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Effect of phosphorus and time of sowing on growth, yield and economics of chickpea (*Cicer arientinum* L.)

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Abstract
A field experiment was conducted during *Rabi* 2020 at Crop Research Farm, Department of Agronomy, SHUATS, Allahabad, (U.P.). The soil of experimental plot was sandy loam in texture, nearly slightly acidic in soil reaction (pH 7.3), low in organic carbon (0.186%), available N (88.35%), available P (13.7 kg/ha), available K (235.2 kg/ha).The experiment was consisted of 9 treatments each replicated three times. The experiment was laid out in Randomized Block Design. The result showed significant increase in plant height (68.09 cm), number of nodules/plant (34.89), dry weight (15.97 g), crop growth rate (17.35 g/m^2/plant) with application of 40 kg P/ha which was sown on November 16 and whereas maximum relative growth rate (0.058g/g/day) was recorded in T_5(30 kg/ha P +26th November 2020) respectively. Number of pods/plant (29.80), number of seeds/pod (1.67), Seed index (15.20 g), Seed yield (2183.33 kg/ha), Stover yield (4266.67 kg/ha), Harvest index (38.25%) significantly increased with application of 40 kg P/ha which was sown on November 16. Gross return (Rs.72099.9/ha), net return (Rs.52602.14/ha) and B:C ratio (2.69) were found significantly highest with application of 40 kg/ha P + 16th November 2020.

Keywords: Chick pea, phosphorus levels, sowing dates and yield

Introduction
Chickpea (*Cicer arientinum* L.) is most important pulse crop in India. It is a highly nutritious legume crop and one of the cheapest sources of protein. Chickpea is an important *rabi* season self-pollinated legume crop having extensive geographical distribution. It is one of the mostly produced and consumed legumes of the world and contains about 21.1% protein, 65.5% carbohydrates, and good amount of fat (4-10%) (Sharma *et al*. 2016) [11]. India grows pulse crops on 293.60 lakh ha area and production 245.06 lakh ton of pulse grain. (Ministry of Agriculture & Farmer Welfare, 2018) [6]. Chickpea crop grown in 105.73 lakh ha area and produce 111.58 lakh ton grain all over the India. (Ministry of Agriculture & Farmer Welfare, 2018) [6]. In Uttar Pradesh Chickpea crop grown in 6.11 lakh ha area and produce 6.84 lakh ton grain. (Pulse Revolution 2018). Pulses are important source of dietary protein as well as conserving and improving physical properties of soil by virtue of their deep root system. Leaf senescence which adds organic matter in the soil. Inoculation of legume seed with *Rhizobium* and Phosphatic fertilizer increases root growth, number of active nodule, the soil fertility and yield of the crop. Phosphorus is a major nutrient element required for proper growth and yield of grain legumes. It is essential for efficient and early root development, enhanced nodulation and leaf size, tillering, flowering, grain yield, and early maturity. (Memon *et al*. 2016) [5]. It plays an important role in photosynthesis process and storage and transfer of energy and sugar and starch utilization by being constituent of energy rich compounds *viz*. Adenosine Triphosphate (ATP) and Adenosine Diphosphate (ADP). Phosphorus application is essential for energy transfer in living cells enhancing root growth besides increasing the mobility of symbiotic bacteria in the root zone which ultimately results in more nitrogen fixation. It also plays a key role in pod filling and ultimately enhances the grain yield. Different planting dates subject the vegetative and reproductive stages of the plant to various temperature, solar radiation and day length. (Dhote *et al*. 2019). Optimum sowing time of chickpea may vary from one variety to another variety and also from one region to another due to variation of agro-ecological conditions and genetic makeup. Optimum sowing time gives more production. Optimum sowing time provides more time for growth and development of plant which is favorable for higher yield whereas both early and late sowing due to frost affect the crop yield and development with lowering seed yield. Earlier or late sowing caused drastic reduction in yield and net profit compared with timely sowing. Sowing of chickpea at optimum time ensures a better harmony among soil, plant and atmospheric system.

