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Effect of different organic and inorganic nitrogenous fertilizers on growth, yield and soil properties of pea (*Pisum sativum* L.)

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Abstract
A field experiment was conducted during *rabi* seasons of 2016-17to find out the effect of Effect of Different Organic and Inorganic Nitrogenous Fertilizers on growth, yield and Soil properties of Pea" (*Pisum sativum* L.) at research farm of Uttaranchal (P.G) College of Bio Medical Sciences and Hospital, Dehradun. The experiment compromised of 8 treatments and combination where control (T_1), NPK (T_2), FYM (T_3), Vermicompost (T_4), NPK + FYM (T_5), NPK + Vermicompost (T_6), NPK + FYM + Vermicompost (T_7) and FYM + Vermicompost (T_8) were applied to all the treatments. The treatments were laid in Randomised Block Design (RBD) with 3 replication of each treatment. The variety of pea used was Arkel. Observations on growth, yield attributing characters and yield recorded and analysed statistically. All the treatments better response to growth and yield attributes over control. Among the various treatment T_7 (NPK + FYM + Vermicompost) proved superior with increased plant height, number of leaves per plant, number of branches per plant, number of pods per plant, number of seed per pod, seed yield. The treatment T_7 also recorded higher value of soil available N, P_2O_5 and K_2O after the crop harvest and lowest was recorded in T1 (control). Next to T_7 the treatment T_5 (NPK + FYM) showed better response to growth attributes, seed yield and after crop harvest, soil available N, $P_2O_5$and K_2 than the rest of the treatments. It is concluding that the bio-fertilizer showed the significant difference. It is suggested that bio-fertilizer may be effective not only sustaining crop productivity and in soil health, but also in supplementing chemical fertilizer of crop.

Keywords: integrated nutrient management, sustainable, organic manure, pea, soil fertility, yield

Introduction
Pea (*Pisum sativum* L.) is one of the most important ancient vegetable and belongs to the family Leguminaceae. It is one of the most sustainable vegetable crops grown in India. Being nitrogen fixing legume, its value has long been recognized as a soil fertility building crop. Its cultivation maintains soil fertility through biological nitrogen fixation in association with symbiotic rhizobium prevalent in its root nodules and thus plays a vital role in fostering sustainable agriculture (Negi *et al.*, 2006) [5]. Nitrogen nutrition is one of the paramount factors which influence growth and yield potential of many different vegetable crops. Suitable application of nitrogen to the growing pea plants was extensively studied by many investigators to attain favourable enhancing effects on growth, yield and quality.It also aids to soil health and provides quality of fodder for cattle. Multiple nutrient deficiencies are reported due to continuous use of only chemical fertilizers, reduction in production per unit area and deterioration of soil health (Kumpawat, 2010) [4]. Use of organic manures alone or in combination with chemical fertilizers will help to improve physico-chemical properties of the soils. Organic manures provide many nutrients, substrate for the growth of microorganisms, reduce the soluble and exchangeable aluminum temporarily by forming complexes and or chelates with organic substances in acidic soils and providing favorable environment for plant growth and also improved physical, chemical and biological properties (Chettri and Bandhopadhaya, 2005) [1]. The objective of this research was to evaluate the effect of organic and inorganic fertilizers on the growth, yield and quality of Pea and on soil properties. Accordingly, the present study was conducted to investigate the influence of seed inoculation with different bio-fertilizer types and various nitrogen fertilizer levels as well as their different interactions on vegetative growth, flowering traits, green pods yield and its components, and chemical composition of pea plants.

