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Effect of irrigation scheduling and phosphorus levels on growth and yield of green gram (*Vigna radiata* L.)

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Abstract
A field experiment was conducted during *Zaid* season (2021) at Crop Research Farm, Department of Agronomy, SHUATS, Allahabad (U.P.). The soil of experimental plot was sandy loam in texture, nearly natural in soil reaction (pH 7.1), low in organic carbon (0.28%), available N (225 kg/ha), available P (19.50 kg/ha) and available9 K (213.7 kg/ha). The Treatments consisted of 3 different irrigation schedules IR_1 (Irrigation at 25DAS), IR_2 (Irrigation at Vegetative Stage (35DAS)), IR_3 (Irrigation at Vegetative (35DAS) and Pod Formation Stage (55DAS)) and 3 levels of Phosphorus (20 kg/ha), (40 kg/ha) and (60 kg/ha). The experiment was laid out in Randomized Block Design with 9 treatments and replicated thrice. The results revealed that the application of Irrigation at Vegetative(35DAS) and Pod Formation(55DAS) + 60Kg P/ha recorded maximum plant height (41.70cm), Number of nodules/plant (5.90), plant dry weight (11.00g/plant), pods/plant (40.30cm), number of seeds per pod (6.80), length of pod (8.40), test weight (36.00g), grain yield (854.08kg/ha), straw yield (1928.70kg/ha) and harvest index was found to be non-significant. Maximum Gross retunes (59017.7INR/ha), Net retunes (37832.3INR/ha) and B:C ratio (1.78) Where also recorded with the treatment with the application of Irrigation at Vegetative (35DAS) and Pod Formation(55DAS) +60Kg P/ha.

Keywords: Irrigation, growth, yield, phosphorus, zaid

Introduction
Pulses are important not only for their value as human food, but also because of high protein content for livestock. Green gram is one of the major pulse crop grown in the India which is cultivated in arid and semi-arid region and it is also called as moong bean. It is originated in the Indo-Burma region and the area of East Asia. For over half a century the world has relied on increasing crop yields to supply an ever-increasing demand for food. World pulse production increased significantly during last two decades. This dramatic increase in world pulse production was a result of 122% increase in crop yields. However, this trend of pulses production cannot be maintained due 0 decreasing cultivable land for rapid urbanization. Pluses vary in maturity periods, hence, are useful in different cropping systems. Green gram locally called as moong or mug belongs to the family Leguminosae, which fixes atmospheric nitrogen and improves soil fertility by adding 20-25kg N/ha. Major states in India which grow green gram are Andhra Pradesh, Madhya Pradesh, Uttar Pradesh, Rajasthan, Bihar, Gujarat and Orissa. In India it is cultivated in area about 300 million hectares. However, the per capita consumption of pulses was 43.3 g/day and 47.2 g/day in the year 2013-14, respectively (Prasad *et al*., 2014). Phosphorus is the second most important nutrient next to the nitrogen. It is the major constituent of protein and nucleic acids. Phosphorus plays a key role in the formation of energy rich bound phosphates (ADP and ATP). It also plays a major role in the growth of new tissue and division of cells plants perform complex energy transmission. The function that requires phosphorus (P) is one of the most needed elements for pulse production. Phosphorus helps in better nodulation and efficient functioning of nodulation grain-development stage, which in turn led to increase in grain yield. Plants acquire phosphorus from soil solution as phosphate and anion. Use of phosphorus solubilizing bacteria as inoculants increase phosphorus uptake. These bacteria also increase prospects of using phosphatic rocks in crop production. Greater efficiency of phosphorus solubilizing bacteria has been shown through co-inoculation with other beneficial bacteria and mycorrhiza (Khan *et al.*, 2009). The cultivation period of summer green gram is from mid-march to end June. During this period, water loss through evaporation accounts for 50% of the normal water loss for the whole year. The irrigation requirement of summer green gram becomes very high due to high evapotranspiration rate.

Under this condition, frequent irrigation produced significantly higher number of pods plant, increased the weight of seed plant and weight of thousand seed, which ultimately resulted in increased seed yield. But the application of frequent irrigations considered as one of the problems for its cultivation are extensive scale. Under such situations it becomes necessary to find out ways and means for minimizing the irrigation requirement.

