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EFFECT OF BIOFERTILIZERS, LIME AND DIFFERENT LEVELS OF NITROGENOUS FERTILIZERS ON THE GROWTH AND YIELD OF GARDEN PEA (*Pisum sativum* L.hortense)

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Abstract: An experiment was carried out in the experimental research farm of School of Agricultural Sciences and Rural Development (SASRD), Nagaland University, Medziphema Campus, Nagaland to observe the effect of biofertilizers, lime and different levels of nitrogenous fertilizers on the growth and yield components of garden pea (*Pisum sativum* L.hortense). The experimental was carried out in Split Plot Design with three replications and consisted of sixteen treatments. Growth parameters like plant height (cm), number of branches, and number of nodules were recorded higher with the application of biofertilisers, lime and levels of nutrients over the control. Further, yield parameters like pods per plant, seeds per pod, test weight(g), length of pod(cm), seed yield(kg ha⁻¹), stover yield (kg ha⁻¹) and harvest index(%) were also enhanced with the application of biofertilisers, lime and levels of nutrients over the control. Among the N levels treatment, highest yield attributing performance with the nitrogen level 20 kg ha⁻¹.

Key words: Biofertilizer, Liming, Nitrogenous fertilizer, Garden pea.

1. Introduction: Garden pea (*Pisum sativum*) belonging to the family leguminaceae is a vegetable crop of immense economic importance in India. Pea has been a major component of human diet and livestock since prehistoric time and presently is attracting more attention as a good nutritive crop. The Mediterranean region, western and central Asia, and Ethiopia have been indicated as centres of origin of crop.

India is the largest pulse producing county, and pulses account for one fifth cultivated area and one twelfth of the total food grain production in India. The area under pulse crops at present is around 23.31 million hectare and the production is around 14.50 million tonnes with the productivity 622 kg ha⁻¹, during 2007-08. Among pulses field pea is an important crop in India having about 7.93 lakh hectare area and 7.10 metric tonnes with 895 kg ha⁻¹ of productivity. Uttar Pradesh is the major pea growing state which alone produces 60 per cent of total pea produced while Nagaland has only 6800 ha under cultivation prompting the further need of study to increase its production and productivity in respect of the growing

importance of the crop. Statistics on the international trade in pea seeds are however scanty, as they are aggregated under 'pulse crops' as a whole. While India has a large production in pulses, the productivity of pulse in India is still very low (5.17 q ha⁻¹) compared to that of USA (10.17 q ha⁻¹) and Australia (7.9 q ha⁻¹). This low productivity of pulses can be attributed to inadequate or no fertilizer application and cultivation of traditional varieties with poor harvest index.

The pea is important for a balanced diet owing to its rich content of protein, carbohydrates, vitamins A and C, Calcium and phosphorus. It is also very rich in minerals like calcium and phosphorus. Besides their nutritional status, they also maintain soil fertility through biological nitrogen fixation in association with symbiotic *Rhizobium* prevalent in their root nodules and thus play a vital role in furthering sustainable agriculture.

Biofertilizers play an important role in increasing fertilizer use efficiency^[1]. It has been established that inoculation of seed with *Rhizobium* increases the seed yield over the un-

inoculated seeds. Beneficial reports regarding the application of *Rhizobium* are available from certain regions of India.

Pea grows on a wide range of soil types with moderate fertility levels, well drained and with pH 5.5–7.0. It is but seriously affected by soil acidity, Al toxicity and water logging. Therefore, lime application on acidic soils under pea crop and the immediate predecessors, increases the yield. Lime application increases the efficiency of fertilizers applied, especially phosphatic fertilizers, on acidic soils and prevents them from being absorbed by the soils.

In Nagaland, 75 per cent of soils are acidic in nature and the magnitude varies upon elevation, rainfall and native vegetation. These soils are abundant in phytotoxic Al, Fe and Mn. Pea does not thrive well in acidic soils thus addition of lime increase NO_3^- -N, P and bulk density of the soil, lower exchangeable Al concentration and wet aggregate stability. Reduced soil acidity and exchangeable Al, in conjunction with increased NO_3^- -N and P would thus contribute to increased crop yield by liming.

Apart from meeting its own requirement of nitrogen, peas are known to leave behind residual nitrogen in soil 50–60 kg ha⁻¹. Pea being a legume does not require much nitrogen for their growth. However nitrogen fertilization of legume has a positive effect on their growth attributes and root nodulation as well as residual fertility status of soil. It is observed that prior to establishment of symbiotic association a starter dose of nitrogen is beneficial to meet their initial nitrogen requirement. Improved leaf growth, dry matter production and increase in pod number may be the result of application of nitrogenous fertilizer which was found to be beneficial for increasing the protein content of the seeds.

