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The Performance of Field pea (*Pisum sativum* L.) as Influenced by Nitrogen Application and Plant Density in Vom Plateau State.

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Abstract: A field experiment was conducted at the National Root Crop Research Institute (NRCRI) Vom, Plateau State, Nigeria during the 2015 and 2016 wet seasons to study the effect of nitrogen and plant density on the productivity of field pea (*Pisum sativum* L.). The treatments consisted of three nitrogen (0, 20 and 40 kg N ha^{-1}) rates and two plant density (222,222 and 133,320 plants ha^{-1}), which were factorially laid in a randomized complete block design and replicated three times. A constant rate of phosphorus fertilizer at 60 kg P ha^{-1} was applied to all treatments. Growth characters measured were; plant height, number of branches, leaf area index while yield characters recorded were number of pods, pod length, number of seeds, 100 seed weight and seed yield. Results obtained on the characters measured as influenced by nitrogen and plant density showed a significant ($P \leq 0.05$) effect throughout the period under investigation. Application of 40 kg N ha^{-1} recorded the higher seed yield than the other rates used, plant density on the other hand, showed that higher seed yield was obtained in both season at 133,320 plants ha^{-1} than when 222,222 plants ha^{-1}. From the foregoing results obtained, it became clear that the application of 40 kg N ha^{-1} or plant density at 133,320 plants ha^{-1} under 25 x 30 cm intra and inter row spacing could be applied to field pea for optimum performance. However, the combined application of nitrogen at 40 kg N ha^{-1} with plant density of 133,320 plants ha^{-1} seem more promising, as it gave the highest seed yield of field pea in this study.

Key words: Field pea, Growth, Performance, Plant density, Nitrogen, Yield

1 INTRODUCTION

Field pea (*Pisum sativum* L.) is an annual grain legume or pulse crop that its production is largely confined to the cooler temperate zones between the tropic of cancer and the Mediterranean region. However, the crop is now grown in most climatic zones including the tropical highlands, where it is grown under cooler conditions at higher elevations [17]. Field pea is hardly grown in West Africa [16]. In Nigeria, even though the crop is hardly grown, it has started gaining some popularity with its production limited to Jos Plateau and on some farms around Zaria under irrigation, which tells why the crop is very expensive in the market.

Field pea is grown for diverse uses such as food for human consumption or as feed for livestock. The crop is a major source of protein (21% - 25%) with high levels of amino acids, lysine and tryptophan that have high nutritional value for the resource poor household. It also contains high levels of carbohydrate, low in fibre and contains 86 to 87 percent total digestible nutrients making the crop an excellent livestock feed. Field pea also contains 5 to 20 percent less of "trypsin inhibitors" compared with soybeans, which allows it to be directly fed to livestock without going through an extrusive heating process [4].

Field pea production in the study area is low despite its yield potential. The low productivity of the crop is attributed to poor soil fertility (due to mining and erosion of topsoil by intense rainfall) and poor agronomic practices by farmers. Although field pea is known to obtained as much as 80% of their total nitrogen requirements through symbiotic fixation of the atmospheric nitrogen, the importance of the externally applied N to the crop have been reported by various workers [2], [10], [15]. Being a leguminous plant, farmers in the study area careless to apply fertilizer, believing that field pea does not require fertilizers (especially nitrogen) for its growth and development. However, this is not possible under continuous land cultivation which is a characteristic of the farming system on the Jos, Plateau. Plant population on farmer's fields also appear lower or higher than the optimum. Low and high density, populated field, may be the principle cause of low yield. Higher plant population increases competition among plants for space, nutrients and light, thereby reducing photosynthetic efficiency and yield, while low density could cause inefficient use of natural resources and inputs [23]. Due to lack of recommendations on these limiting factors of field pea production in the study area, very low yield is obtained. Therefore, enhancing the productivity of the crop through improved agronomic practice such as selection of optimum nitrogen rates and plant density is essential for better performance of the crop.