Materials and Methods
The present investigation entitled Effect of Different Organic and Inorganic Nitrogenous Fertilizers on growth, yield and Soil properties of Pea" (*Pisum sativum* L.) was carried out

during 2016 - 2017 at research farm of Uttaranchal (P.G.) College of Bio-Medical Sciences and hospital, Dehradun to standardize the optimum dose of organic nitrogenous and inorganic nitrogenous fertilizer for obtaining best growth, flowering and production. The experiment was laid out in randomized block design with three replications. The Arkel variety of pea crop was selected for this study. Experiment comprised 8 treatments, which are: T1(Control), T2 (NPK100%), T3 (FYM @10t/ha), T4(Vermi-compost @ 10t / ha), T5 (NPK 100% + FYM @ 10t / ha), T6 (NPK 100% + Vermi-compost @ 10t / ha), T7 (NPK 100% + Vermi-compost @ 10t / ha +FYM @ 10t / ha), T8 (Vermi-compost @ 10t / ha + FYM @ 10t / ha).Pea, variety Arkel was shown on 24th of November, 2016 at the seed rate of 70kg/ha. The seeds were placed 3-4 cm deep in the open furrow distance of 30 cm row to row and 8 to 10 cm plant to plant and then covered with a thin layer of soil.The pods of garden pea were harvested in three pickings at weekly intervals. At 30 days after sowing a light hoeing with khurpi was done to remove the weeds along with the thinning operations maintaining a plant spacing of 8 to 10 cm. A second weeding was done at 60 DAS and all the cultural practices were followed as per package of practices. To avoid drought condition and to save crop plant three lifesaving irrigation were given during the crop growth. The data on various growth parameters and yield attributes characters, nodule and pod yield were recorded under various treatments. Data were collected from five plants of each plot (one replication). Before sowing composite soil samples representing the whole field and after harvest plot wise samples were collected. The organic carbon, pH, available N, P andK were analyzed as per the method described by Jackson (1973) [3]. For determination of performance of variety over treatment Randomized Block Design was applied. Performance of variety over treatment was determined by applied one- factor ANOVA. Test of significance were recorded on the basis of CD differences at 5% and 1% level of significance.

Result and Discussion

Growth and yield Parameters

Plant height (cm)

A perusal of data in table revealed that there were significant differences in the plant height among the treatments in the growth stage and also in the harvesting stages (Table No.1). The highest plant height was recorded in the treatmentT_7 (NPK+FYM+ Vermi-compost) (64.88), followed by T_5 (NPK+FYM) (48.54) and lowest was recorded in T_1 (Control) (27.67). At the harvesting the maximum plant height was found in treatment T_7 (NPK+FYM+ Vermi-compost) while the lowest plant height was recorded in T_1(Control). Further, it was also observed that all the other treatments were significantly better in plant height than the control treatment (Table 4).

Number of leaves per plant

At the stages of growth the significant differences were observed in number of leaves per plant among the treatments Table 1). In such stage the highest number of leaves was recorded in the treatment T_7 (NPK + FYM + Vermi-compost) followed by T_5 (NPK+FYM) and the lowest was recorded in control. At the harvesting stage the treatment T_7 and T_5 showed values of 43.67 (pooled data) and 40.91 (pooled data) respectively while lowest atT_1 only 26.54 leaves per plant in pooled data. (Table 4).

Number of branches per plant.

The data showed that there were significant differences in number of branches per plant among the treatment (Table 1). The treatments T_7 produced highest number of branches i.e.17.87 branches per plant (pooled data, followed by T_6i.e. 17.12 and the least with T_1 i.e. 6.46 (pooled data). At the harvesting also the number of branches per plant was recorded highest with the treatment T_7 and lowest with control. (Table 4).

Fresh shoot weight

The highest weight of fresh weight was recorded in the treatment T_7 (NPK + FYM + Vermi-compost) (20.33) and lowest with T_4 (FYM) (11.62) as shown in (Table 4). All the treatment also showed the significant difference due to different treatments. (Table 1).

Fresh root weight

After that we clean up the roots from dirt and soil without breaking it and we weight the fresh root. The data showed that there were significant differences in fresh root weight among the different treatment (Table 1). Highest fresh root weight was observed in T_1which is 1.91, followed by T_2(1.73), T_3(1.54), T_4(1.96), etc (Table 4).