However despite the growing importance and potential of this crop, its productivity is still low particularly that of India as well as in Nagaland also. Therefore keeping in view of the importance aspects of pea growth and development, the present investigation was under taken to study the effect of biofertilizer, liming and different doses of nitrogen on the growth and yield of garden pea.

2. Materials and Methods

The experiment was conducted at the research farm of School of Agricultural Sciences and Rural Development (SASRD), Medziphema, Nagaland, during November 2011 to January 2012. The research farm is located at 20° 45' 45"

north latitude and 93° 53' 04" east longitude at an altitude of 310 meters above mean sea level.. The texture and fertility status of the soil were ascertained by taking soil samples from a depth of 0–15 cm from different locations of the experimental plots with the help of a soil auger. The soil samples were then processed and analysed in the laboratory which showed the initial soil status to be well drained and sandy loam having pH of 4.4, organic carbon 1.68 and available NPK at 292, 29.55, and 130.10 kg ha⁻¹ respectively. After the field preparation, recommended doses of fertilizers of 60: 30 kg of P and K per ha in the form of Single Super Phosphate and Murate of Potash were applied in all the experimental plots during the final land preparation. Then the two levels of lime: 0t ha⁻¹ and 4t ha⁻¹ (through CaCO₃) and four levels of Nitrogen: 0, 20, 40 and 60 kg ha⁻¹ (through urea) were applied in combination to plots along with the other fertilizers as per the layout plan. The seeds were also treated with *Rhizobium leguminosorum* before sowing, in plan with the layout. The seeds were then manually sown on 9th November 2010, maintaining a distance of 25cm between rows and 15cm between plants. Right after sowing, Malathion powder @ 12 kg plot⁻¹ was applied against termites, ants and worm attack. To maintain a uniform plant population, at 10 days after sowing, thinning and gap filling operation was done to maintain the required plant to plant spacing of 15cm and row to row spacing of 25cm. The fresh weight and other required parameters of the pods and plant samples were taken and subsequently dried for further analysis after which the final soil samples were collected from the respective plots for final analysis of the soil status. All the growth and yield parameters data's were taken as when required.

The samples were then sun dried and later dried in hot air oven for about 24 hrs at 60⁰ C and further analysed for nutrient contents. Nitrogen content in both seed and stover was estimated by modified Kjeldhal method as described by Black (1965). Phosphorous was determined by vanado-molybdate yellow colour method as outlined ^[2]. Potassium was determined by flame photometry as described ^[3]. To determine the nutrient status of the soil for pH, EC, CEC, organic carbon, available nitrogen, phosphorus, potassium and sulphur contents. pH of the soil was determined in soil: water (1:2) ratio by a glass electrode pH meter ^[2]. Electrical Conductivity (EC) was determined in 1: 2 soil:

water extract using conductivity bridge and expressed as dS m^{-1} [4] and the cation exchange capacity (CEC) of the soil was determined by leaching the soil with neutral normal ammonium acetate solution (1N NH_4OAc) at pH 7.0 as described [5]. Organic carbon was determined by employing colorimetric method of estimation. Available phosphorus [6], Available K and S [7].

3. Results and Discussion

3.1 Growth Attributes: Growth attributing parameters were presented table 1. Experimental findings revealed that liming at 4 t ha^{-1} gave the higher plant height 18.74cm, 34.63cm and 52.32cm over un-limed plots at 20, 40 and 60 DAS respectively. This finding was in accordance with that of where it was reported that the highest growth components of garden pea were obtained with application of lime @ 4 t ha^{-1} [8]. Application of lime significantly enhanced several parameters of the symbiosis and growth of pea crops [9]. The effect of liming may be attributed to the fact that lime application makes the soil environment suitable for beneficial microbes thus increasing the biological properties of the soil by supplying sufficient amount of Ca required for the microbial activity. Increasing levels of N also had significant effect on the plant height at 20 and 40 DAS and highest height was recorded with application of 60 kg N ha^{-1} . This result was in line with the findings [10]. The highest plant height was obtained from the application of biofertilizer.

Application of biofertilizer resulted in higher number of branches per plant, recorded as 3.85, 7.25 and 7.79 at 20, 40 and 60 DAS, respectively over the control. This is in line with the findings [10] which concluded that highest values for growth parameters like height and branches were obtained from inoculated plants. Increasing levels of nitrogen application also had significant effect and resulted in highest number of branches (7.79) with application of 60 kg N ha^{-1} which was at par with biofertilizer application at 60 DAS. This was confirmed by the findings [11] reporting the significant increase in the number of branches per plant with increasing levels of nitrogen.

