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Efficacy of organic manures and bio fertilizers on growth and productivity of dwarf pea (*Pisum sativum* L.)

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Abstract
A field experiment was conducted during two consecutive Rabi seasons of 2015-16, 2016-17 at SIF farm of CSA University of Agriculture and technology, Kanpur on sandy loam soil with a view to find out the suitable organic sources and response of field pea to DAP. For this purpose, two doses of DAP (@100kg ha^{-1}, 150kg ha^{-1}) and organic sources (viz, control, Rhizobium inoculation, FYM@10t ha^{-1}, Vermicompost@2t ha^{-1}, FYM 10t ha^{-1} + Rhizobium inoculation and Vermicompost+ rhizobium inoculation) were tried in randomized block design and replicated thrice. The important observations like growth parameters, yield attributes, yield, protein content in seed and economics were recorded. Result showed that application of DAP@150kg ha^{-1} improved the growth and yield attributes and yield of dwarf pea significantly. It gave 27.81 q ha^{-1} seed yield which was 2.29 q ha^{-1} or 8.97% higher than the 100kg DAP ha^{-1}. All the organic sources proved to be over untreated plot in respect to growth, yield attributes and yield of dwarf pea. Application of vermicompost 2 t ha^{-1} + Rhizobium inoculation proved to be best as it gave highest grain yield (32.65q ha^{-1}) and economic return (Rs.52487 ha^{-1}) followed by FYM @10t ha^{-1} + Rhizobium inoculation (30.19q ha^{-1}) grain yield and Rs.47948 ha^{-1} net profit.

Keywords: FYM, vermicompost, rhizobium, DAP, dwarf pea

Introduction
India is the largest producer and importer of leguminous crop (Shakya *et al.*, 2008) [8]. Pea is the major imported pulse, followed by pigeon pea, urd bean, chickpea and mung bean and is the premier pulses grown in the world. Advent of dwarf pea cultivation like KPMR-522(Jai) had marked its best a high input pea crop responding to higher fertility and plant population for yield maximization. Since fertilizer nutrients constitute a major costly production input exploration of yield potentiality of this crop depends on the how efficiently and effectively this input is managed. Inorganic fertilizer alone cannot sustain the soil productivity as well as the large scale use of only chemical fertilizers as a source of nutrients has less efficient (Kumar *et al.*, 2003) [6]. In recent year's bio fertilizers, viz. Rhizobium, PSB and PGPR that are ecofriendly and low cost inputs have emerged as an important and integral component of integrated plant nutrient supply system for pulse crop production. Hence, to combat this problem and to sustain food production the present investigation was carried out to find out the suitable organic sources and responses of field pea to DAP.

Materials and Methods
The experiment was carried out during Rabi seasons of 2015-16 and 2016-17 at SIF farm of C.S. Azad University of Agriculture and Technology, Kanpur. The soil of experimental plot was sandy loam and neutral in reaction (pH 7.5) and low in organic carbon (0.48%), available nitrogen (120kg ha^{-1}), available phosphorus (22.0kg ha^{-1}) and potassium (270kg ha^{-1}). The experiment was laid out in randomized block design with treatments were two doses of DAP (100kg and 150kg ha^{-1}) and six organic sources (viz. control, Rhizobium inoculation, FYM@10t ha^{-1}, Vermicompost@2t ha^{-1}, FYM 10t ha^{-1} + Rhizobium inoculation and Vermicompost+ Rhizobium inoculation. As per treatment, KPMR-522 dwarf pea was sown after proper inoculation with rhizobium culture @200g culture/10kg seeds. The crop was sown @ 120kg ha^{-1} seeds in 30cm rows to maintain the plants at 10cm on 20th November and 22nd November during 2015 and 2016, respectively. The other management practices as per standard recommendation of the region. Harvesting was done on 26th February in 2016 and 3rd march in 2017.

Results and Discussion
Effect of DAP on crop growth
Number of branches per plant showed significant increase with application of DAP@150 kg ha^{-1}. It might be due to cell division in presence of increased phosphorus doses (Jones and Unysses, 1987) [5]. Increase the availability of nitrogen with higher arte of DAP may also be help full in increasing the number of branches because nitrogen is an essential component of protein and related amino acids which are critical not only as building block for plant tissues but also an integral part of cell nuclei and protoplasm (Brady, 1988) [2].

Effect of DAP on yield attributes and yield
The result showed that there was increase in number of pods per plant, pod weight/plant, number of seeds per plant, seed weight/plant, number of seeds per plant with the application of DAP @150kg ha^{-1} in comparison to DAP dose @100kg ha^{-1}. Increase in number of pods and pod characters seems to be associated with more number of branches per plant. Increased availability of phosphorus at higher rate of DAP may also be an important reason for it, because P stimulates flowers and aids in seed formation. Moreover, P play key role in root development, energy transformation, metabolic process of plant. Thus resulted in more translocation of phosphates towards the sink development (Tisdale, 1995) [10].

