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Effect of different levels of phosphorus and dates of sowing on growth and yield of green gram (*Vigna radiata* L.) under climatic condition of Allahabad

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Abstract
A field experiment was conducted during the *Kharif* season 2015 at the Crop Research Farm, Department of Environmental Science, SHIATS, Allahabad (U.P.) to concluded the experiment on the title effect of different levels of phosphorus and dates of sowing on growth and yield of green gram (*Vigna radiata* L.) under climatic condition of Allahabad in factorial Randomized Block Design with nine treatment combinations and replicated thrice. The results revealed that highest plant height (75.81 cm), number of branches (4.00), number of nodules (65.27). Yield and yield attributes *viz.* number of pods plant^{-1} (31.53), Test weight (44g), seed yield (1497 kg ha^{-1}), stover yield (2920 kg ha^{-1}), harvest index (42.45%) were highest recorded in treatment T_3(75 kg phosphorus ha^{-1}+15 July DOS). Treatment combination T_7 (25 kg phosphorus+05 August DOS) require more GDD to reach flowering (959.00) and maturity (1540.70).

Keywords: Phosphorus, sowing date, green gram, GDD, *Vigna radiate* L.

Introduction
Pulses are the main source of protein particularly for vegetarians and contribute about 14 per cent of the total protein of average Indian diet. Production of pulses in the country is far below the requirement to meet even the minimum level per capita consumption. The per capita availability in pulses dwindling fast from 35.0 g/capita per day in 2005 as against the minimum requirement of 84 g per day per capita prescribed by ICMR, which is causing malnutrition among the growing people (Anonymous, 2005-06) [1]. Pulse production is very low and become challenging problem against the requirement of increasing population of our country.

Green gram locally called as moong or mung [*Vigna radiata* (L.) Wilczek]. As it belongs to the family leguminaceae so it has the capacity to fix atmospheric nitrogen. It's one of the important *kharif* pulse crops of India which can be grown as catch crop between *rabi* and *kharif*-seasons. India alone accounts for 65% of its world acreage and 54% of the total production. It is grown on about 3.50 mha in the country mainly in Rajasthan, Maharashtra, Andhra Pradesh, Karnataka, Orissa and Bihar. A phenomenal increase in area, production and productivity has occurred since 1964-65. The area has increased from 1.99 million ha in 1964-65 to 3.54 million ha in 2010-2011. The production has increased from 0.60 million tonnes to 1.81 million tonnes during the same period. Throughout the India, the mungbean is used for different purposes. The major portion is utilized in making *dal*, soup, sweets and snacks (Anonymous, 2012) [2].

In India, production of pulses is around 13.5-15 million tonnes during the last decade, while annual domestic demand is 18-19 million tonnes. The yield of pulses has remained virtually stagnant for the last 40 year (539 kg/ha in 1961 to 544 kg/ha in 2001 to 696 kg/ha in 2013-14). India is short of supply by 2 to 3 million tonnes annually (FAOSTAT, 2013-14) [6].

Phosphorus: Phosphorus is the second most important nutrient that must be added to the soil to maintain plant growth and sustain crop yield. Phosphorus plays a vital role in photosynthesis, respiration, energy storage, cell elongation and improves the quality of crops. Deficient plants may have thin, erect and spindly stems and leaves turn into bluish-green colour. It stimulates early root development and growth and there by helps to establish seedlings quickly. It enhances the activity of *Rhizobium* and increased the formation of root nodules. Thus, it helps in fixing more of atmosphere nitrogen in root nodules.

Sowing date: Various factors responsible for low yield of mungbean at the farmer's field are: un-awareness of farmers about optimum date of sowing, improper planting patterns, insufficient plant protection measures and imbalanced use of fertilizers. Among these factors, proper sowing time and planting patterns are of great importance. Early sowing invites alarge number of insect pests and diseases, while late sowing fetches lesser grain yield due to short growing season and ultimately lesser accumulation of photosynthesis (Quresh & Rahim, 1987) [10].

Materials and Methods

The experiment was carried out during *Kharif* season 2015 at Crop Research Farm, Department of Environmental Science, School of Forestry and Environment, Sam Higgins bottom Institute of Agriculture, Technology and Sciences, Allahabad (U.P.), which is located at $25^0$24' 42" N latitude, 81^0 50' 56" E longitude and 98 m altitude above the mean sea level. This area is situated on the right side of the river Yamuna by the side of Allahabad Rewa Road about 5 km away from Allahabad city. It consists of three sowing date 15 July, 25 July, 05August and three levels of phosphorus 25, 50, 75 kg ha^{-1}. The soil was sandy loam in texture, the pH of the soil was slightly alkaline in reaction (7.4), it was low in organic carbon (0.32 %), low in available nitrogen content (188.3 kg ha^{-1}), medium in available phosphorus (34.5 kg ha^{-1}), low in available potassium (87.3 kg ha^{-1}) and low in available sulphur (6 ppm) contents. The full dose of phosphorus in the form of single super phosphate was applied at 25, 50, 75 kg ha^{-1} at the time of sowing as per the treatments. The recommended dose of nitrogen and potassium were applied at the rate of 20:20 kg. N and K_2O per hectare in the form of urea and muriate of potash. Treatments were T_1-(D_1+P_1) @ 15July DOS + 50% Phosphorus ha^{-1},T_2 -(D_1+P_2) @ 15July DOS + 100% Phosphorus ha^{-1},T_3-(D_1+P_3) @ 15July DOS + 150% Phosphorus ha^{-1},T_4 -(D_2+P_1) @ 25July DOS + 50% Phosphorus ha^{-1}, T_5-(D_2+P_2) 25July DOS + 100% Phosphorus ha^{-1}, T_6-(D_2+P_3) @ 25July DOS + 150% Phosphorus ha^{-1},T_7-(D_3+P_1) @ 05 August DOS + 50% Phosphorus ha^{-1},T_8 -(D_3+P_2) @ 05 August DOS + 100% Phosphorus ha^{-1}, T_9-(D_3+P_3) @ 05August DOS + 150% Phosphorus ha^{-1}.