2 MATERIALS AND METHODS

The research was carried out during the 2015 and 2016 raining seasons, at the National Root Crop Research Institute (NCRI) Farm, Vom located at a latitude of 9^0 41'36.27 N longitude 8^0 52'16.33 E and altitude of 1242m above sea level. Average minimum temperature in the area is about 10.4^0C during the dry season (December to February) and 15^0C during the raining season (May to August) while maximum temperature rarely exceeds 34.4^0C with an average rainfall of about 1400mm (Nigeria meteorological office Jos).

2.1 Soil Sample Collection

Soil samples were collected at five different locations within the experimental area using auger at 0–30cm depth before commencement of each year's trial. The samples were bulked to form a composite, air dried, crushed and passed through 2 mm-sieves to remove coarse particles. A sub-sample from the composite was then taken to Bayero University Kano, soil laboratory to analyse for total nitrogen, using Kjeldahl method [7]; available phosphorus was determined by Bray1 method [6]; Organic carbon and total nitrogen were estimated respectively by [29] method; potassium, exchangeable calcium, magnesium sodium and cation exchange capacity were determined following the procedures of [9]. Particle size distribution was determined using bouyoucos hydrometer method [8] while exchangeable bases were determined using Atomic Absorption-Spectrophotometer (Table 1).

2.2 Treatments and Experimental design

The treatments consisted of three nitrogen (Urea 46%) rates (0, 20 and 40 kg ha^{-1}) and two plant densities (133,320 and 222,222 plants ha^{-1} respectively). The treatments were factorially combined and laid in a Randomized Complete

Block Design (RCBD) with three replications. A gross plot size of 3m x 3m ($9m^2$) was maintained from which a sampling unit of 1.2 x 3m ($3.6m^2$) as net plot was determined at the middle of each plot in both seasons for recording of growth and yield characters. To obtain the required plant density of 133,320 and 222,222 plants ha^{-1}, spacing of 15 and 25 intra with common inter row of 30cm was adopted. Thinning to one seedling per stand was carried out. The 60 kg P ha^{-1} and three rates of nitrogen were applied, incorporated into the soil and covered properly at sowing and 5 DAE, respectively.

During the period of the investigation, all the plots and paths were kept free of weeds as at when due using small hoe. There was no incidence of pest or disease on the field. Therefore, no control measure was carried.

2.3 Data collection

Data on growth (plant height, number of branches $plant^{-1}$ and leaf area index) and yield (number of pods per plant, pod length, number of seeds per pod, pod yield, 100 seed weight and seed yield) characters were taken at 45 and 60 DAE and at physiological maturity, respectively. Both pod yield, 100 seed weight and seed yield were weigh using M_X-RADY electronic balance.

2.4 Plant height (cm)

Plant height was obtained by placing a measuring tape at the base of each plant (ground level) to the terminal bud. All the 10 sampled plants were measured and the average taken on per plant basis.

2.5 Number of branches

Field pea plants have a dominant main stem and several branches, with the main stem simply being the longest. Number of branches was obtained by counting all the branches from the main stem of the 10 randomly selected plants at 45 and 60 DAE and their average value recorded accordingly.

2.6 Leaf area index (LAI)

Leaf area index was obtained as the ratio of the leaf area of the leaf to the land area upon which the plant grows. The leaf area index was measured following the descripting [34].

$$LAI \quad \frac{\text{Leaf area of plant}}{\text{Ground area occupied by the plant}}$$

2.7 Number of pods

Number of pods per plant was taken by counting all the pods from each plant. The data was taken from the randomly selected 10 stands within the net plot and the average value was recorded.

2.8 Pod length (cm)

This represents the distance from the pod apex to the base of the pod. Pod length was taken by placing the measuring tape at one end of the pod to the other end and the average value was recorded for all the pods measured per plant and for all the sampled plants accordingly.

2.9 Pod yield (kg ha^{-1})

Pod yield was obtained from all the stands within the net plots according to treatments. The pods were first weighed and the average was recorded and later converted to pod yield per hectare.

2.10 Number of seeds per pod

Number of seeds per pod was recorded by first threshing all the pods and counting all the seeds from all the randomly selected plants per plot. The average values obtained were then recorded and considered on per plant basis.