Dry shoot weight

We dry up the arial parts of the plants part by the help of sunlight and hot air oven. After drying we take the weight of dry shoot. As the plant size is bigger in T_7 (NPK + FYM + Vermi-compost) the weight of the plant also highest in T_7 and lowest observed in control. In T_7 and T_1 we recorded the data was 3.84 gm and 1.21 gm respectively (Table 4).

Dry root weight

We also take the weight of dry root weight. We observed that the highest weight of dry root weight was in the treatment T_7 (NPK + FYM + Vermi-compost) and the lowest weight of dry root weight was recorded in the treatment T_1 control that was 0.48 in T_7 and 0.19 in T_1(Table 4).

Number of nodules per plant.

The perusal of data in table indicated that the number of nodules per plant irrespective of the different treatments increased from 45 DAS to 60 DAS and declined afterwards in the experimental period. (Table 2)

The number of nodules was highest in the treatment T_7 i.e. (NPK + FYM + Vermi-compost) (39.08) and lowest in the treatment T_1 control (21.91). (Table 4)

Fresh and dry weight of nodules.

After taking the data of number of nodules per plant we take the weight of fresh and dry nodules. Results showed the significant difference for fresh and day nodules due to different treatments (Table 2). We find that the highest fresh weight of nodules is in T_7 (NPK + FYM + Vermi-compost) (4.02) and followed by T_5 (NPK + FYM) (3.49) and the lowest was recorded in the treatment T_1 i.e. control (2.67).After that we record the weight of dry nodules by drying up in hot air oven. The highest data was recorded in the treatment T_7 i.e. (NPK + FYM + Vermicompost) (1.44) it is because the nodules size is much larger in the treatment T_7. And the lowest data was recorded in the treatment T_1 i.e. control (0.89) (Table 5).

Number of pods per plant

A perusal of table 4.4 revealed that the number of pods per plants showed significant difference among the treatments (Table 2). We find that the highest number of pods is in treatment T_7 i.e. NPK + FYM + Vermi-compost) we find that 34 (pooled data) pods per plants in t_8 and the lowest number of pods is in treatment T_1 i.e. control, we find 7.58 (pooled data) pods per plants. After analysis the data we find that there is a highly significant in the treatment T_7 but there in insignificant in other treatment (Table 5).

Number of seed per pods.

The data furnished in the table revealed that the number of seeds per pod differed significantly among the treatments (Table 2). Among the treatments the highest number of seeds per pod was recorded in the treatment T_7 i.e. NPK + FYM + vermin-compost with 8.33 (pooled data) and the lowest number of seed per pod was recorded in the treatment T_1 control with 5.50 (pooled data). After analysed my data, we find that there is a highly significant in the treatment T_7 but there is insignificant in other treatment (Table 5).

Number of seed per plant.

The data furnished in the table revealed that the number of seeds per plant differed significantly among the treatments (Table 2). Among the treatments the highest number of seeds per plant was recorded in the treatment T_7 i.e. NPK + FYM + vermin-compost with 267.55 (pooled data) and the lowest number of seed per plant was recorded in the treatment T_1 control with 42.33 (pooled data). After analysed my data, we find that there is a highly significant in treatment T_7 but there is insignificant showed in other treatment (Table 5).

Test weight (1000 seeds weight).

The table revealed that the weight of 1000 seed is highly affected significantly by the different treatments **(**Table 2). The highest recorded was in the treatment T_7 i.e. NPK + FYM + Vermi-compost with 306.66 gm (pooled data) and the lowest was found in the treatment t_1 control with 170.66 gm (pooled data). According to the data analysis we find the there is a highly significant in test weight in the treatment T_7 but there is non -significant showed in other treatment (Table 5).

Seed yield

The perusal of the table clearly indicated that the different treatment responded highly significantly in the seed yield (Table 3). Among the treatment, T_7 (NPK + FYM + Vermi-compost) produced the maximum seed yield i.e., 19.50 q/ha (pooled data) and the lowest was recorded in the treatment T_1 i.e., control with 13.83 q/ha. We find that there is a highly significant in terms of seed yield in the treatment T_8 but it showed that there is insignificant in other treatment (Table 5).

