Growth, yield and nutrient content of mungbean as influenced by foliar potassium application and irrigation levels

Abstract

A field experiment was conducted in 2018 to study the response of *Summer* Mungbean (*Vigna radiata* L. Wilczek) to foliar potassic fertilization under different moisture regimes. The experiment was laid out in split plot design by having 16 treatment combinations with 2 irrigation levels in the main plot and 6 foliar potassium sprays in subplots, which were replicated thrice. Results revealed that the growth parameters of mungbean *viz.*, plant height, plant spread, number of leaves/plant, LAI, dry matter accumulation/plant, and grain yield were significantly higher under 0.6 IW/CPE ratio as compared to 0.4 IW/CPE ratio. Nutrient content (N, P and K) was also found higher under 0.6 IW/CPE ratio than 0.4 IW/CPE ratio. Among potassium treatments, foliar application of 1%K through KNO_3/KCl at flowering and pod development stage produced significantly higher values of growth parameters *viz.*, plant height, number of leaves and branches/plant and dry matter accumulation/plant at all the stages of growth except at 25 DAS. Foliar application of 1%K through KNO_3/KCl at flowering and pod development stage recorded significantly higher grain and straw yield than rest of the treatments. Nutrient content was found higher under foliar application of 1%K through KNO_3/KCl at flowering and pod development stage but did not differ significantly.

Key words: *Summer* mungbean, KCl, KNO_3, foliar spray, 0.4 and 0.6 IW/CPE ratio.

Introduction

Pulses are a wonderful gift from nature. They can be grown on a wide range of climatic conditions and soils. Pulses are rich in protein and are regarded as the main protein source for vegetarians. Pulses are considered as the second major constituent of the Indian diet after cereals. Pulses besides enriching the soil by fixing atmospheric nitrogen and improving the organic matter in the soil. Pulses are also used as green manuring crops. Besides enriching the soil nutrient status and physical structure, pulses also suit well in mixed cropping, intercropping, crop rotation and dry farming. They are the nutritional source for humans and cattle as well, thereby contributing to a more sustainable food system. On an average, pulses contain 22-25% protein as against 8-10% in cereals. "The total acreage under pulses in the world is about 85.4 million ha with an annual production of 87.4 million tonnes and productivity of 1023 kg ha^{-1}. India ranks first in area and production of pulses with 34% and 26% of the world, respectively. In India, pulses were cultivated in more than 27.9 million ha of an area with a production of 23.0 million tonnes at an average productivity of 823 kg ha^{-1}” [1]. “The main pulse-producing states in India are Rajasthan, Madhya Pradesh, Maharashtra, Karnataka and Uttar Pradesh. Rajasthan is the leading producer of pulses accounting for about 6.34 million ha of the area with a production of 4.50 million tonnes at an average productivity of 709 kg ha^{-1}. The productivity in Rajasthan is lower than the national average due to only 23.3 % of the total pulse cultivated area being under irrigated conditions” [1].

Among pulses, Mungbean can be grown as a catch crop because of its short growth period. In *summer* due to high temperature, high transpiration rate and low water availability, moisture stress occurs at various growth stages. Drought stress occurs when the water near the root surface is not sufficient for absorption. As the soil dries up, the rhizobium population decreases radically immediately [2]. As the moisture stress increases, it drastically reduces nitrogen fixation along with plant growth [3]. Among the tools of crop production, irrigation became the most important factor in the changing global scenario. Day by day the requirement for water during the *summer* months is increasing due to high temperature and higher evapotranspiration needs [4]. Adequate water is required at all growth stages of mungbean crop but they are very much susceptible to water stress during flowering and pod filling stage. Shortage of water during these sensitive stages will cause a significant reduction in yield. Water stress negatively affects many plant processes including photosynthesis, transpiration, evaporation, etc. [5] which also cause a substantial reduction in dry matter accumulation [6]. Efficient use of water during *summer* will help in enhancing the production, productivity of pulses, water productivity and water use efficiency. Scheduling of irrigation is the major factor that plays a key role in producing higher yields during *summer* season. Therefore, scheduling irrigation in a scientific manner will improve water use efficiency and reduce water losses. Irrigation water economy can be aimed through scheduling of irrigation at the right time and meteorological approach based pan evaporation is one of the simplest, most reliable and economical method.