2.11 100 seed weight (g)

One hundred seeds were first counted randomly for each plot and then weighed. The average values were then recorded in grams ha^{-1}

2.12 Seed yield (kg ha^{-1})

Seeds from all the net plots were weighed and the average values were recorded according to the treatments used and later converted to seed yield per hectare.

2.13 Data analysis

All the data collected were subjected to analysis of variance using SPSS Statistics V. 20 (software). Treatment means observed to be significantly different were however, separated using Duncan Multiple Range Test following the procedure of [12] at 5% level of probability.

3 RESULTS AND DISCUSSION

The Physico-chemical properties of soil based on 0-30 cm soil depth before starting the experiment during the 2015 and 2016 rainy seasons is presented in table1. The soil analysis result indicated that texture of the soil was clay with pH of 6.0 which fall within the range suitable for the crops. Generally, the fertility of the soil was poor, low in organic carbon, available nitrogen and available phosphorus. In such soils the amount of the primary nutrient that could immediately be available to a crop becomes inadequate.

3.1 Plant height (cm)

Productivity of field pea as influenced by nitrogen and plant density on plant height is presented in table 2. Nitrogen and plant density all showed significant ($P \le 0.05$) effect on plant height. The table indicated an increase in plant height with increase in nitrogen application from 0 to 40 kg Nha^{-1}. Application of 40 kg N ha^{-1} consistently produced taller plants, while control plot had shorter plants throughout the study period. Such favourable effect of nitrogen application on vegetative growth could be expected, since nitrogen is known as an essential plant nutrient which plays a major role in nucleic acids and protein synthesis, cell division, cell elongation and protoplasm formation which ultimately increase plant growth. This is in agreement with the findings of [1] and [24] who showed a linear trend between plant height and nitrogen rate. Plant density of 222,222 plants ha^{-1} when 15cm intra row was applied consistently produced significantly ($P \le 0.05$) taller plants than when 133,320 plants ha^{-1} obtained under 25 cm intra row spacing was used in both seasons. The significantly higher plant height observed under plant population of 222,222 plants ha^{-1} could be due to the high degree of competition for light, water and nutrients between plants at higher densities. This was supported by [24] who indicated that denser plant population of pea increased plant height due to competition among plants.

3.2 Number of branches

Table 3 shows the effect of nitrogen and plant density on number of branches $plant^{-1}$. Throughout the two-year trial, it was observed that increases in application of nitrogen resulted in significant ($P \le 0.05$) and progressive increase in number of branches $plant^{-1}$. Number of branches obtained from the application of 40 kg ha^{-1} was highest. Control plot on the other hand produced fewer number of branches than 40 kg ha^{-1} [13]. Higher number of branches plant^{-1} could be due to the fact that nitrogen application enhanced vegetative growth and development of plant, which ultimately may have increased the number of branches plant^{-1} at 40 kg N ha^{-1}. A similar result was observed in field pea where increases in nitrogen and phosphorus rate tend to increase basal branches plant^{-1} [13], [26], [30] and [36].

At different plant densities used, significantly (P ≤ 0.05) effect was observed on number of branches plant^{-1}. Higher number of branches was observed under 25 cm intra row with 133,320 plants ha^{-1}. Plots with 222,222 plants ha^{-1} on the other hand, produced fewer number of branches throughout the period of the investigation. It was observed that decrease in plant population resulted in more number of branches throughout the years under investigation. Branching has an important effect on pea yield because greater branching contributes to higher yields at lower population densities [32].

Interaction between nitrogen rates and plant density at 45 DAE in 2016 showed that higher number of branches plant^{-1} was obtained when 40 kg N ha^{-1} was applied to 133,320 plants ha^{-} However, irrespective of the two plant densities used, control led to the production of fewer number of branches than the other treatments applied (Table 4).