Straw yield.

The different treatments responded significantly to straw yield in experimental periodis shown in Table 3. The treatment T_7 showed the highest straw yield i.e., 27.91 q/ha and the lowest straw yield was recorded in the treatment control with 19.91 q/ha (Table 5).

All the growth parameters like plant height, number of leaves, number of branches, fresh shoot weight, fresh root weight, dry root, and dry shoot etc. showed the significant difference except root fresh weight due to the different organic and inorganic treatments. Our results closely related to the results of Sanyal, 2001 [7] who suggest that this might be due to the combined application of organic manures along with inorganic sources and bio fertilizers, produced the best response on growth parameters due to high initial microbial load supported by sufficient quantity of organic carbon to be later used for microbial proliferation and consequently releasing the nutrients that readily assimilates, supporting the biotic principle of carbon sequestration through improved biomass production.

And all the yield contributing characteristics like number of seed, test weight, seed yield, and straw yield showed the significant differences due to different treatments. This might be due to integration of organic and inorganic sources of nutrients enhanced the growth and nodulation of crop and in turn produced more pod yield (Gopinath and Mina, 2011) [2]. Such response of integrated combination was due to relatively high nutrient concentration and initial microbial population helped in mobilizing the unavailable pool of nutrients in soil, thereby triggering the acquisition of optimum nutrient supply across critical crop stages (Pandey *et al*, 2006) [6].

Soil properties after crop harvesting

Organic carbon (%) of soil

The careful study of the data indicated that the organic carbon differed significantly among the different treatments (Table 3). It was observed that there was increase in the soil organic carbon in all the treatments from the initial value (4.05) and the increase was more pronounced in the treatments receiving organic manures. The highest value of organic carbon is in the treatment T_7 (NPK + FYM + Vermi-compost) i.e. 4.75% and closely followed by the Treatment T_8(Vermi-compost + FYM) i.e. 4.22 and the lowest was recorded in the treatment control i.e. 3.16% (Table 6).

Soil pH

The data revealed that the pH of the soil after crop harvested decreased from the initial value (5.60) in all the treatment and the difference was not significant (Table 3).The pH decreased more in the treatment where organic manure was incorporated into the soil. The highest value of pH was recorded in the treatment T_7 i.e. 5.41 (Table 6).

Available soil nitrogen (N)

The perusal of the table indicated that there was significant increase in available soil nitrogen in all the treatments except T_1 (control) after the crop harvest from the initial value of available nitrogen (436.60 kg N/ha) (Table 6).

The difference in the increase of available soil nitrogen was significant among the different treatments. The highest increase in available nitrogen was estimated in the treatment T_7 (NPK + FYM + Vermi-compost) i.e. 483.30 kg N/ha and followed by T_6 (NPK + Vermi-compost) i.e. 475.10 kg N/ha and the lowest data was recorded in the treatment T_1 control i.e. 457.15 kg N/ha but it increased from the initial recorded i.e. 436.60 kg N/ha. So it is highly significant (Table 3).

Available soil phosphorus (P_2O_5)

There was significant increase in soil available P_2O_5 after crop harvest except in the controlfrom the initial value of 45.16 kg P_2O_5/ha. The treatment T_7 (NPK + FYM + Vermi-compost) recorded the highest increase in P_2O_5 i.e. 62.70 kg P_2O_5/ha and followed by T_5 (NPK + FYM) i.e. 54.62 kg P_2O_5/ha. However, the available P_2O_5 decreased tremendously from the initial value in the control i.e. 36.33 kg P_2O_5/ha (Table 6).

