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Research Communication

Effect of irrigation regimes and foliar sprays of potassium on growth and economics of summer greengram (*Vigna radiata*)

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ABSTRACT

An agronomic investigation was carried out at Rahuri, Maharashtra, India during summer 2018, to study the effect of irrigation schedule and foliar application of potash on growth, yield and quality of summer greengram [*Vigna radiata* (L.) R. Wilczek]. The experiment was laid out in a split-plot design with 3 replications. The experiment consists of 12 treatments involving 4 main-plot treatments, i.e. irrigation schedules at 40, 60, 80 and at 100 mm CPE and the subplot treatments are foliar application of 1% potash (KNO_3) at flowering, at pod-development stage and at flowering and pod-development stage. Scheduling of irrigation at 40 mm CPE recorded significantly higher growth attributes like plant height, number of leaves, leaf area, plant spread, number of branches, dry matter and seed yield of summer greengram (13.31 q/ha) at harvesting and it was at par with treatment irrigation at 60 mm CPE (13.08 q/ha). Foliar application of 1% potash (KNO_3) at flowering and at pod development stage resulted in significantly higher growth attributes and seed yield of summer green gram (12.42 q/ha). Among the different irrigation schedules, treatment irrigation at 40 mm CPE resulted in the maximum gross monetary returns (₹67,560/ha), net monetary returns (₹33,705/ha) and benefit: cost (B : C) ratio (1.99) and it was at par with treatment irrigation at 60 mm CPE having net monetary returns (₹31,358/ha) and B:C ratio (1.99). The foliar application of 1% potash (KNO_3) at flowering and at pod development stage recorded significantly higher gross monetary returns (₹62,651/ha), net monetary returns (₹30,917/ha), and B : C ratio (1.97). Irrigation at 60 mm CPE and foliar application of 1% potash at flowering and pod-development stage to summer greengram found suitable preposition to achieve the highest grain yield as well as net monetary returns

Key words: Summer greengram, Irrigation, Foliar spray of potash, Growth attributes, Economics

Pulses play an important role in Indian agriculture, as they restore soil fertility by fixing atmospheric nitrogen through their nodules. In India, greengram is grown on an area of about 3 million ha, with production of 1 million tonnes. The yield potential of greengram is low because of the fact that, the crop is mainly grown in rainfed conditions with poor management practices and also due to various physiological, biochemical as well as inherent factors associated with crop. The cultivation period of summer greengram is from mid-March to end of 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 greengram becomes very high due to high evapo-transpiration rate. Under this condition, frequent irrigation produced significantly higher number of pods/plant, increased the weight of seed/plant and weight of 1,000 seed, which ultimately resulted in increased seed yield. But the application of frequent irrigations considered as one of the problem for its cultivation at extensive scale. Under such situation it becomes necessary to find out ways and means for minimizing the irrigation requirement.

Potassium is one of the major essential plant nutrients which acts as activator for many enzymes of carbohydrates and protein metabolism. It plays an essential role in production and translocation of sugar. The increased production of starch and sugar in legumes fertilized with potash benefits the symbiotic bacteria and thus enhances the fixation of nitrogen. It enhances the ability of the plant to resist disease, insect attacks under adverse conditions. It helps in osmotic and ionic regulations. Greengram, being a dryland

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crop, expected to respond well to potassium (K), as K plays an important role in water relations and water-use efficiency and it is known to make the plant tolerant against extreme dry and wet season. Application of potash at the time of flowering reduces flower drop and at the time of pod-development stage, it makes seed shiny and enhances seed quality. The supply of nutrients through roots is restricted in some soil conditions such as salinity, high and low *p*H, sodicity etc. To overcome such problems, one such strategy may be foliar application of potassic sources of nutrients for exploiting genetic potential of the crop and to withstand the water-stress condition. This is considered as an efficient and economic method of supplementing part of the nutrient requirements at critical stages. Nutrients play an important role in increasing the seed yield in pulses (Chandrashekhar and Bangaruswamy, 2014). Considering these points, the present investigation was carried out.