3.3 Leaf area index

Significant (P≤ 0.05) difference was observed among the nitrogen rates and plant density applied (Table 5). Leaf area index increase with increase in nitrogen rates at all the sampling period. The highest leaf area index was produced with 40 kg N ha^{-1}. Control plots on the other hand produced the least leaf area index at all sampled dates. The production of higher LAI with increasing levels of nitrogen throughout the two years of the study compared to the control plots therefore, shows the important of nitrogen as a constituent of polynucleotides which help in cell division and expansion of cells resulting in higher leaf area. Work reported by [19] [27] showed that leaf area index (LAI) of French bean was significantly influenced by the application of different levels of nitrogen as well as phosphorus fertilizer.

The table also showed that significantly higher (P≤ 0.05) values of leaf area index were recorded at plant density of 133,320 plants ha^{-1} than that obtained from 222,222 plants ha^{-1} in 2015 at 45 DAE and at both sampled period in 2016 trial. The increase in LAI was closely related to the number of branches, which in turn increased the total number of leaves, which could also be attributable to an increase in leaf expansion rate that provide a potential source of photosynthetic apparatus for the plant.

The interaction between nitrogen and plant density on leaf area index revealed that higher leaf area index was produced with applied nitrogen rate of 40 kg N ha^{-1} to 133,320 plants ha^{-1} which was significantly at par with the interaction between 20 kg N ha^{-1} and 133,320 plants ha^{-1} at 60 DAE in 2015. In all these controls produced the least value among the interaction on LAI.

3.4 Number of pod plant^{-1}

Table 7, revealed that application of nitrogen from 0 to 40 kg ha^{-1} resulted in a progressive and significant increase in the number of pod $plant^{-1}$ of field pea. Significantly (P≤ 0.05) higher number of pods $plant^{-1}$ was recorded at 40 kg N ha^{-1} throughout the study period. Control plots on the other hand recorded the lowest number of pod $plant^{-1}$ in both years. [21] and [25] also obtained similar results on number of pods ha^{-1}.

Similarly, plant density significantly (P≤0.05) influenced number of pod $plant^{-1}$. The application of 133,320 plants ha-1 obtained under 25cm row spacing gave higher number of pod $plant^{-1}$ than 222,222 plants ha^{-1} under 15cm row spacing in both years. At high densities, the shedding of plant during flowering may reduce the supply of assimilates resulting to abortion of proportion of pods and influence ovule development. This result corroborates the works of [18] [11].

3.5 Pod length (cm)

Productivity of field pea as it was influenced by nitrogen and plant density (Table 7) showed that all the nitrogen rates applied significantly (P ≤ 0.05) influenced pod length in two-year trial. It was observed that pod length increases significantly with nitrogen rate from 0 to 40 kg ha^{-1}. Plots treated with nitrogen at 40 kg N ha^{-1} had longer pods than all the other treatments studied. Control plots however, produced the shortest pods throughout the study period. The consistent results exhibited by nitrogen throughout the study period could be attributed to better plant development through effective mineralization and efficient utilization of applied nitrogen by the plant, especially that there was adequate rainfall during the growing season, which makes the primary growth elements available in sufficient amount.

Except in 2015, no significant effect was observed between the two plant densities used. In 2015 rainy season, plant density of 133,320 plants ha^{-1} produced significantly (P ≤ 0.05) longer pods than when 222,222 plants ha^{-1} were used.

3.6 Pod yield (kg ha^{-1})

Table 7 also showed the effect of application of nitrogen and plant density on pod yield. The application of these factors indicated a significant (P ≤ 0.05) effect on pod yield (kg ha^{-1}) of field pea. This character increase with increase rates of nitrogen applied. Application of nitrogen at 40 kg N ha^{-1} produced higher pod yield than the other rates used in the study. Pod yield obtained in control plot was lower in both years of the research. This could be due to better performance in characters such as number of pods $plant^{-1}$ and pod length which were as a result of the positive effect of nitrogen on these characters.

Plant density also had significant (P ≤ 0.05) influenced on pod yield during the period of the trials, except in 2015 where non-significant effect was observed. In both years, higher pod yield was obtained from plant density of 133,320 plants ha^{-1}.