3.2 Yield Attributes: The experimental findings showed the significant influence of biofertilizer, levels of nitrogen and liming on the yield attributing parameters. The effect of biofertilizer (*Rhizobium* inoculation) on the number of nodules per plant was significant higher (14.63) over the control. This finding is in accordance with [12] who reported that *Pisum sativum* treated

with *Rhizobium* resulted in significant increase in nodulation. *Rhizobium* inoculants alone recorded the highest number and dry weight of nodules per plant [13].

The findings showed the significant influence of biofertilizer and levels of nitrogen on the number of pods per plant. Inoculated plants gave more number of pods per plant (11.41) over un-inoculated plants (10.86) and levels of nitrogen also increased the number of pods over control and resulted in the highest number of pods (11.45) at 20 kg N ha^{-1} . This is in line with the findings [11], that, increased application of nitrogen results in increased number of pods per plant.

The length of pods was significantly affected by *Rhizobium*, levels of nutrients and lime over the control. With application of biofertilisers, gave the high pod length of 8.01cm, as compare to control (6.97). Kumar (2011) also reported the significant increase in the number of pods per plant, length of the pod(cm), number of seeds per pod and yield of mature green pods (q ha^{-1}) of garden pea by the application of *Rhizobium* inoculation.

The number of grains per pod was also significantly affected by, biofertilisers, levels of N and liming. 20 kg N ha^{-1} resulted in highest number of grains per pod of 7.01. These findings are in close line [14], that, maximum number of seeds per pod was observed at 20 kg N ha^{-1} fertilizer level. Biofertilisers and lime gave 6.75 and 6.8 over the control, respectively.

The test weight (1000 seed weight) was significantly affected by the application of biofertilizer, increasing levels of nitrogen and lime. The highest test weight (213.96 g) was obtained from the nitrogen dose 20 kg ha^{-1} . Increase in test weight in field pea (*Pisum sativum*) with increased application of levels of nitrogen [11]. Test weight also increased with application of biofertilisers. Higher test weight and enhanced harvest index of vegetable pea by inoculating the seeds with *Rhizobium leguminosarum*. Lime also gave the significant responses regarding test weight [15].

Seed yield and stover yield were significantly influenced by all factors viz., biofertilizer, liming and different levels of nitrogen. Biofertilizer recorded higher seed yield ($3894.20 \text{ kg ha}^{-1}$) over un-inoculated plants ($3594.58 \text{ kg ha}^{-1}$). This result is in line with the conspicuous increase in yield and nutrient uptake in pea crop which was reported [1] through their field experiments by seed inoculation with

Rhizobium or PSB and the combined inoculation. The composite inoculation of *Rhizobium leguminosarum* significantly increased the yield of pea^[8].

Liming at 4 t ha⁻¹ also had a significant effect on the increased yield (3856.00 kg ha⁻¹) of seeds. Arshad and Gill (1996) also observed that liming increased field pea grain yield and dry matter production in all tillage systems. This may be due to the positive effect of lime in the soil which enhances the soil properties and increases the nutrient uptake by plant roots.

Different levels of nitrogen also significantly affected the seed and stover yield. The highest seed yield was recorded with 20 kg N ha⁻¹ and stover yield by 40 kg N ha⁻¹. This finding is in accordance with^[11] which reported increased grain in field pea with increased application of Nitrogen. Positive and significant differences in development of plant, yield and yield components were seen using 20 kg ha⁻¹ nitrogen applications^[16]. The highest seed yield (3976.1 kg ha⁻¹) was recorded from the treatment 20 kg ha⁻¹ nitrogen applications, while the highest stover yield (2851.1 kg ha⁻¹) was recorded from the treatment 40 kg ha⁻¹ nitrogen applications. Similar results were obtained^[17].

The harvest index was significantly increased by the effect of all three factors *viz.* biofertilizer, liming and different levels of nitrogen. This is due to the high concentration and uptake of N by the plants which was aided by the application of biofertilizer and also liming. This finding relates with that who reported that accumulation of large amount of N is essential for high seed yields, and consequently high harvest index^[18]. The highest HI (59.95) was recorded from the treatment 20 kg ha⁻¹ nitrogen applications.