Materials and Methods

The experiment was conducted during *Zaid* season of 2021. The experiment was conducted in Randomized Block Design consisting of nine treatment combinations with three replications and was laid out with the different treatments allocated randomly in each replication. The soil of the experimental field was sandy loam in texture, slightly alkaline reaction (pH 7.1) with low level of organic carbon (0.28%), available N (225 Kg/ha), P (19.50 kg/ha) and higher level of K (92.00 kg/ha). The treatment combinations are T_1 – Irrigation at 25DAS + 20kg P/ha, T_2 – Irrigation at 25DAS + 40Kg P/ha, T_3 – Irrigation at 25DAS + 60KgP/ha, T_4 - Irrigation at Vegetative Growth (35DAS) + 20Kg P/ha, T_5 - Irrigation at Vegetative Growth (35DAS) + 40Kg P/ha, T_6 - Irrigation at Vegetative Growth (35DAS) + 60Kg P/ha, T_7 - Irrigation at Vegetative (35DAS) and Pod Formation (55DAS) + 20Kg P/ha, T_8 - Irrigation at Vegetative(35DAS) and Pod Formation (55DAS) + 40Kg P/ha, T_9 - Irrigation at Vegetative(35DAS) and Pod Formation (55DAS) + 60Kg P/ha. The observations were recorded on different growth parameters at harvest *viz*. plant height (cm), number of nodules per plant, plant dry weight, Number of pods per plant, number of seeds per pod, test weight, grain yield and stover yield

Result and Discussion

A. Growth Attributes

At 60 DAS, significantly maximum plant height (41.70cm) was recorded with application of Irrigation at Vegetative (35DAS) and Pod Formation (55DAS) + 60Kg P/ha. However, treatment with application of Irrigation at Vegetative (35DAS) and Pod Formation (55DAS) + 40KgP/ha (40.90cm) was statistically at par with application of Irrigation at Vegetative (35DAS) and Pod Formation (55DAS) + 60KgP/ha compared to other treatments. At 60 DAS recorded that significantly maximum number of nodules (5.90) was observed with application of Irrigation at Vegetative (35DAS) and Pod Formation (55DAS) + 60KgP/ha. However, treatment with application of Irrigation at Vegetative (35DAS) and Pod Formation (55DAS) + 40KgP/ha (5.40) were statistically at par with application of Irrigation at Vegetative (35DAS) and Pod Formation (55DAS) + 60KgP/ha compared to other treatments. At 60 DAS recorded significantly maximum plant dry weight (11.00g) recorded with application of Irrigation at Vegetative (35DAS) and Pod Formation (55DAS) + 60KgP/ha which was significantly superior over rest of the treatments. However, treatment with application of Irrigation at Vegetative (35DAS) and Pod Formation (55DAS) + 40Kg P/ha (10.27g) were statistically on par with application of Irrigation at Vegetative (35DAS) and Pod Formation (55DAS) + 60Kg P/ha compared to other treatments.

Yield Attributes

Number of pods/plants recorded maximum was obtained with application of Irrigation at Vegetative (35DAS) and Pod Formation (55DAS) + 60KgP/ha (40.30). however, treatment with application of Irrigation at Vegetative (35DAS) and Pod Formation (55DAS) + 40KgP/ha (38.80) were statistically at par with application of Irrigation at Vegetative (35DAS) and Pod Formation (55DAS) + 60KgP/ha compared to other treatments. Number of seeds/pods recorded maximum was obtained with application of Irrigation at Vegetative (35DAS) and Pod Formation (55DAS) + 60KgP/ha (6.80) significantly superior over rest of the treatment. However, treatments with application of Irrigation at 25DAS + 20kgP/ha (5.70) is minimum compared to other treatments. Pod length recorded maximum was obtained with application of Irrigation at Vegetative (35DAS) and Pod Formation (55DAS) + 60KgP/ha (8.40cm) however, treatment with application of Irrigation at Vegetative (35DAS) and Pod Formation (55DAS) + 40KgP/ha (8.20) were statistically at par with application of Irrigation at Vegetative (35DAS) and Pod Formation (55DAS) + 60Kg P/ha compared to other treatments. Test weight recorded maximum with application of Irrigation at Vegetative (35DAS) and Pod Formation (55DAS) + 60Kg P/ha (36.00) significantly superior over rest of the treatments. However, treatment with application of Irrigation at Vegetative (35DAS) and Pod Formation (55DAS) + 40KgP/ha (35.80), Irrigation at Vegetative Growth (35DAS) + 40KgP/ha (34.60) and Irrigation at 25DAS + 60KgP/ha (34.03) were statistically at par with application of Irrigation at Vegetative (35DAS) and Pod Formation (55DAS) + 60Kg P/ha compared to other treatments.