Results and Discussion

Interaction effect of phosphorus and dates of sowing on growth parameter on green gram

The interaction effects of different levels of phosphorus and sowing date on plant height was non-significant at 15 DAS and 30 DAS, but it was significant at 45 DAS and 60 DAS. The maximum plant height recorded at 15, 30, 45, 60 DAS was 10.33, 20.63, 45.83, 75.81 cm respectively in T_3-15July sowing date + 75 kg phosphorus ha^{-1}. The increase in plant height of green gram with increasing rate of phosphorus application also reported by Owla *et al.* (2007) [7] and Ali *et al.* (2010) [4].

The interaction effects of different levels of phosphorus and sowing date on number of branches was significant at 45 DAS and 60 DAS. The maximum number of branches recorded at 45, 60 DAS was 3.86, 4.00 respectively in T_3-15July sowing date+ 75 kg phosphorus ha^{-1}.

The interaction effects of different levels of phosphorus and sowing date on number of nodules was non-significant at 15, 30, 45, 60 DAS. The maximum number of nodules recorded at 15, 30, 45, 60 DAS was 6.67, 30.60, 65.27, 24.67 respectively in T_3-15July sowing date + 75 kg phosphorus ha^{-1}. The increase in number of nodules of green gram with increasing rate of phosphorus application also reported by Owla *et al.* (2007) [7] and Ali *et al.* (2010) [4] and Ram and Dixit (2001) [9].

The number of nodules also affected by sowing date. The third week of July is best date of sowing comparison to last week of June and first week of July. Fraz *et al.* (2006) [8].

The interaction effects of different levels of phosphorus and sowing date onplant dry weight was non-significant at 30, 60 DAS but it was significant at 45 DAS. The highest dry weight was recorded at 30, 45, 60 DAS was 1.64, 10.64, 30.92 respectively in T_3-15July sowing date + 75 kg phosphorus ha^{-1}. The increase in number of nodules of green gram with increasing rate of phosphorus application also reported by Ali *et al.* (2010) [4] and Owla *et al.* (2007) [7] and Ram and Dixit (2001) [9].

Interaction effects of phosphorus and sowing date on yields attributes and yield of green gram

The interaction effects of different levels of phosphorus and sowing date onnumber of pods $plant^{-1}$, straw yield, and test weight was non-significant. The highest number of pods, straw yield and test weight recorded 31.53, 27.56, 42.80 respectively in T_3-15July sowing date + 75 kg phosphorus ha^{-1}.

The interaction effects of different levels of phosphorus and sowing date onnumber of grains pod^{-1}, seed yield, and harvest index was significant. The highest number of grain pod^{-1}, seed yield and harvest index recorded recorded 12.80, 13.33, 42.80 respectively in T_3-15July sowing date + 75 kg phosphorus ha^{-1}. The increase in number of grains pod^{-1}, seed yield, straw yield of green gram with increasing rate of phosphorus application also reported by Owla *et al.* (2007) [7] and Ali *et al.* (2010) [4], Bairwa *et al.* (2014) [5] and Ram and Dixit (2001) [9]. The number of nodules also affected by sowing date. The third week of July is best date of sowing comparison to last week of June and first week of July. Fraz *et al.* (2006) [8] and Malik *et al.* (2006) [3].

Table 1: Interaction table on effect of different levels of phosphorus and sowing dates on growth and yield of green gram (*Vigna radiata* L.)

