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Effect of nutrients and genotypes on growth and yield of pigeonpea (*Cajanus cajan* (L.) Millasp)

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Abstract
A field experiment was conducted during the *kharif* season of 2018-19 on sandy-loam soil at G.B. Pant University of Agriculture and Technology, Pantnagar, Uttarakhand, to study the "Performance of promising pigeonpea [*Cajanus cajan* (L.) Millsp] genotypes at different rates of fertilization in *tarai* region of Uttarakhand." with an objectives to optimize the fertilizer dose for getting maximum yield per hectare and effect on growth, yield attributes and yield of pigeonpea (*Cajanus cajan* (L.) Millasp). The experiment laid out in factorial RBD design keeping genotypes, *viz*. PA 421, PA 291, UPAS 120, and different fertility level management are control, 75% RDF, 100% RDF, 125% RDF at the time of sowing. The results obtained during course of investigation revealed that genotypes significantly influenced various growth parameters, yield attributing characters and yield. Genotype PA 421 was significantly superior over PA 291 and UPAS 120 in terms of yield attributing and PA 421 recorded 20.35% and 22.30% higher grain yield than PA 291 and UPAS 120, respectively. Among the fertility levels, 125% RDF recorded significant response to all the growth parameters at various growth stages which resulted in higher growth parameters, yield attributes and yield (2359 kg/ha) of pigeonpea compared to other fertility levels, 125% RDF was at par with 100% RDF. Hence, for achieving higher yield of pigeonpea, genotype PA 421 with the application of 100% RDF can be a better option in *tarai* regions of Uttarakhand.

Keywords: Genotypes, Fertility level, RDF, NPK

Introduction
Pigeonpea [*Cajanus cajan* (L.) Millsp], which is also known as arhar, tur, redgram, congopea, no eye pea *etc*., is one of the most important pulse crop cultivated in India. Nutritious and wholesome, the green seeds (pods) of pigeonpea serve as vegetable. The factors responsible for lower yield of pigeonpea in India as compared to the whole world are lack of improved and high yielding short duration varieties, good quality seed, poor nutrient management *etc*. This could be improved by adopting suitable agro-techniques in general and proper nutrition in particular. Pigeonpea remove about 63.3 kg N, 15.8 kg P_2O_5 and 49.8 kg K_2O per hectare to produce one tone of pigeonpea grains (Tamboli *et al*., 1995) [10]. Proper nutrient management in pigeonpea meets out its nutrient demand and resulted in higher yield. The yield as well as nutrient use efficiency can be boosted by following balanced nutrient management. The balanced nutrient management method basically focuses on increase in crop yield, improvement in quality of produce and maintenance or improvement of soil fertility. To achieve balanced nutrition nitrogen, phosphorus and potassium are the three major macronutrient applied through fertilizer in pigeonpea.

Materials and Materials
A field experiment was conducted during *kharif* season of 2018 in Pulse Agronomy Block of Norman E. Borlaug Crop Research Centre, G. B. Pant University of Agriculture and Technology, Pantnagar (Uttarakhand). The maximum temperature during the crop season ranged between 20.3-37.2 ^{0}C. and minimum temperature ranged between 3.9-26.9^{0}C. During the crop growing season, 1316.9 mm rainfall was received. The soil of experimental field was sandy loam in texture having high organic carbon (0.83%), low available nitrogen (270.9 kg/ha), high available phosphorus (26.1 kg/ha) and medium available potassium (230 kg/ha), with slightly alkaline soil reaction (pH=7.3).The experiment was laid out in randomized block design with two factors and three replications. Treatments were consisted of three genotypes *viz.,* PA 421, PA 291 and UPAS 120 and four fertility levels *viz.,* control (no fertilizer), 75% RDF, 100% RDF and 125% RDF. The fertilizer was applied as basal, using RDF (18:48:24 kg/ha N: P_2O_5: K_2O), which was fulfilled through 150 kg/ha NPK mixture (12:32:16).