The field investigation was conducted during the summer season of 2018 at the Mahatma Phule Krishi Vidyapeeth, Rahuri, Maharashtra. The soil was loamy in texture (*p*H 8.1, EC 0.24 dS/m and organic carbon 0.43%) having field capacity, permanent wilting point and bulk density 28.65%, 14.48% and 1.24 Mg/m^3, respectively. The available nitrogen, phosphorus and potassium in soil were 260.5, 19.78 and 470.74 kg/ha respectively. The experiment was laid-out in a split-plot design, consisting of 12 treatment combinations with 4 mainplot treatments (irrigation schedules), viz. I_1, irrigation at 40 mm cumulative pan evaporation (CPE); I_2, irrigation at 60 mm CPE; I_3, irrigation at 80 mm CPE and I_4, irrigation at 100 mm CPE; and 3 sub-plot treatments (foliar application of 1% potash at different growth stages); i.e. F_1, at flowering stage; F_2, at pod-development stage and F_3, at flowering and pod-development stage. For sowing of summer greengram, the 'Vaibhav' variety with 15–20 kg/ha seed rate was used. Basal dose of fertilizer 20 : 40 : 0 N : P : K kg/ha was applied to all plots. The soil samples were analysed before start and after the experiment. The samples were used for determination of initial status of soil, viz. *p*H, EC, organic carbon and available N, P and K. Five randomly plants were selected and marked with tags from each net plot for recording different biometric observations and yield-contributing characters. Biometric observations were recorded at an interval of 15 days. Benefit: cost (B : C) ratio was calculated based on the ratio of gross income to total cost of cultivation.

Growth and yield

Effect of irrigation schedule: Significantly maximum plant height was recorded at harvesting during the summer season, when irrigation was scheduled at 40 mm CPE, followed by treatment irrigation at 60 mm CPE. Significantly minimum plant height was registered when irrigation was given at 100 mm CPE at all crop stages. The highest plant height at 40 mm CPE might be due to increased availability of nutrients along with optimum irrigation up to the grand-growth phase of crop which increases the cell elongation and faster multiplication of meristematic region, resulting increased plant height (Singh *et al*., 2018).

Irrigation at 40 mm CPE resulted in significantly higher number of leaves/plant at harvesting (Table 1). Significantly minimum number of leaves/plant was recorded under irrigation at 100 mm CPE. Irrigation at 40 mm CPE and 60 mm CPE registered higher number of leaves/plant of summer greengram as also reported by Idnani and Gautam, (2008).

Irrigation at 40 mm CPE resulted in significantly highest leaf area/plant (2.24 dm^2) at 15 days after sowing, which was at par with irrigation at 60 mm CPE (2.16 dm^2). Significantly lowest leaf area/plant was recorded under irrigation at 100 mm CPE. Irrigation at 40 mm CPE and 60 mm CPE registered highest leaf area/plant of summer greengram. These might be recorded owing to higher plant height and vigourous growth of crop because of optimum application of water (Yadav and Singh, 2014).

Irrigation at 40 mm CPE resulted in significantly highest plant spread and number of branches/plant at harvesting. Significantly lowest plant spread and were recorded under irrigation at 100 mm CPE at harvesting. Idnani and Gautam, 2008 reported that, irrigation at 40 mm CPE and 60 mm CPE registered highest plant spread of summer greengram.

Chavan *et al.,* 2014 also reported higher number of branches/plant in summer greengram with irrigation at 40 mm CPE and 60 mm CPE.

Irrigation at 40 mm CPE recorded significantly maximum dry matter/plant at harvesting and minimum under irrigation at 100 mm CPE. Optimum amount of irrigation to crop leads to vigorous growth which results in higher uptake of nutrients and growth parameters and reflected as maximum dry matter of plant (Yadav and Singh, 2014).

Irrigation at 40 mm CPE resulted in significantly higher grain yield (13.31 q/ha) than all other treatments. However, it was at par with treatment irrigation at 60 mm CPE (13.08 q/ha). This indicates that seed yield increased with increase in irrigation frequency. The highest seed yield obtained under irrigation schedule at 40 mm CPE resulted from the cumulative effect of higher number of pods/plant, seeds/pod and test weight compared to other irrigation schedules (Prajapati *et al.,* 2006)

The highest haulm yield was recorded with 40 mm CPE. The reason for increased haulm yield under more frequently irrigated regimes might be owing to more efficient photosynthesis, as the evapo-transpirational demand were

fulfilled better under more water availability and the plants gave more dry-matter and leaf area and ultimately higher haulm yield (Parmar and Thanki, 2007).

Effect of foliar application of potash

The maximum plant height was obtained when foliar application of potash was done at flowering and pod-development stage (Table 1). Significant increase in plant height with foliar application of potash attributed to the fact that potash strengthen the stalk. These results confirm the findings of Laxshmi *et al*. (2018).