Crop management practices can include both by applying fertilizer through soil and as well as on foliage. However, currently, the foliar application of nutrients to pulses is in limited use for increase of stress resistance mechanism. There is no time for basal application of nutrients to pulses when grown as relay cropping, where pulses are sown before harvest of the first crop, so basal application of nutrients to pulses becomes impossible. Balusamy and Meyyazhagan [7] suggested that “the foliar application of nutrients was more appropriate, efficient and economical than soil application”. “Application of nutrients on foliage at proper stages of crop growth plays an important role in utilization of nutrients and better performance of the crop" [8]. "Generally, Indian soils are rich in potassium but its availability to crops is low and not sufficient. In India, nowadays intensive cropping and intercropping systems are gaining importance and high-yielding varieties responds positively to different levels of potassium doses. Macronutrients play a key role in boosting the grain yield in pulses. Foliar treatment of macronutrients like nitrogen and potassium was found as effective as soil application" [9]. "Potassium is one of the macronutrient which plays a major role in plant growth and sustainable crop production. It involves in activation of more than 60 plant enzymes" [10]. "It imparts resistance in plants against diseases and pests attack. It also helps in maintaining the turgor pressure of the cell which is necessary for cell expansion. It also helps in the osmoregulation of plant cell, and support in opening and closing mechanism of stomata" [11]. "Taken as a whole, potassium is an enzyme activator, helps in the synthesis of starch and protein, helps in metabolism, plays a major role in stomatal regulation and also takes part in chlorophyll formation and grain development. It provides strength to stem and imparts resistance against lodging. Potassium (K^+) is reported as an important element in reducing the ill effects of soil water stress. Potassium stimulates root growth and hence explores more soil water. Therefore, there is very much essential to give potassium nutrition externally to enhance overall plant growth and plant productivity. Application of potassium in the course of vegetative and reproductive stages can reduce the ill effects of water stress". [10] Thalooth *et al.* [12] reported that "foliar application of potassium improves the water content in the broad bean leaves". "Foliar application of potassium increases the drought tolerance in mungbean plant" [13]. "Application of potassium at the time of flowering showed the beneficial effect on all the growth characters" [14].

Hence, considering the above facts, the research was planned to study the effect of foliar potassium application and irrigation regimes on mungbean crop.

Materials and methods

The experiment was conducted to study the "Growth, yield and nutrient content of mungbean as influenced by foliar potassium application and irrigation levels" at Crop research center, Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut (U.P.), during the summer season of 2018. Meerut comes in the semi-arid and sub-tropical climatic zone. The soil of the experimental field was sandy loam in texture and soil was medium in available phosphorus and available potassium but low in organic carbon and available nitrogen. The total amount of rainfall received during the crop period was 74.5 mm. however, it did not affect the treatment imposition during the crop growth.

The experiment was laid out in Split plot design by having 12 treatment combinations comprising two irrigation levels (I_1-0.6 IW/CPE and I_2-0.4 IW/CPE) in the main plot and 5 foliar potassium sprays (T_2-1%K by KCl at flowering, T_3-1%K by KNO_3 at flowering, T_4-1%K by (KCl+KNO_3) at flowering, T_5-1%K by KCl at flowering and pod development and T_6-1%K by KNO_3 at flowering and pod development) along with control (T_5- water spray) in sub plots replicated thrice in 12 plots each of size 5.0 m × 4.5 m. Sowing of mungbean (Pant mung-5) using 25 kg ha^{-1} was done at a spacing of 30 cm × 10 cm. One pre-sowing irrigation was given before land preparation especially to provide sufficient moisture for land preparation and immediately after sowing one irrigation of 70 mm depth was given for proper germination and ensuring the better establishment of the crop irrespective of cumulative pan evaporation readings (CPE). Afterwards, irrigation of 70 mm depth was provided as per treatments based on cumulative pan evaporation readings (CPE). The amount of water applied was measured using parshall flume laid at the beginning irrigation channel. After initial common irrigation, a total of five irrigations were scheduled for the treatment with 0.6 IW/CPE [on 20, 30, 46, 63 and 72 Days after sowing (DAS)] and 3 irrigations were scheduled for the treatment with 0.4 IW/CPE ratio (on 30, 46 and 68 DAS). The recommended dose of fertilizer (20:40:0 kg of N: P_2O_5:K_2O ha^{-1}) was applied to all the treatments through urea and DAP at the time of sowing and foliar potassium application was given as per treatments to each plot.