The biological yield, grain yield and straw yield were increased and maximum value observed with application of DAP @150kg ha^{-1}. The yield is governed by plant growth and yield attributes. The plant growth and yield attributes were significantly superior in DAP@ 150kg ha^{-1} treated plot. Grain and straw yield response of pulses to higher dose of N_2 and P_2O_5 have also reported. (Jat and Ahlawat, 2004) [4].

Effect of organic sources on growth, yield attributes and yield
Effect of Rhizobium
Rhizobium inoculation improved the growth and development of the plant and also increases the yield and yield contributing characters significantly. It increased the fresh weight per plant, pod weight per plant etc. it enhanced the grain yield by 1.49q ha^{-1} or 6.52% over untreated plot.

Rhizobium inoculation is known to enhance the supply of N to the plant through B.N.F. resulting in greater nitrogen uptake and its translocation. This will have favorable effect on development of photosynthetic organs and rate of accumulation of growth characters like plant height, number of branches and fresh and dry matter leading to higher yield attributes (El-Haidi and EL-Sheikh, 1999) [3].

Effect of FYM
With the application of FYM a significant increase was recorded in biological yield, straw yield and grain yield over control. It is because of increase growth and development of yield attributing characters. It is also increases the shelling percentage significantly. It also significantly increased the yield and its contributing characters with Rhizobium inoculation.

FYM itself is a source of primary nutrient, secondary and different micro nutrients. It forms different complexes with metal cation present in the soil and restrict their losses from system. It helps in the conversion of unavailable nutrient to available form through increased microbial activity in the soil. Besides, FYM improved the physical, chemical and biological properties of soil which provide better condition for roots and crop growth (Balyan *et al.*, 2002) [1].

The FYM+Rhizobium combination gave better environment for crop growth and nutrient availability which improved these yield attributes (Srivastava and Lal, 1994) [9].

Effect of Vermicompost
Results related to number of branches and pods per plant, yield and yield attributes revealed that application of vermicompost in combination with Rhizobium significantly promoted the pod weight and pod length, number of seeds per plant and 100 seed weight. Application of Vermicompost and Vermicompost+Rhizobium resulted in significant increase in grain, straw yield and biological yield and harvest index. Increase in the yield attributes by vermicompost finally led to higher grain and straw yield.

Incorporation of vermicompost not only increase the nutrient availability but also improves the physical properties of the soil. It also provides a substrate for growth of many microorganism and also provide all macro and micro nutrients in suitable proportion. It favors the soil microorganisms particularly Rhizobium. Thus application of vermicompost improves the overall properties of the soil leading to enhanced vegetative growth of the crop. Yield of a crop dependent on the source-sink relationship and its cumulative function of various growth parameters and yield attributing characters. It was steady supply of nutrients during entire crop growth period through vermicompost which consequently led to higher yield (Siag and Yadav, 2004) [7].

Interaction effect of organic sources and DAP
In most of the characters interaction effect was not found significant except protein content percent. The highest protein content percent was obesrved in treatment 6 (22.65%) with application of DAP@150 kg/ha.

Table 1: Effect of organic sources and DAP doses on number of branches per plant, number of pods per plant, pod length (cm) and pod weight (g).

Treatments	Organic sources							Significance		
DAP Doses	T1	T2	T3	T4	T5	T6	Mean	Factor	SE(d)	CD (p=0.05)
Number of branches/plant										
D1	3.35	3.65	4.05	4.65	5.10	5.79	4.43	DAP	0.14	0.30
D2	4.65	5.40	6.55	7.70	8.25	8.88	6.90	Organics	0.25	0.52
Mean	4.00	4.52	5.30	6.17	6.67	7.33		DxT	0.35	0.74
Number of pods/Plant										
D1	11.85	13.60	14.61	15.55	16.35	17.55	14.91	DAP	0.47	0.99
D2	13.85	16.05	18.00	19.85	23.35	24.30	19.06	Organics	0.83	1.72
Mean	12.85	14.82	16.30	17.70	19.35	20.92		DxT	1.17	NS
Pod length (cm)										
D1	4.38	4.40	4.43	4.46	4.50	4.57	4.45	DAP	0.02	0.05
D2	4.68	4.79	4.85	4.93	5.00	5.08	4.88	Organics	0.04	0.09
Mean	4.53	4.59	4.64	4.69	4.75	4.82		DxT	0.06	NS
Pod weight(gm)										

D1	11.55	13.15	14.23	15.15	15.90	16.45	14.40	DAP	0.27	0.57
D2	13.35	15.10	16.20	17.65	16.40	19.19	16.64	Organics	0.47	0.99
Mean	12.45	14.12	15.21	16.40	17.15	17.82		DxT	0.67	NS

Table 2: Effect of organic sources and DAP doses on number of seeds per pod, number of seeds per plant, 100 seed weight (g) and seed weight per plant (g).