The maximum leaves/plants were obtained when foliar application potash was done at flowering and pod-development stage. It might be attributed to the favourable influence of potash on metabolism and biological activity and its stimulating effect on photosynthetic pigments and enzyme activity which in turn encourage vegetative growth of plants. The results are in conformity with Thalooth *et al*. (2003).

The leaf area/plant was obtained was maximum when foliar application of 1% potash at flowering and pod-development stage. The mean leaf area/plant was increased with the advancement of age of crop till 45 days after sowing and after that it was decreased at harvesting.

Significantly, maximum plant spread was also obtained when foliar application of potash at flowering and pod development stage at harvest stage. Significant increase in plant spread with foliar application of potash might be owing to increased availability of nutrients to plants leading to maximum plant growth in terms of plant height and leaf area which in turn contributed higher plant spread as also reported by Laxshmi *et al*. (2018).

The maximum number of branches/plant^{-1} and dry-matter/plant were obtained when foliar application of 1% potash was done at flowering and pod-development stage. The mean number of branches/plant and dry-matter/plant were increased with the advancement of age of crop till the harvesting of the crop. Our results confirm those of Umar *et al.* 2008 for branches/plant.

During the study, we examined that these results also resembles the findings of (Chandrasekhar and Bangarusamy, 2014).

The maximum seed yield was obtained when foliar application of potash at flowering and pod-development stage (12.42 q/ha). Foliar spray of potash had the greatest stimulatory effect on moisture stress at different stages of growth significantly number of pods/plant, dry weight of pod, number of seeds increased the seed protein content. However, number of seeds/pod, dry-matter/plant and test weight of seeds ultimately increases the grain yield of summer green gram Vekaria *et al*. (2013).

The haulm yield of summer green gram was influenced significantly by to foliar application of 1% potash at different growth stages. Significantly, the maximum haulm yield was obtained when foliar application of 1% potash at flowering and pod development stage (Thanunathan *et al.,* 2018).

The interaction effect between irrigation schedules and

Table 1. Growth attributes and yield of summer greengram as influenced by irrigation schedules and foliar application of potash at different growth stages

Treatment	Growth attributing characters (At harvest)						Seed yield (t/ha)	Haulm yield (t/ha)
	Plant height (cm)	Leaves/ plant	Leaf area/ plant (dm^2)	Plant spread (cm)	Branches/ plant	Dry-matter/ plant (g)		
Irrigation schedules (I)								
I_1, 40 mm CPE	58.2	12.4	35.1	30.1	4.6	23.3	1.33	2.54
I_2, 60 mm CPE	55.4	11.8	33.2	28.9	4.3	22.0	1.30	2.49
I_3, 80 mm CPE	54.0	11.1	29.4	26.7	3.9	21.1	1.17	2.42
I_4, 100 mm CPE	51.1	10.6	27.4	25.6	3.6	20.1	0.98	1.89
SEm±	0.32	0.08	0.33	0.11	0.04	0.19	0.02	0.03
CD (P=0.05)	1.11	0.28	1.12	0.39	0.14	0.65	0.07	0.11
Foliar application of 1 % potash at different growth stages (F)								
F_1, At flowering	53.8	11.3	30.7	27.3	4.1	21.2	1.17	2.28
F_2, At pod development	54.3	11.4	31.1	27.3	4.1	21.4	1.18	2.31
F_3, At flowering and pod development	56.0	11.8	32.0	29.0	4.3	22.3	1.24	2.43
SEm±	0.2	0.08	0.17	013	0.02	0.17	0.01	0.03
CD (P=0.05)	0.6	0.25	0.52	0.40	0.06	0.51	0.04	0.10
C. Interaction (I x F)								
SEm±	0.4	0.16	0.34	027	0.04	0.34	0.02	0.06
CD (P=0.05)	Sig.	NS	NS	NS	NS	NS	NS	NS
General mean	54.7	11.5	31.3	27.8	4.17	21.6	1.2	2.34

foliar application of 1% potash at different growth stages were found significant in respect of plant height at harvesting stage. The maximum plant height (59.37 cm) was obtained under scheduling of irrigation at 40 mm CPE and foliar application of potash at flowering and pod-development stage. The interaction effect between irrigation schedules and foliar application of 1% potash at different growth stages on leaves/plant, leaf area/plant, plant spread, branches/plant, dry matter/plant, seed yield and haulm yield of summer greengram was found non significant.