Treatment combination	Plant height(cm)				Number of branches		Number of nodules				Plant dry weight (g)			Number of pods $plant^{-1}$	Number of grain $pods^{-1}$
	15 DAS	30 DAS	45 DAS	60 DAS	45 DAS	60 DAS	15 DAS	30 DAS	45 DAS	60 DAS	30 DAS	45 DAS	60 DAS	60 DAS	60 DAS
T_1 : P 25 kg ha^{-1} + 15 July DOS	9.80	18.72	40.80	70.47	2.70	2.70	6.20	28.30	52.50	16.01	1.40	7.37	22.60	22.80	9.87
T_2 : P 50 kg ha^{-1} + 15 July DOS	10.07	19.80	44.67	74.53	3.32	3.32	6.37	29.93	59.40	20.87	1.46	8.59	26.10	25.53	11.00
T_3 : P 75 kg ha^{-1} + 15 July DOS	10.33	20.63	45.83	75.81	3.86	4.00	6.67	30.60	65.27	24.67	1.64	10.64	30.92	31.53	12.80
T_4 : P 25 kg ha^{-1} + 25 July DOS	8.40	16.00	37.03	68.37	2.44	2.63	6.10	27.97	50.40	15.57	1.23	7.17	22.19	20.40	8.51
T_5 : P 50 kg ha^{-1} + 25 July DOS	8.60	17.57	39.30	70.77	3.04	3.26	6.20	29.20	57.03	19.83	1.31	8.33	25.69	24.07	9.40
T_6 : P 75 kg ha^{-1} + 25	9.04	18.13	41.67	72.27	3.63	3.73	6.27	30.17	63.27	22.33	1.45	9.45	29.87	28.00	11.37

July DOS															
T_7 : P 25 kg ha^{-1} + 05 August DOS	7.60	15.04	35.80	67.03	2.16	2.26	5.93	27.90	49.37	15.17	1.09	7.03	21.89	19.89	8.03
T_8 : P 50 kg ha^{-1} + 05 August DOS	8.37	16.37	37.63	69.13	2.89	3.04	6.03	29.03	55.67	18.27	1.24	8.17	25.22	21.03	8.70
T_9 : P 75 kg ha^{-1} + 05 August DOS	8.90	17.80	40.10	71.02	3.32	3.57	6.13	30.03	61.00	21.97	1.33	9.29	29.07	25.17	10.01
F- test	NS	NS	S	S	NS	S	NS	NS	NS	NS	NS	S	NS	NS	S
S. Em (±)	0.08	0.10	0.29	0.27	0.36	0.03	0.07	0.36	1.31	0.56	0.06	0.13	0.52	0.90	0.15
C. D. at 5%	-	-	0.87	0.82	-	0.09	-	-	-	-	-	0.41	-	-	0.46

Table 2: Interaction table on effect of different levels of phosphorus and sowing date on the yield and yield attributes of green gram (*Vigna radaita* L.)

Treatment combinations	Seed yield (q ha^{-1})	Straw yield (q ha^{-1})	Harvest index (%)	Test weight (g)
T_1 : P 25 kg ha^{-1} + 15 July DOS	11.30	22.83	33.10	38.20
T_2 : P 50 kg ha^{-1} + 15 July DOS	13.80	27.00	33.82	42.67
T_3 : P 75 kg ha^{-1} + 15 July DOS	14.96	29.20	33.88	44.00
T_4 : P 25 kg ha^{-1} + 25 July DOS	10.30	21.40	32.49	37.83
T_5 : P 50 kg ha^{-1} + 25 July DOS	12.48	25.60	32.78	41.23
T_6 : P 75 kg ha^{-1} + 25 July DOS	13.33	27.56	32.60	42.80
T_7 : P 25 kg ha^{-1} + 05 August DOS	9.93	20.80	32.32	36.87
T_8 : P 50 kg ha^{-1} + 05 August DOS	10.87	25.00	30.30	40.50
T_9 : P 75 kg ha^{-1} + 05 August DOS	12.47	26.40	32.08	41.93
F- test	S	NS	S	NS
S. Em (±)	0.25	0.35	0.47	0.36
C. D. at 5%	0.75	-	1.42	-

Table 3: Interaction table on effect of different levels of phosphorus and dates of sowing on agrometeorological indices

Treatment combinations	GDD(at flowering initiation)	GDD(at maturity)	Heat use effeciency
T_1 : P 25 kg ha^{-1} + 15 July DOS	859.15	1410.50	0.80
T_2 : P 50 kg ha^{-1} + 15 July DOS	817.15	1367.10	1.00
T_3 : P 75 kg ha^{-1} + 15 July DOS	775.85	1302.00	1.14
T_4 : P 25 kg ha^{-1} + 25 July DOS	934.20	1475.60	0.69
T_5 : P 50 kg ha^{-1} + 25 July DOS	912.50	1434.20	0.87
T_6 : P 75 kg ha^{-1} + 25 July DOS	869.00	1367.10	0.97
T_7 : P 25 kg ha^{-1} + 05 August DOS	959.20	1540.70	0.64
T_8 : P 50 kg ha^{-1} + 05 August DOS	903.00	1497.30	0.72
T_9 : P 75 kg ha^{-1} + 05 August DOS	852.00	1432.20	0.87
F- test	NS	NS	S
S. Em (±)	7.49	0.63	0.06
C. D. at 5%	-	-	0.12

Conclusions

From the above findings it is concluded that among all the treatment an application of 75 kg Phosphorus ha^{-1} + 15 July DOS was found to be the best for obtaining highest growth and yield of sunflower.

The study findings also have brought an expectation that further investigation on different levels of fertilizers in growing seasons and soil types can be a step forward to identify more realistic effect of different fertilizers on the growth and yield of green gram. Finally these findings will help our farmer to apply balanced fertilizer application and suitable sowing time which will be synchronized with crop demand and also will reduce the cost of production.

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