3.3 Nutrient Uptake: Biofertilizer had significant affect on the total uptake of N, P, and K, by the

Table .1 : Effect of biofertilizer, liming and different doses of nitrogen on length of branch (cm) and number of branch/plant at 20 ,40 and 60DAS

Treatments	Plant height			Number of branch/plant		
	20 DAS	40 DAS	60 DAS	20 DAS	40 DAS	60 DAS
	Biofertilizer (<i>Rhizobium</i>)					
Uninoculated	17.07	32.81	48.33	3.52	6.63	7.45
Inoculated	18.33	35.36	53.02	3.85	7.25	7.79
S.Em±	0.34	0.12	0.26	0.01	0.01	0.01
C.D (P=0.05)	NS	1.12	2.36	0.05	0.05	NS
	Liming					
Unlimed	17.67	32.55	50.03	3.62	6.77	7.51
Limed	18.74	34.63	52.32	3.75	7.01	7.74
S.Em±	0.35	0.31	0.39	0.02	0.01	0.01
C.D (P=0.05)	1.16	1.02	1.318	NS	0.03	0.02
	Nitrogen levels					
N ₀ (0 kg ha ⁻¹)	17.23	31.61	46.93	3.68	6.18	6.58
N ₁ (20 kg ha ⁻¹)	18.50	33.81	52.85	3.83	6.85	7.57

crop. This finding is asserted by the findings^[19] that biofertilizer significantly enhanced N and P uptake by soybean. The increased uptake of these nutrients was due to increased supply of nutrients which enhanced proliferation of root system under balanced nutrient application which in turn facilitated better absorption of water and nutrients along with improved soil physical environment.

Liming also significantly affected the total uptake of N, P and K. Higher uptake of N at 202.34 kg ha⁻¹, 22.37 kg ha⁻¹, and K at 104.28 kg ha⁻¹ respectively, obtained by liming over control was. Highest total NPK uptake was observed at pH 6.32 due to liming with an increase of 4-2-17 kg ha⁻¹ from the un-limed plots^[20].

Increasing levels of nitrogen also significantly influenced the uptake of nutrients. Field experiments that maximum NPK uptake were recorded by the application of 90 kg N ha⁻¹. The highest uptake of N (209.12 kg ha⁻¹) was recorded from the treatment nitrogen dose @ 40 kg ha⁻¹^[21].

Sulphur uptake was also significantly affected by biofertilizer and increasing levels of nitrogen. Sulphur also improves the use efficiency of other essential plant nutrients, particularly N and P. The highest uptake (22.35 kg ha⁻¹) was recorded from the treatment B₁L₁N₂ (biofertilizer, liming @ 4 t ha⁻¹ and 40 kg N ha⁻¹

4. Conclusion: On the basis of above findings, we conclude that garden pea responded highest with application of biofertilizer, lime and nitrogen level 20 kg/ha. This is one year experimental data result, for making recommendation of treatment package at least two –three consecutive year experiment is required. So, further research experiments should be conducted.

N ₂ (40 kg ha ⁻¹)	17.78	34.60	51.38	3.61	7.01	7.68
N ₃ (60 kg ha ⁻¹)	19.30	34.33	52.55	3.63	7.10	7.79
S.Em±	0.49	0.43	0.55	0.02	0.01	0.01
C.D (P=0.05)	1.65	1.44	NS	NS	0.04	0.03
Treatments	Plant height			Number of branch/plant		
	20 DAS	40 DAS	60 DAS	20 DAS	40 DAS	60 DAS
Biofertilizer (<i>Rhizobium</i>)						
Uninoculated	17.07	32.81	48.33	3.52	6.63	7.45
Inoculated	18.33	35.36	53.02	3.85	7.25	7.79
S.Em±	0.34	0.12	0.26	0.01	0.01	0.01
C.D (P=0.05)	NS	1.12	2.36	0.05	0.05	NS
Liming						
Unlimed	17.67	32.55	50.03	3.62	6.77	7.51
Limed	18.74	34.63	52.32	3.75	7.01	7.74
S.Em±	0.35	0.31	0.39	0.02	0.01	0.01
C.D (P=0.05)	1.16	1.02	1.318	NS	0.03	0.02
Nitrogen levels						
N ₀ (0 kg ha ⁻¹)	17.23	31.61	46.93	3.68	6.18	6.58
N ₁ (20 kg ha ⁻¹)	18.50	33.81	52.85	3.83	6.85	7.57
N ₂ (40 kg ha ⁻¹)	17.78	34.60	51.38	3.61	7.01	7.68
N ₃ (60 kg ha ⁻¹)	19.30	34.33	52.55	3.63	7.10	7.79
S.Em±	0.49	0.43	0.55	0.02	0.01	0.01
C.D (P=0.05)	1.65	1.44	NS	NS	0.04	0.03