Materials and Methods

The experiment was carried out during the *Rabi* season of 2020 at Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, SHUATS, Prayagraj (U.P.), which is located at geographical coordinates 25^0 24' 42" N latitude, 81^0 50' 56" E longitude and 98 m altitude above the mean sea level. Prayagraj has a subtropical and semi-arid climatic condition, with both extremes of temperature, *i.e.* winter and summer. The soil samples were collected randomly from 0 to 15 cm depth from 5 spots of the experimental field just before layout of with experiment. Soil samples tested in a KVK, SHUATS research station. Soil texture class was sandy loam low available Nitrogen (88.35 kg/ha), available Phosphorus (13.7 kg/ha) and medium available potassium (235.2 kg/ha) with EC (0.395 ds/m^{-1}), pH (7.3), organic carbon (0.395%). The Experiment was laid out in Randomized Block Design consisting of 9 treatments each replicated thrice. The treatment combination offered were T_1: 20 kg/ha P + 16th November 2020, T_2: 20kg/ha+ 26th November 2020, T_3: 20 kg/ha +6th December 2020, T_4:30 kg/ha P +16th November 2020, T_5: 30 kg/ha P + 26th November 2020, T_6:30 kg/ha P + 6th December 2020, T_7:40 kg/ha P +16th November 2020, T_8: 40 kg/ha P + 26th November 2020 and T_9: 40 kg/ha P + 6th December 2020.N and K were applied as RDF (20:30) in form urea and MOP whereas P was applied as per treatment in form SSP. Seeds were sown in line at a depth of 5 cm at the row to row distance of 30 cm and plant to plant spacing of 10 cm with the seed rate of 60 kg/ha. Variety used for testing was PUSA 362. The crop was harvested (1sq m) exactly from the net plot size from the center and weighed before threshing. For observation five plants were randomly selected in a zig-zag pattern avoiding the harvest zone and border rows and /or plants within the plots.

Statistical Analysis

The data recorded for different parameters were subjected to statistical analysis by adopting Fisher method of analysis of Variance (ANOVA) as described by Gomez and Gomez (2010). Critical difference (CD) values were calculated with "F" test at 5% significance level.

Result and Discussion

Growth attributes: Data presented in Table 1 shows the effect of phosphorus and date of sowing on growth attributes of chickpea (*Cicer arientinum* L.). Plant height (68.09 cm) was recorded significantly highest with application of 40 kg P/ha of which was sown on November 16. Number of nodules/plant (34.89) were recorded significantly highest with application of 40 kg P/ha which was sown on November 16. Dry weight (15.97 g) was recorded significantly highest with application of 40 kg P/ha whose sowing was done on November 16.Crop growth rate (17.35 g/m^2/day) was recorded significantly highest with application of T_7 (40 kg/ha P + 16th November 2020) where asT_8(15.76 g/m2/day) was found statistically on par with highest. Relative growth rate (0.058 g/g/day) was recorded significantly highest with application of 30 kg p/ha+ 26th November 2020. Whereas, T_4(0.056g/g/day) and T_6(0.055g/g/day) were found statistically on par with highest.

Adequate supply of phosphorus increased plant height and developed reproductive parts. Phosphorus had a positive effect on root growth. Phosphorus requirement is essential for crops like chickpea as they fix nitrogen through symbiotic association with *Rhizobium.* Plant height also affected due to early sowing of chickpea during November because of increased photosynthesis due to high temperature. Phosphorus application increase root nodule due to enhanced growth of rizobia. The application of Phosphorus with microbial association and its activity improved the number of nodules. Great amount of rain were received during January and February coupled with cool temperature which resulted in significantly increased number of nodules. Dry weight increased due to higher photosynthetic rate. Photosynthetically active radiation (PAR) amount directly affects the dry matter production due to different date of sowing. The CGR was significantly higher might be due to application of Phosphorus which increased the chlorophyll content and higher photosynthates. From 2nd week of November upto 1st week of December CGR declined due to lower temperature, which caused cessation of cell division activity in the meristematic tissues. Higher dry matter production by plant growth regulator treatment relative growth rate (RGR) increased in 2nd fortnight of November. It is also increased with application phosphorus upto 40kg/ha. All these finding similar to (Chauhan *et al.* 2017, Kumar *et al*. 2019, Das *et al*. 2013, Prasad *et al.* 2012) [1, 4, 2, 8].