Treatments	**Organic sources**							**Significance**		
DAP Doses	**T1**	**T2**	**T3**	**T4**	**T5**	**T6**	**Mean**	**Factor**	**SE(d)**	**CD (p=0.05)**
Number of seeds/pod										
D1	3.53	3.59	3.63	3.65	3.70	3.75	3.64	DAP	0.04	0.08
D2	3.70	3.80	3.90	4.05	4.15	4.25	3.97	Organics	0.07	0.15
Mean	3.61	3.69	3.79	3.85	3.92	4.00		DxT	0.105	NS
Number of Seeds/Plant										
D1	42.43	44.45	47.05	50.25	53.55	55.25	49.83	DAP	0.85	1.77
D2	46.90	48.35	50.65	52.33	55.05	57.35	51.77	Organics	1.48	3.07
Mean	44.68	46.40	48.85	51.29	54.30	56.30		DxT	2.09	NS
100 Seed weight (g)										
D1	22.90	23.30	23.60	23.90	24.14	24.50	23.72	DAP	0.27	0.57
D2	23.57	24.41	24.84	25.65	27.00	27.44	25.49	Organics	0.48	1.00
Mean	23.23	23.85	24.22	24.77	25.57	25.97		DxT	0.68	NS
Seed weight(g)/Plant										
D1	9.05	9.45	9.92	10.65	11.11	11.55	10.28	DAP	0.30	0.62
D2	10.35	11.07	12.12	13.07	13.98	14.85	12.57	Organics	0.52	1.08
Mean	9.70	10.26	11.02	11.86	12.64	13.20		DxT	0.74	NS

Table 3: Effect of organic sources and DAP doses on Biological yield, Straw yield, grain yield, shelling % and harvest index.

Treatments	**Organic sources**							**Significance**		
DAP Doses	**T1**	**T2**	**T3**	**T4**	**T5**	**T6**	**Mean**	**Factor**	**SE(d)**	**CD (p=0.05)**
Biological yield (q/ha)										
D1	59.60	63.19	66.07	68.85	71.63	73.60	67.15	DAP	1.23	2.56
D2	63.00	65.50	69..80	73.20	75.40	77.45	70.12	Organics	2.14	4.44
Mean	61.30	64.34	67.93	71.02	73.51	75.52		DxT	3.03	NS
Grain Yield (q/ha)										
D1	21.97	23.25	24.45	26.15	27.90	29.45	25.52	DAP	0.57	1.19
D2	23.65	25.35	26.65	28.40	30.19	32.65	27.81	Organics	0.99	2.07
Mean	22.81	24.30	25.55	27.27	29.04	31.05		DxT	1.41	NS
Straw yield (q/ha)										
D1	37.63	39.94	41.62	42.70	43.73	44.15	41.62	DAP	0.57	1.19
D2	39.35	40.15	43.15	44.80	45.21	45.80	43.07	Organics	1.00	2.07
Mean	38.49	40.04	42.38	43.75	44.47	44.97		DxT	1.41	NS
Shelling (%)										
D1	67.15	68.25	70.10	71.90	73.33	74.90	70.93	DAP	0.19	0.39
D2	69.15	71.33	73.25	75.10	77.15	79.05	74.17	Organics	0.33	0.69
Mean	68.15	69.79	71.67	73.50	75.24	76.97		DxT	0.47	NS
Harvest index (%)										
D1	36.52	36.79	37.00	37.98	38.95	40.01	37.87	DAP	D1	36.52
D2	37.52	38.70	38.18	38.79	40.03	42.01	39.22	Organics	D2	37.52
Mean	37.02	37.74	37.59	38.38	39.49	41.08		DxT	Mean	37.02

Table 4: Effect of organic sources and DAP doses on Protein content (%), Gross income, Net profit and benefit cost ratio.

Treatments	**Organic sources**							**Significance**		
DAP Doses	**T1**	**T2**	**T3**	**T4**	**T5**	**T6**	**Mean**	**Factor**	**SE(d)**	**CD (p=0.05)**
Protein content (%)										
D1	21.15	21.39	21.55	21.70	21.79	21.90	21.58	DAP	0.03	0.08
D2	21.45	21.60	21.88	21.99	22.25	22.65	21.97	Organics	0.06	0.13
Mean	21.30	21.49	21.71	21.84	22.02	22.27		DxT	0.09	0.19
Gross income Rs/ha										
D1	47703.00	50494.00	53062.00	56570.00	60173.00	63315.00	55219.50	DAP	838.51	1738.96
D2	51235.00	54715.00	57615.00	61280.00	64901.00	69880.00	59937.66	Organics	1452.35	3011.97
Mean	49463.00	52604.50	55338.50	58925.00	32537.00	66597.00		DxT	2053.93	NS
Net profit Rs/ha										
D1	32741.64	35409.44	36388.76	39455.82	43376.57	46772.00	38908.31	DAP	665.08	1379.30
D2	36118.01	39474.19	40786.14	44010.21	47948.94	52487.01	43470.75	Organics	1151.96	2389.02
Mean	34429.83	37441.81	38587.45	41733.01	45662.75	49282.31		DxT	1629.13	NS
Benefit: Cost ratio										
D1	2.180	2.347	2.182	2.305	2.582	2.637	2.372	DAP	0.07	0.16
D2	2.389	2.598	2.423	2.548	2.828	3.017	2.633	Organics	0.13	0.27
Mean	2.285	2.472	2.302	2.426	2.705	2.827		DxT	0.18	NS

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