Other standard agronomic practices were adopted during crop cultivation. Seeds of three varieties were sown at the rate of 12 kg/ha. Seeds were sown on ridge at 3-4 cm depth and at a uniform distance of 60 cm between row to row and 20 cm between plants to plant. The plant height (cm), number of trifoliate leaf, number of branches and dry matter accumulation/plant were recorded during the year of experiment and expressed in standard units. The weight of plant was expressed as g/m2 and grain yield from each net plot area was recorded in kilogram and then converted into kilogram/hectare by multiplying with conversion factor based on net plot size.

Result and Discussion

Effect of nutrients and genotypes on growth of pigeonpea

The data on plant height (cm) at various crop growth stages have been presented in Table 1.

In general, plant height increased continuously with the advancement in crop age irrespective of the treatments. However, maximum increase was observed between 45 to 75 days after sowing. Different genotypes and fertility levels significantly influenced the plant height at different crop growth stages. Amongst the genotype the maximum plant height was recorded with the genotype (PA 291) as compared to other genotypes but genotype PA421 and UPAS 120 was at par with each other at all the growth stages of crop i.e. 45, 75 , 105 DAS and at maturity . This might be attributed to the inherent character of different genotypes which helped them to attain their respective plant height.

In general, increase in fertility level led to increase in plant height at all the stages of crop growth. At 45 DAS the maximum plant height was recorded with the application of 125% RDF which was statistically at par with 100% RDF but significantly superior over other levels. At 75, 105 DAS and maturity, 125% RDF achieved significantly higher plant height as compared to other fertility levels. At all growth stages, the lowest plant height was recorded when no fertilizer (control) was applied. Increase in plant height of pigeonpea at higher fertility levels may be ascribed to increase in nitrogen content of chlorophyll which helped in increasing photosynthesis and meristematic activity of plant. Besides, nitrogen is essential component of amino acids which in-turn are vital building block of development of tissue and consequently increased the plant height. The results were in conformity with the finding of Singh and Pal (2003) [9].

Different genotype and fertility level significantly influenced the number of trifoliate leaves at all the successive crop growth stages. Among all the genotypes, PA 421 gave significantly higher number of trifoliate leaves per plant at 45 and 75 DAS than other genotypes but PA 291 were statistically at par with that of UPAS 120. At 105 and maturity, there was non-significant difference in number of trifoliate leaves per plant among all the genotypes.

Fertility levels significantly influenced number of trifoliate leaves per plant. At 45, 75 and 105 DAS, maximum number of trifoliate leaves per plant was recorded with the application of 125% RDF which in-turn was statistically at par with application of 100% RDF. However at maturity, there was no significant difference in number of trifoliate leaves but still numerically higher trifoliate leaves was found in 125 and 100% RDF. The lowest number was recorded in control at all growth stages. The increase in number of trifoliate leaves was attributed due to role of balanced NPK in various physiological and biological processes which might have contributed to the growth of meristematic region and ultimately number of trifoliate leaves. Similar results were reported by Egbe and Vange (2008) [2] and Ramesh *et al.* (2006) [7].

Table 1: Effect of nutrients and genotypes on growth (Plant height, trifoliate leaves and number of primary branches per plant) of pigeonpea