Results and discussion

Effect of irrigation regimes and foliar potassium application on plant population of mungbean at harvest

Irrigation regimes: Irrigation schedules had brought a significant difference in the plant population of mungbean at maturity (Table 1). The plant population of mungbean at maturity increased with increasing the number of irrigations. Significantly higher plant population at maturity and significantly lower mortality (10.1 %) were noticed under 0.6 IW/CPE irrigation level than 0.4 IW/CPE ratio. Higher plant population might be due to adequate moisture supply during the entire crop growth, which improves the root system and maintains water status in plant cells. The lowest plant population and highest mortality (%) was recorded under 0.4 IW/CPE ratio irrigation schedule which might be due to the fact that plants have undergone moisture stress for some period of life cycle and thus adversely affected the plant stand. The results are in confirmation to the findings of Kanubhai [15] and Chaudhary *et al*. [16].

Foliar potassium application: The plant population of mungbean at maturity also increased with increasing the number of potassium sprays. Highest plant population (298700 plants/ha) and the lowest mortality (9.3 %) was recorded with the application of 1%K through KNO_3 spray at flowering and pod development and the lowest plant population was recorded under water spray (284800 plants/ha) though the difference between treatments was not significant. The higher plant population in potassium applied plots than in control might be due to the major role of potassium in the transport of water and nutrients, besides maintaining the water potential in the plant cells which could be helpful in higher plant stand at harvest. Our results are in close proximity with Marskole [17] in soybean.

Interaction effect between irrigation regimes and foliar potassium application on plant population was found to be non significant.

Growth and Developmental Studies

Effect of irrigation regimes and foliar potassium application on the growth of mungbean

The data with respect to plant height, plant spread, number of leaves, leaf area index (LAI) and Dry matter accumulation (DMA) as influenced by irrigation schedules and foliar potassium management is presented in Table 2-6.

Irrigation regimes: The tallest plants were recorded with irrigation applied at 0.6 IW/CPE ratio at all the stages of crop growth. Significantly higher plant height was recorded with irrigation at 0.6 IW/CPE (19.7, 46.3 and 55.1cm) over 0.4 IW/CPE ratio (16.5, 41.4 and 47.7cm) at 25, 50 and at harvest, respectively (Table 2). Irrigation scheduled at 0.6 IW/CPE ratio showed significantly higher plant spread of 16.1, 36.8 and 33.2 cm at 25 DAS, 50 DAS and at harvest, respectively over at 0.4 IW/CPE ratio (Table 3). This might be due to the good establishment of roots and adequate moisture supply in soil which made higher nutrient mobilization and uptake and better condition for cell division and cell enlargement, which ultimately increased the plant height and plant spread. The results are in close conformity with the findings of Yadav and Singh [18] and Patel *et al.* [19] in mungbean.

Significantly maximum number of physiologically active leaves/plant were recorded with irrigation at 0.6 IW/CPE ratio (3.82, 7.75 and 5.36 at 25, 50 DAS and at harvest, respectively) as compared to 0.4 IW/CPE ratio (Table 4). Significantly maximum leaf area index was recorded under 0.6 IW/CPE ratio irrigation schedule (3.11, 4.24 and 3.77 at 25, 50 DAS and at harvest, respectively) over 0.4 IW/CPE ratio irrigation schedule at all the stages of crop growth (Table 5). This might be due to more availability of essential nutrients under frequently irrigated conditions, maintenance of higher water status in plants and cooler canopy temperature which resulted in more absorption of photosynthetically active radiation and a higher rate of photosynthesis that helps in the formation of taller, thicker stem and root system, which ultimately increased the number of leaves/plant and LAI. Similar results were also found by Chaudhary *et al.* [16] in mungbean and Singh *et al.* [20] in french bean**.**

The highest dry matter production was recorded when irrigation was scheduled at 0.6 IW/CPE ratio (4.3, 8.6 and 12.4 g/plant at 25, 50 DAS and at harvest, respectively) which was significantly superior to 0.4 IW/CPE ratio (Table 6). It is well-known fact that sufficient supply of soil moisture helps in plant cell division and cell enlargement, resulting in better photosynthetic area, plant growth and thereby higher dry matter accumulation/plant. Similar results were also found by Idnani and Gautam [21] and Patel *et al.* [22].

Foliar potassium application: The influence of foliar potassium application on plant height, plant spread, number of leaves, leaf area index and dry matter accumulation of mungbean was found to be non-significant at the initial stage of crop as the potassium spray was given at the time of flowering and pod development stages.