Available soil potassium (K_2O)

Result showed that the available soil K_2O increased from the initial value of 403.2 kg K_2O/ha, after crop harvest. The increase in the soil K_2O after crop harvest was significant among the different treatments (Table 3). The highest increased in soil available K_2O was estimated in T_7 (NPK + FYM + Vermi-compost) i.e. 420.23 kg K_2O/ha and was followed by T_6 (NPK + Vermi-compost) i.e. 419.18 kg K_2O/ha and the lowest was estimated in T_1 (control) i.e. 408.86 kg K_2O/ ha (Table 6).

Application of organic manure alone or in combination of inorganic sources and bio-fertilizer showed significant effect on soil properties. All the treatments recorded significantly higher level of available N in soil after crop harvesting over control. Available P and K in soil were also recorded maximum with the integrated use of organic manures, bio fertilizers and inorganic sources. These observations are in close conformity with observations made by Sanyal (2001) [7], who observed build-up in soil organic matter following the application of organic manures.

Soil organic carbon content was also increased with the incorporation of organic manures in the soil. Confirming that most of the organic manures are effective building up the organic carbon status of soil since microbial abundance helped in sequestering the mineralized carbon from organic manures and loading in to the soil carbon pool Singh *et al.* (2016) [8].

Conclusion

Based on the finding of field experimentation, the seed yield of 19.50 q/ ha (pooled data) can be obtained from the application of NPK 100kg/ha + FYM 10t/ha + Vermi-compost 10t/ha. The fertility status of the soil was also markedly improved after the crop harvest in this treatment by recording higher values of available nitrogen, P_2O_5 and K_2O. So, this treatment combination was found to be the best among the various treatment of combination.

In case the above treatment could not be taken up due to some difficulties, than the application of NPK 100kg/ha + FYM 10t/ha is the better treatment which a higher seed yield of 18.33 q/ha (pooled data). It is concluding that the bio-fertilizer showed the significant difference. It is suggested that bio-fertilizer may be effective not only sustaining crop productivity and in soil health, but also in supplementing chemical fertilizer of crop.

Table 1: Analysis of variance (ANOVA) for different field parameters in pea

Source of variances	Df	Mean Square						
		Plant height	No. of Leaves	No. of branches	Fresh shoot weight (gm)	Fresh root weight (gm)	Dry shoot weight (gm)	dry root weight (gm)
Replication	2	19.38	1.11	1.94	1.19	0.35-E02	0.55E-01	0.12E-01
Treatment	7	326.76**	80.34**	39.67**	23.34**	0.25	1.67**	0.21E-01**
Error	14	24.20	8.65	3.88	1.33	0.13	0.12	0.45E-02

Table 2: Analysis of variance (ANOVA) for different field parameters in pea

Source of variances	Df	Mean Square						
		number of nodules per plants	weight of fresh nodules (mg)	weigth of dry nodules (mg)	Average no.of pods per plants	Average no. of seed per pods	Average no. of seed per plants	test weight (1000 seed weight)
Replication	2	2.21	0.49E-01	0.11	168.94	1.08	1799.89	731.37
Treatment	7	84.93**	0.46**	0.73E-01*	183.91*	2.32**	13467.27**	4189.89**
Error	14	1.47	0.24E-01	0.18E-01	63.92	0.32	87.79	229.61

Table 3: Analysis of variance (ANOVA) for different field parameters and soil property in pea

Source of variances	Df	Mean Square						
		Seed yield q/heactare	Straw yield q/hectar	Organic carbon %	Soil pH	Available N kg/ha	Available P_2O_5 kg/ ha	Available K_2O kg/ha
Replication	2	17.88	1.63	0.37E-01	0.18E-01	4.25	78.33	5.25
Treatment	7	9.11**	16.76**	0.57**	0.82E-02	160.73**	221.40	43.25**
Error	14	0.24	1.02	0.99E-01	0.71	9.77	108.56	3.87