Table 1: Effect of levels of phosphorus and date of sowing on growth attributes of chickpea (*Cicer arientinum* L.)

		At 100 DAS			During 80-100 DAS	
Treatment No.	**Treatment combinations**	**Plant Height(cm)**	**Number of nodules /plant**	**Dry weight (g/Plant)**	**Crop Growth Rate(CGR) (g/m^2/day)**	**Relative growth rate(RGR) (g/g/day)**
1.	20 kg/ha P + 16th November 2020	56.50	9.78	8.52	7.60	0.051
2.	20 kg/ha P + 26th November 2020	55.01	6.33	6.75	6.61	0.038
3.	20 kg/ha P + 6th December 2020	52.22	3.11	5.78	4.89	0.031
4.	30 kg/ha P + 16th November 2020	62.12	20.22	11.34	14.27	0.056
5.	30 kg/ha P +26th November 2020	60.08	15.78	10.40	13.42	0.058
6.	30 kg/ha P +6th December 2020	58.09	11.44	9.68	10.16	0.055
7.	40 kg/ha P + 16th November 2020	68.09	34.89	15.97	17.35	0.049
8.	40 kg/ha P +26th November 2020	66.01	29.66	13.52	15.76	0.049
9.	40 kg/ha P + 6th December 2020	64.19	24.33	12.06	14.04	0.049
	F-test	S	S	S	S	S
	S.Em(±)	0.07	0.58	0.23	1.43	0.001
	CD at 5%	0.20	1.73	0.70	3.03	0.004

Yield attributes

Data presented in Table 2for yield attributes shows significant difference among all treatments. Number of pods/plant (29.80) were recorded significantly highest with application of 40 kg/ha P+ 16th November 2020 while T_8(27.40) was found to statistically on par with T_7. Number of seeds/pod

(1.67) were recorded significantly highest with application of 40 kg P/ha +16th November 2020, while T_8(1.47) was found to statistically on par with T_7. Seed Index (15.20g) was recorded significantly highest with application of 40 kg/ha P + 16th November 2020. Seed yield (2183.33kg/ha) was recorded significantly highest with application of 40 kg/ha P + 16th November 2020, while T_1(2013.33kg/ha),T_5 (1920.00kg/ha),T_8 (1656.67 kg/ha) were found to statistically on par with T_7. Stover yield (4266.67 kg/ha) were recorded significantly highest with application of40 kg/ha P + 16th November 2020, while T_1(3933.33 kg/ha) was found to statistically on par with T_7. Harvest index (38.25%) were recorded significantly highest with application of 40kg/ha P + 16th November 2020, while T_1(37.85%) and T_5(37.65%) were found to statistically on par with T_7, respectively.

Phosphorus levels resulted in enhanced photosynthetic activity which ultimately produced greater number of pods/plant. Number of pods/plant increased in sowing at 2nd Fortnight of November and reduced during 1st week of December due to low temperature stress. Low temperature reduced pod setting from perfect flower. Increment in number of seeds/pod depend upon ability of assimilation and translocation of nutrients towards pods during seed maturation it may get affected due low temperature. Phosphorus ensure uniform and directly maturity of crop and also involved in transformation of energy in higher value of growth and yield attributes and also that due to phosphorus early development translocation of food materials in plant body resulted in better uptake of nutrients and ultimately in better seed yield. The increase in seed yield in early sowing dates may be due to longer duration crop and higher photosynthetically active radiation (PAR). Increased stover yield under early sowing might be due to higher dry matter accumulation and phosphorus application upto 40 kg/ha. Highest harvest index in case of early sowing might be due to more economic yield. All these finding similar to (Roy *et al.* 2017, Reddemma *et al*. 2019, Memon *et al.* 2016, Gulpadya *et al*. 2014) [9, 10, 5, 3].