Economics

Effect of irrigation schedules

The cost of cultivation (₹/ha) of greengram crop differed significantly for different irrigation schedules. Irrigation at 40 mm CPE recorded significantly maximum cost of cultivation than irrigation at 60, 80 and 100 mm CPE because of higher cost required for frequently irrigating the crop at 40 mm CPE irrigation treatment (Table 2).

The gross monetary returns of summer green gram crop differed significantly for different irrigation schedules. Irrigation at 40 mm CPE recorded significantly higher gross monetary returns (67,560₹/ha)and it was at par with irrigation at 60 mm CPE (62,915₹/ha). However, these were more than, that at irrigation at 80 mm CPE (59,175₹/ha), and irrigation at 100 mm CPE (54,515₹/ha) on mean basis. Higher crop yield might have resulted in maximum gross monetary returns (Roy *et al.,* 2015).

The net monetary returns (₹/ha) differed significantly for different irrigation schedules. Irrigation at 40 mm CPE recorded significantly maximum net monetary returns (33,705₹/ha) and it was at par with irrigation at 60 mm CPE (31,358₹/ha), which were more than that with, irrigation at 80 mm CPE and 100 mm CPE (Table 2). Higher gross monetary returns resulted in maximum net monetary returns for summer green gram crop, as also reported by Idnani and Gautam (2008).

The B : C ratio also differed significantly for different irrigation schedules. Irrigation at 60 mm and 60 mm CPE recorded significant maximum B: C ratio (1.99) being comparatively more than that recorded with irrigation at 80 and 100 mm CPE on mean basis. Higher gross monetary returns resulted in maximum B: C ratio for summer green gram crop.

Effect of foliar application of potash

The foliar application of potash at flowering and pod-development stage recorded significantly maximum cost of cultivation (₹28,682/ha) than at flowering (₹27859/ha) and at pod development stage (Table 2). These might be due to more cost required for foliar spray at 2 growth stages of summer green gram i.e. at flowering and pod-development stage than the other treatments.

The foliar application of potash at flowering and pod-development stage recorded significantly maximum gross monetary returns (₹62,651/ha) net monetary returns for summer green gram (₹30,917/ha) than at flowering and at pod development stage (Table 2). Higher crop yield might have resulted in maximum gross monetary returns. Higher gross monetary returns resulted in maximum net monetary

Table 2. Economics of greengram as influenced by irrigation schedules and foliar application of 1% potash at different growth stages

Treatment	Gross monetary return ($\times 10^3$₹/ha)	Cost of cultivation ($\times$ ₹10^3/ha)	Net monetary returns ($\times 10^3$₹/ha)	Benefit: cost ratio
Irrigation Schedules (I)				
I_1, 40 mm CPE	67.5	33.8	33.7	1.99
I_2, 60 mm CPE	62.9	31.5	31.3	1.99
I_3, 80 mm CPE	59.2	30.1	29.1	1.97
I_4, 100 mm CPE	54.5	29.2	25.2	1.86
SEm±	0.74	0.004	0.74	-
CD (P=0.05)	2.56	0.016	2.56	-
Foliar application of 1 % potash at different growth stages (F)				
F_1, At flowering	60.0	30.8	29155	1.94
F_2, At pod development	60.4	30.8	29537	1.96
F_3, At flowering and pod Development	62.6	31.7	30917	1.97
SEm±	0.39	0.004	0.39	-
CD (P=0.05)	1.17	0.012	1.17	-
Interaction (I x F)				
SEm±	0.78	8.27	0.78	-
CD (P=0.05)	NS	NS	NS	-
General mean	61.0	31.1	29.8	1.96

returns for summer greengram crop.

The B : C ratio differed significantly due to foliar application of 1% potash at different growth stages. The foliar application of potash at flowering and pod-development stage recorded higher B : C ratio (1.97) than that at flowering (1.94) and at pod-development stage (1.96). Higher gross monetary returns resulted in maximum B : C ratio for summer green gram crop.

Interaction: The interaction effect between irrigation schedules and foliar application of 1% potash at different growth stages in respect of cost of cultivation, gross monetary returns, net monetary returns and B: C ratio was found non-significant.

Hence, it could be concluded that, the irrigation at 60 mm CPE and foliar application of 1% potash at flowering and pod development stage to summer green gram found suitable preposition to achieve highest grain yield as well as net monetary returns.

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