Table .2 : Effect of biofertilizer, liming and different doses of nitrogen on grains per pod, pods per plant and length of pod (cm), number of nodules per plant at 20 DAS, days to 50% flowering and test weight (g) seed yield (kg ha⁻¹), stover yield (kg ha⁻¹) and harvest index (%)

Treatments	Yield attributing parameters								
	Grains per pod	Pods per plant	Length of pod (cm)	Number of nodules/plant 20 DAS	Days to 50% flowering	Test weight (g)	Seed yield (kg ha ⁻¹)	Stover yield (kg ha ⁻¹)	Harvest index (%)
Biofertilizer (<i>Rhizobium</i>)									
Uninoculated	6.45	10.86	6.97	11.13	41.99	207.23	3594.58	2730.4	56.83
Inoculated	6.76	11.41	8.01	14.63	39.94	212.60	3894.20	2794.8	58.21
S.Em±	0.03	0.01	0.18	0.04	0.04	0.80	10.35	5.27	0.05
C.D (P=0.05)	0.10	0.06	0.51	0.13	NS	7.06	90.85	46.3	0.49
Liming									
Unlimed	6.59	10.99	6.32	12.17	40.84	198.15	3632.79	2670.2	56.72
Limed	6.80	12.31	7.35	12.53	41.07	209.68	3856.00	2755.1	58.32
S.Em±	0.02	0.02	0.09	0.03	0.02	1.35	16.79	8.79	0.078
C.D (P=0.05)	0.07	0.07	0.29	0.11	0.06	4.78	56.23	26.54	0.26
Nitrogen levels									
N ₀ (0 kg ha ⁻¹)	6.33	10.9	5.25	11.26	43.57	200.42	3479.3	2628.9	56.95
N ₁ (20 kg ha ⁻¹)	7.01	11.45	7.26	13.41	41.80	213.96	3976.1	2744.1	59.95
N ₂ (40 kg ha ⁻¹)	6.9	11.23	7.55	12.60	39.53	213.04	3829.8	2851.1	57.15
N ₃ (60 kg ha ⁻¹)	6.59	10.93	7.27	12.10	40.37	212.25	3692.3	2826.2	56.65
S.Em±	0.02	0.025	0.13	0.041	0.034	1.919	23.747	12.432	0.111
C.D (P=0.05)	0.07	0.08	0.45	0.14	0.12	6.42	79.52	41.63	0.37

Table 3 : Effect of biofertilizer, liming and different doses of nitrogen on N,P and K content in seed(%), stover (%) and uptake (kg ha⁻¹).

Treatment	N		P			K			Total K uptake (kg ha-1)
	Seed (%)	Stover (%)	Total N uptake (kg ha-1)	Seed (%)	Stover (%)	Total P uptake (kg ha-1)	Seed (%)	Stover (%)	
Biofertilizer (<i>Rhizobium</i>)									
Uninoculated	4.01	1.40	187.7	0.37	0.30	21.64	1.22	1.96	97.60
Inoculated	4.24	1.46	207.1	0.38	0.31	23.33	1.25	2.06	106.33
S.Em±	0.01	0.01	0.93	0.02	0.03	0.34	0.03	0.06	0.29
C.D (P=0.05)	0.03	0.15	8.21	0.05	NS	NS	NS	NS	2.60
Liming									
Unlimed	4.20	1.42	192.54	0.38	0.31	22.60	1.22	1.98	99.65
Limed	4.20	1.44	202.34	0.36	0.29	22.37	1.24	2.03	104.28
S.Em±	0.02	0.02	0.99	0.03	0.02	0.34	0.02	0.04	0.78
C.D (P=0.05)	NS	NS	3.34	NS	0.10	NS	0.066	NS	2.61
Nitrogen levels									
N0 (0 kg ha-1)	3.91	1.34	171.36	0.35	0.29	20.16	1.18	1.92	92.28

N1 (20 kg ha-1)	4.25	1.41	208.23	0.39	0.30	23.81	1.21	2.01	103.66
N2 (40 kg ha-1)	4.31	1.49	209.14	0.38	0.31	23.76	1.29	2.04	107.88
N3 (60 kg ha-1)	4.34	1.48	202.13	0.36	0.30	22.20	1.25	2.04	104.04
S.Em±	0.04	0.03	1.41	0.04	0.04	0.49	0.03	0.06	1.10
C.D (P=0.05)	0.13	0.11	4.72	0.16	NS	1.64	0.11	0.21	3.70

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