*Significant at P<0.5, **significant at P<0.01

Table 4: Effect of treatments on different growth and yield of garden pea

Treatment	Plant Height (cm)	No. of leaves	No. of branch	Fresh shoot weight (gm)	Fresh root weight (gm)	Dry shoot weight (gm)	Dry root weight (gm)	No. of nodules per plant (gm)
T1	27.67	26.54	6.46	12.25	1.91	1.21	0.19	21.91
T2	42.82	39.64	11.46	13.27	1.73	2.41	0.35	32.50
T3	40.94	37.29	13.96	13.16	1.45	2.53	0.37	32.00
T4	41.78	40.25	15.69	11.62	1.96	2.86	0.33	36.91
T5	48.54	40.91	15.27	12.01	1.78	2.95	0.37	34.58
T6	39.12	37.37	17.12	13.41	2.27	3.14	0.28	36.91
T7	64.88	43.67	17.87	20.33	1.81	3.84	0.48	39.08
T8	44.39	40.75	13.98	12.83	1.35	2.69	0.38	35.83
Gm	43.77	38.30	13.97	13.61	1.78	2.70	0.34	33.71
Sem	2.84	1.69	1.13	0.66	0.21	0.20	0.38E-01	0.70
cd at 1%	11.97	7.14	4.79	2.81	0.89	0.84	0.16	2.95
cd at 5%	8.63	5.17	3.45	2.03	0.64	0.60	0.12	2.12
Cv	11.26	7.67	14.10	8.50	20.56	12.85	19.41	3.60

Table 5: Effect of treatments on different growth and yield of garden pea

Treatment	Weight of fresh nodules (gm)	Weight of dry nodules (gm)	No. of pods per plant	No. of seed per pod	No. of seed per plant	Test weight gm (1000 seed weight)	Seed yield q/ha	Straw yield q/ha
T1	2.67	0.89	7.58	5.50	42.33	170.66	13.83	19.91
T2	3.19	1.14	25.83	7.33	92.41	257.33	16.00	23.25
T3	3.31	1.20	16.08	6.50	109.08	239.33	16.34	22.33
T4	3.14	1.11	22.16	7.25	163.91	247.00	17.68	24.25
T5	3.49	1.06	18.91	6.25	119.75	258.00	18.33	25.41
T6	3.63	1.04	15.66	6.08	97.66	255.00	18.12	25.16
T7	4.02	1.44	34.00	8.33	267.55	306.33	19.50	27.91
T8	3.2	1.11	22.41	6.75	155.83	257.33	17.52	23.41
Gm	3.34	1.12	20.33	6.75	131.07	248.87	17.16	23.95
Sem	0.90E-01	0.77E-01	4.61	0.33	16.20	8.74	00.28	0.58
cd at 1%	0.38	0.32	19.43	1.39	68.19	36.81	1.21	2.46
cd at 5%	0.27	0.23	13.99	1.00	49.15	26.53	0.87	1.77
Cv	4.69	11.93	39.32	8.47	21.41	6.08	2.90	4.22

Table 6: Effect of treatments on soil properties after harvest of garden pea.

Treatment	Organic Carbon	Soil pH	Available nitrogen kg/ha	Available P2O5 kg/ha	Available K2O kg/ha
T1	3.16	5.26	457.15	36.33	408.86
T2	4.09	5.34	470.53	46.83	415.86
T3	4.02	5.31	472.43	45.29	415.66
T4	4.00	5.32	472.26	44.27	413.06
T5	3.86	5.42	474.53	54.62	418.73
T6	4.05	5.31	475.10	37.74	419.18
T7	4.75	5.41	483.30	62.70	420.23
T8	4.22	5.33	469.00	48.50	413.33
Initial status	4.05	5.60	436.60	45.16	403.2
Gm	4.02	5.34	471.79	47.03	415.61
Sem	0.18	0.48E-01	1.80	6.01	1.13
cd at 1%	0.76	0.20	7.59	25.31	4.78
cd at 5%	0.55	0.14	5.47	18.24	3.44
Cv	07.85	1.57	0.66	22.15	0.47

CD= critical deference, CV=Critical Variance, Sem= standard mean error,
GM= Grant mean, Control (without treatment)

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