Treatment	Plant height (cm)				Trifoliate leaves (Number/plant)				Number of primary branches per plant			
	45 DAS	75 DAS	105 DAS	Maturity	45 DAS	75 DAS	105 DAS	Maturity	45 DAS	75 DAS	105 DAS	Maturity
Genotype												
PA 421	73.3	143.1	166.9	208.0	51.2	204.5	319.0	238.1	7.8	17.0	24.7	30.3
PA 291	83.9	152.8	175.3	217.3	41.9	200.0	314.2	240.2	6.5	15.6	22.3	26.9
UPAS 120	76.5	147.1	158.2	203.0	37.2	187.3	314.4	233.4	5.9	12.7	21.2	26.2
SEm±	2.2	2.0	1.9	2.8	2.0	2.8	8.3	4.6	0.3	0.5	0.9	1.0
C.D. at 5%	6.5	6.0	5.8	8.1	5.8	8.4	NS	NS	0.8	1.6	2.3	2.9
Fertility level												
Control (no fertilizer)	72.4	139.4	149.3	187.3	36.1	183.7	289.1	226.3	5.3	12.4	19.3	23.9
75% RDF*	74.9	144.9	163.6	203.5	41.4	191.2	309.3	236.3	6.0	14.6	21.6	26.1
100% RDF	80.0	149.3	172.8	218.5	45.6	201.1	327.0	243.7	7.3	15.3	23.2	28.6
125% RDF	84.4	157.1	181.3	228.2	51.6	213.6	338.8	242.7	8.3	18.0	26.8	32.6
SEm±	2.5	2.4	2.3	3.2	2.3	3.3	9.5	5.3	0.3	0.6	0.9	1.0
C.D. at 5%	7.5	6.7	6.9	9.4	6.7	9.7	28.2	NS	0.9	1.9	2.7	3.3

The information showed that number of primary branches expanded with the headway in yield development stage regardless of the treatments. Among various genotypes, PA 421 recorded altogether higher number of branches at all the growth stages when contrasted with different genotypes, besides at 75 DAS. Genotype PA 291 was genuinely at par with that of UPAS 120 regarding branches, besides at 75 DAS.

At all the development stages, altogether greatest number of branches was recorded with the use of 125% RDF contrasted with other fertility levels. The treatment wherein there was no use of fertilizer (control) produced most minimal number of branches at all the development stages. The outcomes uncovered that with advancing crop growth stages, increase in fertility levels may have expanded the creation of phytohormones especially cytokinin which helped in expanding the production of branches per plant. Comparative outcomes were additionally found by Singh and Yadav (2008).

The data revealed that three genotypes differed significantly with respect to plant spread. Genotype PA 421 recorded significantly higher plant spread as compared to other genotypes in all the crop growth stages except at 105 DAS. The increased in plant spread of PA 421 was probably due to the optimum plant height which is very much needed for better translocation of photosynthates for lateral growth of

plant. As pigeonpea is an indeterminate crop, neither too long nor too small plant height is desirable for good lateral growth.
With the increment in fertility level, plant spread increased. At 45 DAS plant spread with the application of 125% RDF was statistically at par with that of 100% RDF treatment but found superior to all other fertility levels. In all the growth stages, the plant spread was minimum in control. The plant spread increased with the increase in fertility levels due to more translocation of photosynthates towards lateral part of the plant and similar results were confirmed by Kumar *et al.* (2003) [4] and Pandey and Kushwaha (2009) [6].
Dry matter accumulation increased with the age of the crop and attained its maximum value at maturity stage. Among different genotypes, PA 421 recorded significantly higher dry matter accumulation per plant compared to other genotypes at all the successive growth stages. The lowest dry matter accumulation was recorded in UPAS 120.
With the successive increase in fertility levels, the dry matter accumulation per plant increased significantly. Higher dry weight accumulation per plant was recorded with the application of 125% RDF at all the successive growth stages. At 45 and 75 DAS, no significant difference was found between 100 and 75% RDF but at 105 DAS and maturity, 100% RDF have been significantly differed over 75% RDF in terms of dry matter accumulation.
The results revealed that genotypes itself were responsible for variation in dry matter accumulation while applied NPK enhanced the growth of pigeonpea. Similar results were found by Baboo and Mishra (2001) [1] and Pandey and Kushwaha (2009) [6].

