}) and minimum value was recorded under T_1 i.e. 46.23 kg ha^{-1} and highest available K (308.81 kg ha^{-1}) was recorded under T_9 although INM has resulted some variations in the N,P and K content in pea but the effect was not marked. The higher the value of NPK in soil at harvest may be the residual effect of applied nutrients and favorable effect of integrated nutrient management in extracting the various nutrients from soil bye the crop and greater mineralization of FYM due to synergistic effect of dual inoculation of nitrogen fixer and phosphobacteria Bhardwaj *et al.* 2012 [17] and Kumar and Prasad (2008) [12]. Nutrient contents are also furnished in Table 2 higher N content was recorded in treatment T_3 (5.23 %), highest leaf P was recorded under T_3 (0.68 %) which was statistically at par with T_9 (0.66 %) and lowest in T_1 (0.31 %) treatment and higher leaf K was recorded under T_3 (3.22 %) treatment and lowest in T_1 (2.01 %) treatment. Reported that major leaf nutrients i.e. N, P and K were recorded significantly more when plants were treated with 80% NPKM + 20% N through FYM and VC (50:50)+ PGPR. The increased leaf nutrient content might be due to the beneficial effect of Vermicompost brought about by presence of macro and micronutrients and vital plant promoting substances in Vermicompost Anita and Prerna (2003) [1] and Arancon *et al*. (2006).

Yield and uptake

Integrated nutrient management had profound influence on both yield and uptake (Table 3). The highest yield (162.27 q/ha) and uptake (66.25 kg/ha) of N, P (11.13 kg/ha) and K (51.38 kg/ha) at harvest was recorded in the treatment receiving 80% NPKM + 20% N through FYM and VC (50:50) + PGPR T_3 and it was on par with which was T_9 and T_8. Lowest yield was recorded in T_1 (125.27 q/ha) and lowest N (39.48 kg/ha), P (6.74 kg/ha) and K (30.38 kg/ha) was recorded in the T_1 (Control) treatment. The increase in pea yield may be attributed to the beneficial effect of combined use of organics with balanced inorganic fertilization to the extent of 80% NPKM + 20% N through FYM and VC (50:50) + PGPR. These results indicated importance of FYM and vermicompost which supplied secondary and micronutrients in addition to NPK. These results also brings out the need for integrated nutrient management in the production of pea. Results obtained in the present study are in consonance with those of De *et al.* (2006) [9], Jaipaul *et al.* (2011) [11], Ghosh *et al.* (2014) [10] and Kumawat *et al.* (2015) [13] in Pea. The higher uptake of nutrients may be attributed to The increased uptake of the nutrients under balanced NPK supply was due to many intricate factors enabling better root (and shoot) growth facilitating in better absorption of water and nutrient from soil (Datt *et al*. 2003) [8], Sepehya *et al.* (2012) [17] and Chaitanya *et al.* (2013) [5], Meena *et al.* (2016) [14].

Table 1: Effect of integrated nutrient management on pH, EC and organic carbon in pea

Treatments	pH (1:2)	EC (dS m^{-1})	Organic Carbon (g kg^{-1})
T_1: Absolute control	6.18	0.33	10.39
T_2: 70% NPKM + 30% N through FYM and VC (50:50)	6.32	0.48	12.21
T_3: 80% NPKM + 20% N through FYM and VC (50:50)	6.31	0.38	12.39
T_4: 90% NPKM +10% N through FYM and VC (50:50)	6.35	0.37	12.25
T_5:100% NPK + 100% FYM	6.23	0.39	11.18
T_6:100% NPK +100% VC (equivalent to FYM as per N content)	6.25	0.43	11.82
T_7:110% NPKM (50:50 of FYM and VC as per N content)	6.55	0.39	12.32
T_8:120% NPKM (50:50 of FYM and VC as per N content)	6.72	0.42	12.49
T_9:130% NPKM (50:50 of FYM and VC as per N content)	6.74	0.47	12.57
CD (0.05)	ssNS	NS	0.08

Table 2: Effect of integrated nutrient management on nutrient availability at harvest in soil and nutrient content in pea.

Treatments	Available nutrients			Nutrient content (%)		
	N (kg/ha$^{-1)}$	P (kg/ha$^{-1)}$	K (kg/ha$^{-1)}$	N	P	K
T_1: Absolute control	304.90	46.23	229.48	4.05	0.31	2.01
T_2: 70% NPKM + 30% N through FYM and VC (50:50)	381.27	64.23	288.35	5.01	0.56	2.15
T_3: 80% NPKM + 20% N through FYM and VC (50:50)	404.14	69.52	291.33	5.23	0.68	3.22
T_4: 90% NPKM +10% N through FYM and VC (50:50)	387.53	66.86	283.29	5.06	0.60	2.37
T_5:100% NPK + 100% FYM	360.57	60.56	271.10	4.58	0.49	2.05
T_6:100% NPK +100% VC (equivalent to FYM as per N content)	374.61	61.90	276.29	4.63	0.52	2.06
T_7:110% NPKM (50:50 of FYM and VC as per N content)	399.38	68.66	290.05	5.07	0.61	3.03
T_8:120% NPKM (50:50 of FYM and VC as per N content)	408.13	71.05	298.38	5.10	0.63	3.11
T_9:130% NPKM (50:50 of FYM and VC as per N content)	410.36	71.50	308.81	5.12	0.66	3.17
CD (0.05)	6.22	2.22	6.28	0.09	0.03	0.06

Table 3: Effect of integrated nutrient management on yield and nutrient uptake in Pea crop.

Treatments	Yield (q/ha)	Nutrient Uptake (kg/ha)		
		N	P	K
T_1: Absolute control	125.27	39.48	6.74	30.38
T_2: 70% NPKM + 30% N through FYM and VC (50:50)	142.56	53.96	9.71	44.70
T_3: 80% NPKM + 20% N through FYM and VC (50:50)	162.27	66.25	11.13	51.38
T_4: 90% NPKM +10% N through FYM and VC (50:50)	142.64	55.42	9.13	45.77
T_5:100% NPK + 100% FYM	131.61	49.83	8.50	45.20
T_6:100% NPK +100% VC (equivalent to FYM as per N content)	135.29	55.16	8.58	45.19
T_7:110% NPKM (50:50 of FYM and VC as per N content)	149.15	57.94	9.98	45.85
T_8:120% NPKM (50:50 of FYM and VC as per N content)	153.50	58.77	10.12	48.78
T_9:130% NPKM (50:50 of FYM and VC as per N content)	160.50	61.06	10.37	49.24
CD (0.05)	7.59	4.05	0.70	4.91

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