Yield

Grain yield, recorded maximum with application of Irrigation at Vegetative (35DAS) and Pod Formation (55DAS) + 60KgP/ha (854.08 Kg/ha) significantly superior over rest of the treatments. However, treatment with application of Irrigation at Vegetative (35DAS) and Pod Formation (55DAS) + 40KgP/ha (814.08Kg/ha) were statistically at par with application of Irrigation at Vegetative (35DAS) and Pod Formation (55DAS) + 60KgP/ha compared to other treatments. Stover yield, recorded maximum with application of Irrigation at Vegetative (35DAS) and Pod Formation (55DAS) + 60KgP/ha (1928.70Kg/ha) significantly superior over rest of the treatments. However, treatments with application of Irrigation at Vegetative (35DAS) and Pod Formation (55DAS) + 40KgP/ha (1739.73Kg/ha) were statistically at par with application of Irrigation at Vegetative (35DAS) and Pod Formation (55DAS) + 60Kg P/ha compared to other treatments.

Table 1: Effect of irrigation scheduling and phosphorus levels on growth attributes of green gram

Treatments	Plant height (cm) 60 DAS	Number of nodules/plant At 60 DAS	Plant dry weight (g) At 60DAS
Irrigation at 25DAS + 20kg P/ha	38.50	3.90	7.77
Irrigation at 25DAS + 40Kg P/ha	39.30	4.40	8.80
Irrigation at 25DAS + 60KgP/ha	40.00	5.00	8.63
Irrigation at Vegetative Growth (35DAS) + 20Kg P/ha	39.60	4.80	8.59
Irrigation at Vegetative Growth (35DAS) + 40Kg P/ha	40.30	5.10	8.51
Irrigation at Vegetative Growth (35DAS) + 60Kg P/ha	40.40	5.20	9.27
Irrigation at Vegetative(35DAS) and Pod Formation (55DAS) + 20Kg P/ha	39.90	4.80	9.39
Irrigation at Vegetative(35DAS) and Pod Formation (55DAS) + 40Kg P/ha	40.90	5.40	10.27
Irrigation at Vegetative(35DAS) and Pod Formation (55DAS) + 60Kg P/ha	41.70	5.90	11.00
S.Em(±)	0.26	0.14	0.34
CD (p=0.05)	0.79	0.41	1.04

Table 2: Effect of irrigation scheduling and phosphorus levels on Yield attributes and yield of green gram

Treatments	Number of pods/plant	Number of seeds/pods	Test weight	Pod length	Grain yield (Kg/ha)	Stover yield (Kg/ha)	Harvest index (%)
Irrigation at 25DAS + 20kg P/ha	33.10	5.70	31.87	7.10	608.32	1496.10	32.45
Irrigation at 25DAS + 40Kg P/ha	33.60	6.10	32.27	7.30	702.53	1616.70	30.15
Irrigation at 25DAS + 60KgP/ha	36.10	6.40	34.03	7.70	740.63	1684.26	30.42
Irrigation at Vegetative Growth (35DAS) + 20Kg P/ha	34.20	6.10	32.60	7.40	715.30	1663.20	30.00
Irrigation at Vegetative Growth (35DAS) + 40Kg P/ha	36.80	6.40	34.60	7.90	747.70	1707.10	30.35
Irrigation at Vegetative Growth (35DAS) + 60Kg P/ha	38.10	6.70	33.33	8.20	787.46	1778.16	30.16
Irrigation at Vegetative (35DAS) and Pod Formation (55DAS) + 20Kg P/ha	35.60	6.30	32.27	7.60	724.86	1641.60	30.56
Irrigation at Vegetative (35DAS) and Pod Formation (55DAS) + 40Kg P/ha	38.80	6.70	35.80	8.20	814.08	1739.73	32.08
Irrigation at Vegetative (35DAS) and Pod Formation (55DAS) + 60Kg P/ha	40.30	6.80	36.00	8.40	854.08	1928.70	30.60
S.Em (±)	0.48	0.15	0.64	0.05	12.74	62.77	1.36
CD (5%)	1.45	0.44	1.90	0.16	38.21	188.18	-----

Conclusion

On the basis of one season experimentation application Irrigation at Vegetative (35DAS) and Pod Formation (55DAS) + 60KgP/ha was found more productive (854.08kg/ha).

The conclusions drawn are based on one season data only which requires further confirmation for recommendation.

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