Table 2: Effect of levels of phosphorus and date of sowing on yield attributes of chickpea (*Cicer arientinum* L.)

		At harvest					
Treatment No.	**Treatment combinations**	**Number of pods/ plant**	**Number of seed/pods**	**Seed Index (g)**	**Seed yield (kg/ha)**	**Stover yield (kg/ha)**	**Harvest Index (%)**
1.	20 kg/ha P + 16th November 2020	22.33	1.00	14.21	2013.33	3933.33	37.85
2.	20 kg/ha P + 26th November 2020	22.27	1.13	14.12	1200.00	2411.67	36.07
3.	20 kg/ha P + 6th December 2020	21.40	1.00	13.95	1090.00	2101.67	32.12
4.	30 kg/ha P + 16th November 2020	24.40	1.20	14.95	1350.00	2575.33	36.15
5.	30 kg/ha P +26th November 2020	23.87	1.13	14.63	1920.00	3715.33	37.65
6.	30 kg/ha P +6th December 2020	22.87	1.07	14.32	1193.33	2165.00	34.57
7.	40 kg/ha P + 16th November 2020	29.80	1.67	15.20	2183.33	4266.67	38.25
8.	40 kg/ha P +26th November 2020	27.40	1.47	15.15	1656.67	3143.33	36.45
9.	40 kg/ha P + 6th December 2020	25.80	1.33	15.02	1133.33	2208.33	34.23
	F-test	S	S	S	S	S	S
	S.Em(±)	0.88	0.08	0.10	195.40	35.74	0.28
	CD at 5%	2.65	0.23	0.02	585.80	107.15	0.85

Economics of Treatments

In Table 3, economic analysis of the treatments was given. Maximum gross return (₹72099.9/ha), Net return (₹ 52602.14/ha), B:C ratio (2.69) were recorded with application of T_7 (40 kg/ha P + 16th November 2020) as compared to other treatments. The value of increased yield was much more than the cost of Phosphorus application which increased the net returns and B: C ratio these finding similar to (Prasad *et al*. 2012) [8].

Table 3: Effect of levels of phosphorus and date of sowing on economics of chickpea (*Cicer arientinum* L.)

Treatment No.	Treatment combinations	Total cost of cultivation (₹/ ha)	Gross return (₹/ ha)	Net return (₹ / ha)	Benefit cost ratio
1.	20 kg/ha P + 16th November 2020	17497.76	56948.25	39450.49	2.25
2.	20 kg/ha P + 26th November 2020	17497.76	59716.65	42218.89	2.41
3.	20 kg/ha P + 6th December 2020	17497.76	36005.6	18507.84	1.05
4.	30 kg/ha P + 16th November 2020	18497.76	39566.65	21086.89	1.13
5.	30 kg/ha P +26th November 2020	18497.76	52166.65	33668.89	1.82
6.	30 kg/ha P +6th December 2020	18497.76	38833.3	20335.54	1.09
7.	40 kg/ha P + 16th November 2020	19497.76	72099.9	52602.14	2.69
8.	40 kg/ha P +26th November 2020	19497.76	47750.05	28252.29	1.44
9.	40 kg/ha P + 6th December 2020	19497.76	41666.4	22168.64	1.13

Conclusion

On the basis of above experiment it can be conclude that, the application of 40 kg/ha P + 16th November 2020 sustain higher growth attributes, seed yield (2183.33 kg/ha), Stover yield(4266.67 kg/ha), Net return (₹52602.14) and B:C ratio (2.69) as compared to other treatment combination. Hence, this treatment found more desirable for higher growth and yield also economical for the farmers.

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