3.7 Number of seeds pod^{-1}

Number of seed pod^{-1} was influenced significantly (P≤ 0.05) by the application of nitrogen rates (Table 8). The highest number of seed pod^{-1} was obtained with the application of 40 kg N ha^{-1} which was at par with 20 kg N ha^{-1}.

The lowest number of seed pod^{-1} was obtained in the control plot (0 kg N ha^{-1}) in both years of the trial. [20] recorded increased in number of seed pod^{-1} with increase nitrogen levels up to 60 kg N ha^{-1} in Blackgram.

The effect of plant density (Table 8) on number of seed pod^{-1} on the other hand, was not significant during the period under study, however, statistically higher number of seed was recorded from plant density of 133,320 plants^{-1}. Similar to this result, [32] reported that a progressive and consistent reduction in the number of seeds per pod occurred with increased plant population.

3.8 100 seed weight (g)

The influence of nitrogen and plant density on 100 seed weight of field pea is presented in Table 8. 100 seed weight was significantly (P≤ 0.05) influenced by nitrogen rates. Close observation showed that increase in applied nitrogen from 0 up to 40 kg N ha^{-1} increase the weight of field pea seed. Plots treated with 40 kg N ha^{-1} produced heavier seed throughout the two years trial, however, it was significantly at par with 20 kg N ha^{-1} in 2016 season.

At the two-plant density, 100 seed weight was not affected by plant density in both years of the research. However, heavier seeds of field pea were recorded from plant density of 133,320 plants ha^{-1}.

3.9 Seed yield (kg ha^{-1})

Table 8 showed the effect of application of nitrogen and plant density on seed yield. Like 100 seed weight, seed yield was significantly influenced (P≤ 0.05) by nitrogen rates in both seasons. Throughout the period of the study, it was observed that increase in nitrogen applied from 0 up to 40 kg N ha^{-1} resulted in significant and progressive increase in grain yield of field pea. Nitrogen 40 kg N ha^{-1} recorded highest seed yield than other rates used. Significantly lowest seed yield however, was obtained in control plots. Higher seed yield observed at 40 kg N ha^{-1} could be attributed due to greater partitioning of dry matter into the economic portion such as seed. [22] and [33] found an increased seed yield of pea, bean and chickpea as a result of increase nitrogen (at 0, 20, 40 and 60 kg N ha^{-1}) application.

Plant density on the other hand, showed that seed yield increases when intra row spacing increases. Significantly higher seed yield was obtained from plant density of 133,320 plants^{-1} under 25cm intra row spacing in all the years. Higher seed yield maintained with plant density of 133, 320 plant^{-1} could be due to the ability of the crop to make compensatory increases in the number of pods plant^{-1} as plant population decreases [14]. These results are in accordance with the findings of [3], [5], [22] and [28]

The interaction between nitrogen and plant density on seed yield was observed in 2016 trial. Significantly higher seed yield was obtained when 40 kg N ha^{-1} was application to 133,320 plants ha^{-1}. However, irrespective of the two plant densities used, control plots had the least seed yield among all the other treatments applied (Table 9). The positive results obtained from the interaction between nitrogen at 40 kg N ha^{-1} with plant density of 133,320 plants ha^{-1} could be due to higher values for yield components such as number of pod plant^{-1},

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number of seed pod^{-1}, and 100 seed weight recorded throughout the period of the study compared to control plot. The result is agreement with that of [19] in their study on French bean.

Table 1: Some soil properties (0-30 cm) of experimental field at Vom, prior to sowing

	Value at 0-30cm	
Parameter	2015	2016
Sand	46.8	46.84
Silt	29.28	29.00
Clay	23.92	24.16
Texture	Sand loam	Sand loam
pH	5.65	6.40
Total organic carbon (%)	0.56	0.55
EC (ds m-1)	0.12	0.12
Total N (%)	0.10	0.07
Available P (mg kg-1)	3.6	4.1
Available K (mg kg-1)	198	201

Table 2: Effect of nitrogen and plant density on plant height (cm) of field pea at 45 and 60 DAE during the 2015 and 2016 seasons at Vom.