Table 2: Effect of nutrients and genotypes on growth (Plant spread and dry matter accumulation) of pigeonpea

Treatment	Plant spread (cm)				Dry matter accumulation (g/plant)			
	45 DAS	75 DAS	105 DAS	Maturity	45 DAS	75 DAS	105 DAS	Maturity
Genotype								
PA 421	23.6	49.3	94.3	143.2	51.2	204.5	319.0	238.1
PA 291	19.9	43.7	88.4	138.0	41.9	200.0	314.2	240.2
UPAS 120	21.0	45.4	91.7	140.4	37.2	187.3	314.4	233.4
SEm±	0.9	0.4	1.0	0.9	2.0	2.8	8.3	4.6
C.D. at 5%	2.3	1.1	2.6	2.7	5.8	8.4	NS	NS
Fertility level								
Control (no fertilizer)	18.7	41.7	84.1	133.0	36.1	183.7	289.1	226.3
75% RDF*	20.6	44.6	88.6	139.7	41.4	191.2	309.3	236.3
100% RDF	22.7	47.7	93.2	143.6	45.6	201.1	327.0	243.7
125% RDF	24.0	50.7	100.0	145.9	51.6	213.6	338.8	242.7
SEm±	0.9	0.4	0.9	1.0	2.3	3.3	9.5	5.3
C.D. at 5%	2.7	1.3	2.6	3.2	6.7	9.7	28.2	NS

Effect of nutrients and genotypes on yield of pigeonpea
Data pertaining to yield attributing characters and yield of pigeonpea has been given in Table 2.The number of pods per plant, pod length (cm), number of grains per pod, grain yield per plant (g/plant), grain yield per hectare was significantly influenced by the genotypes. Genotype PA 421 gave significantly higher number of pod per plant, pod length (cm), number of grains per pod, grain yield per plant (g/plant), grain yield per hectare as compared to PA 291 and UPAS 120. PA 291 was statistically similar to UPAS 120. Similar results were reported by Telgot *et al.* (2004) [11].

Table 3: Effect of nutrients and genotypes on yield of pigeonpea

Treatment	Yield attributes						
	No. of Pods/plant	Pod length (cm)	No. of grain/pod	1000-grain weight (g)	Grain yield (g/plant)	Grain yield (kg/ha)	H.I. (%)
Genotype							
PA 421	377.9	5.2	4.5	80.9	80.9	2,477	20.6
PA 291	257.4	4.8	3.8	82.1	65.5	2,058	19.0
UPAS 120	258.1	4.9	4.0	81.5	59.5	2,024	19.6
SEm±	3.5	0.1	0.2	1.1	1.2	71	0.64
C.D. at 5%	10.3	0.3	0.3	N/S	3.7	210	N/S
Fertility level							
Control (no fertilizer)	269.4	4.6	3.7	78.3	56.7	1,934	19.6
75% RDF*	281.0	5.0	4.0	79.7	64.4	2,142	20.6
100% RDF	307.7	5.1	4.2	83.0	74.6	2,308	20.3
125% RDF	333.1	5.3	4.4	85.0	78.9	2,359	18.5
SEm±	4.0	0.1	0.1	1.3	1.4	82	0.74
C.D. at 5%	12.0	0.3	0.4	N/S	4.2	242	N/S

Different fertility levels significantly influenced the number of pods per plant, the length of the pod (cm), number of grains per pod, grain yield per plant (g/plant), grain yield per hectare (q/ha), was recorded maximum with application of 125% RDF which was found statistically at par with 100% RDF. Harvest index, 1000-seeds weight was not influenced significantly by both genotypes and fertility levels. The increase in rate of fertilizer application led to the increase in leaf area, dry matter production and consequently increases number of pods per plant and grains per pod. The cumulative effect of all these was reflected in higher grain yield per plant. Same results were in conformity of results reported by Saritha *et al.* (2012) [8] and Meena and Sharma (2012) [5]. Similar results were recorded by Kantwa *et al. (*2005) [3] and Mathur *et al.* (2007)

Conclusion
On the basis of above investigation, it can be inferred that PA 421 recorded superior with respect to growth and yield attributing characters, as compared to PA 291 and UPAS 120. PA 291 and UPAS 120 were at par with each other in terms of these parameters. 125% RDF was found at par with 100% RDF in terms of yield and net return but found significantly higher over other fertility levels. Adoption of pigeonpea genotype PA 421 and 100% RDF may give higher grain yield and economic benefit in *tarai* region of Uttarakhand.

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