	2015		2016	
	Days After Emergence			
Treatment	45	60	45	60
Nitrogen (kg ha^{-1})				
0	73.94c	103.94c	82.39c	94.33b
20	85.94b	116.94b	86.12b	119.00a
40	88.89a	121.44a	87.78a	121.44a
LS	*	*	*	*
SE±	1.23	2.91	1.51	2.37
D (plant ha^{-1})				
222,222	85.85a	114.41a	86.74a	120.63a
133,320	80.00b	106.70b	85.23b	107.59b
LS	*	*	*	*
SE±	1.06	1.93	1.23	2.37
Interaction				
N x D	NS	NS	NS	NS

Means followed by same letter (s) on the same column do not differ significantly at 5% probability level by Duncan Multiple Range Test. D= Plant density LS= Level of Significant *=Significant NS= Not Significant.

Table 3: Effect of nitrogen and plant density on number of branches plant^{-1} of field pea at 45 and 60 DAE during the 2015 and 2016 seasons at Vom.

Treatment	2015		2016	
	Days After Emergence			
	45	60	45	60
Nitrogen (kg ha^{-1})				
0	2.61c	3.28c	2.50c	3.39c
20	4.11b	4.56b	3.61b	5.28b
40	4.28a	4.89a	4.11a	6.56a
LS	*	*	*	*
SE±	0.14	0.17	0.11	0.13
D (plant ha^{-1})				
222,222	3.33b	3.85b	2.63b	4.00b
133,320	4.00a	4.63a	4.18a	6.15a
LS	*	*	*	*
SE±	0.12	0.14	0.09	0.10
Interaction				
N x D	NS	NS	*	NS

Means followed by same letter (s) on the same column do not differ significantly at 5% probability level by Duncan Multiple Range Test. D= Plant density LS= Level of Significant *=Significant NS= Not Significant.

Table 4: Interaction between nitrogen and plant density on number branches plant^{-1} of field pea at 45 DAE during the 2016 season at Vom.

Treatment	Density (plant ha^{-1})	
	222,222	133,320
Nitrogen (kg ha^{-1})		
0	2.22d	2.78c
20	2.67cd	4.56b
40	3.00c	5.22a
LS	*	
SE±	0.16	

Means followed by same letter (s) on the same column do not differ significantly at 5% probability level by Duncan Multiple Range Test. LS= Level of Significant *=Significant

Table 5: Effect of nitrogen, phosphorus and plant density on leaf area index of field pea at 45 and 60 DAE during the 2015 and 2016 seasons at Vom.

Treatment	2015		2016	
	Days After Emergence			
	45	60	45	60
Nitrogen (kg ha^{-1})				
0	3.33c	3.05c	3.16c	2.72c
20	5.44b	4.33b	4.89b	4.22b
40	6.20a	5.11a	5.50a	4.94a
LS	*	*	*	*
SE±	0.25	0.21	0.16	0.13
D (plant ha^{-1})				
222,222	4.63b	3.89	4.11b	3.81b
133,320	5.41a	4.00	4.93a	4.11a
LS	*	NS	*	*
SE±	0.20	0.17	0.13	0.10
Interaction				
N x D	NS	*	NS	NS

Means followed by same letter (s) on the same column do not differ significantly at 5% probability level by Duncan Multiple Range Test. D= Plant density LS= Level of Significant *=Significant NS= Not Significant.

Table 6: Interaction of nitrogen and plant density on leaf area index of field pea at 60 DAE during the 2015 season at Vom.

Treatment	Density (plant ha^{-1})	
	222,222	133,320
Nitrogen (kg ha^{-1})		
0	4.44c	4.56c
20	6.00b	7.55a
40	6.56b	8.00a
LS	*	
SE±	0.32	

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Means followed by same letter (s) on the same column do not differ significantly at 5% probability level by Duncan Multiple Range Test. LS= Level of Significant *=Significant

Table 7: Effect of nitrogen and plant density on number of pod plant^{-1}, pod length (cm), and pod yield of field pea during the 2015 and 2016 seasons

Treatment	Number of pod plant^{-1}		Pod length (cm)		Pod yield (kg ha^{-1})	
	2015	206	2015	2016	2015	2016
Nitrogen (kg ha^{-1})						
0	9.44c	10.06c	4.94c	5.56c	1288.11c	1410.78c
20	14.44b	14.22b	6.33b	6.50b	1914.94b	2046.67b
40	17.00a	16.67b	6.78a	6.94a	2279.28a	2251.89a
LS	*	*	*	*	*	*
SE±	0.31	0.37	0.10	0.09	60.31	56.30
D (plant ha^{-1})						
222,222	13.30b	12.85b	5.88b	6.30	1790.00	1769.00b
133,320	13.96a	14.44a	6.15a	6.37	1836.89	2037.22a
LS	*	*	*	NS	NS	*
SE±	0.25	0.30	0.08	0.08	49.24	45.98
Interaction						
N x D	NS	NS	NS	NS	NS	NS

Means followed by same letter (s) on the same column do not differ significantly at 5% probability level by Duncan Multiple Range Test. D= Plant density LS= Level of Significant *=Significant level NS= Not Significant.

Table 8: Effect of nitrogen and plant density on number of seed, 100 seed weight (g), seed yield (kg ha-¹) of field pea at during the 2015 and 2016 seasons

Treatment	Number of seed pod^{-1}		100 seed weight (g)		Seed yield (kg ha^{-1})	
	2015	2016	2015	2016	2015	2016

Nitrogen (kg ha^{-1})						
0	4.61c	4.33b	22.61c	23.61b	1076.72c	1211.06c
20	5.17b	5.22a	24.17a	24.30a	1810.00b	1926.83b
40	5.61a	5.22a	24.52a	25.11a	2064.20a	2109.67a
LS	*	*	*	*	*	*
SE±	0.13	0.13	0.16	0.18	36.92	46.36
D (plant ha^{-1})						
222,222	5.07	4.98	23.43b	23.55b	1668.70	1656.90b
133,320	5.18	5.07	24.02a	24.00a	17731.89	1928.15a
LS	NS	NS	*	*	*	*
SE±	0.11	0.11	0.15	0.13	30.15	37.86
Interaction						
N x D	NS	NS	NS	NS	*	NS

Means followed by same letter (s) on the same column do not differ significantly at 5% probability level by Duncan Multiple Range Test. D= Plant density LS= Level of Significant *=Significant level NS= Not Significant.

Table 9: Interaction of nitrogen and plant density on seed yield of field pea during the 2016 season

Treatment	Density (plant ha^{-1}) 222,222	133,320
Nitrogen (kg ha^{-1})		
0	1028.333d	1225.111d
20	1443.111c	1961.667b
40	1635.111c	2295.333a
LS	*	
SE±	93.215	

Means followed by same letter (s) on the same column do not differ significantly at 5% probability level by Duncan Multiple Range Test. LS= Level of Significant *=Significant

4. CONCLUSION

The results obtained revealed that increasing the dosage of nitrogen up to 40 kg N ha^{-1} exerted positive effect on field pea in terms of growth and yield in the study area. At the different plant densities used, higher intra row spacing of 25 cm, given a plant population of 133,320 plants ha^{-1} seem more optimum for higher growth and yield of the crop than at higher plant density of 222,222 plants ha^{-1}. Similarly, combined application of nitrogen at 40 kg N ha^{-1} and plant density of 133,320 plants ha^{-1} could lead to better seed yield of field pea. Based on aforementioned, the highest doses of nitrogen at 40 kg N ha^{-1} or plant densities of 133,320 plants ha^{-1} used in the present study could be applied to field pea by farmers in the study area for optimum performance. It is possible to conclude that the combined application of 40 kg N ha^{-1} and plant density of

133,320 plants ha^{-1} seem more promising, as it gave optimum seed yield of field pea. However, investigating the same study in multi-location which may provide an optimum rate of nitrogen fertilizer and plant density for the study area is recommended. Similarly, further studies are also required to investigate the role of other limiting factors such as varieties, phosphorus fertilizer and date of planting.

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