Significantly higher plant height (45.7 cm) and plant spread (36.0 cm) at 50 DAS were recorded with the application of 1%K spray through ($KCl+KNO_3$) at flowering as compared to control but statistically similar with remaining treatments. At harvest, foliar application of 1%K through KNO_3 at flowering and pod development stage recorded significantly higher plant height (56.0 cm) and plant spread (32.7 cm) over control. This increase might be due to the well-known fact that potassium enhances cell division and cell expansion as well as the positive influence of potassium on water and nutrient uptake, thus creating the cell turgor necessary for growth, resulting in higher plant height and plant spread. These results are in close conformity with those of Govindan and Thirumurugan [23] in mungbean, Goud *et al.* [24] in chickpea and Sanjay [25] in mungbean.

Maximum number of physiologically active leaves/plant (7.63) and leaf area index (3.95) at 50 DAS were recorded with the foliar application of 1%K by ($KCl+KNO_3$) at flowering which was significantly higher over control but remained *at par* with rest of the treatments. Maximum number of physiologically active leaves/plant (5.37) and leaf area index (3.55) at harvest was recorded with the 1%K spray through KNO_3 at flowering and pod development stage followed by 1%K spray through KCl at flowering and pod development stage though both were statistically similar but significantly higher than the control. The positive effect of potassium in increasing the number of leaves/plant and LAI might be due to its biochemical role in the stimulation of photosynthesis and transfer of its products to active growing sites in addition to its role in meristematic cell division and elongation/expansion that reflects positively on the number of leaves and leaf area index. Al-Shaheen *et al.* [26] also opined that the water and potassium union affected the leaf area and all the plant activities, consequently an increase in plant elongation and then the leaf area. Similar findings were also made by Govindan and Thirumurugan [23] in mungbean, Balasaheb [27] in soybean and Lakshmi *et al.* [28] in urdbean.

Foliar application of 1%K through ($KCl+KNO_3$) at flowering stage recorded maximum dry matter production (8.1 g/plant) at 50 DAS, being *on par* with rest of the treatments but significantly higher over control (6.9 g/plant). However, at harvest, foliar application of 1%K through KNO_3 at flowering and at pod development stage recorded higher dry matter accumulation (12.7 g/plant) which was comparable with 1%K by KCl spray at flowering and at pod development stage (12.4 g/plant) and significantly higher over rest of the treatments. The lowest dry matter production in mungbean was recorded under control plots (10.0 g/plant). The increase in dry matter accumulation/plant might be due to the fact that potassium nitrate provides potassium as well as nitrogen, both influence the water economy and crop growth, through their impact on water uptake, root growth, maintenance of turgor, transpiration and stomatal behavior. It enhances the photosynthetic activity in plants and which ultimately led to more biomass production/plant. Our results are in close conformity with the findings of Chandrasekhar and Bangarusamy [29] in mungbean, Vekaria *et al.* [30] in mungbean, Sanjay [25] in mungbean and Lakshmi *et al.* [28] in urdbean.

Interaction effect between irrigation regimes and foliar potassium application on growth parameters were found to be non significant.

Effect of irrigation regimes and foliar potassium application on yield of mungbean

The yield data of mungbean as influenced by irrigation regimes and foliar potassium application is presented in Table 7.

Irrigation regimes: Significantly higher grain yield (1100 kg/ha) and straw yield (2381 kg/ha) were observed under 0.6 IW/CPE ratio irrigation schedule over 0.4 IW/CPE ratio. However, the pace of increment in grain and straw yield of I_1 over I_2 was to the tune of 25.2 and 9.1 %, respectively. The highest grain and straw yield at 0.6 IW/CPE ratio was mainly due to sufficient moisture supply during the entire growth period, increased irrigation frequency increased the soil moisture status which resulted in higher leaf water potential, higher photosynthesis, consequently increased dry matter production and yield attributes, which ultimately increased grain yield and straw yield. These findings are in close conformity with those of Yadav and Singh [18] in mungbean and Patel *et al.* [19] in mungbean.

Foliar potassium application: Foliar application of 1%K by KNO_3 (one at flowering and the other at pod development stage) produced significantly higher grain yield (1152 kg/ha) and straw yield (2544 kg/ha), which were statistically *on par* with 1%K by KCl spray (one at flowering and other at pod development stage) (1098 and 2478 kg/ha, respectively) than rest of the treatments. This might be due to the favorable effect of potassium on the metabolism and biological activity and its stimulating effect on photosynthetic pigments and enzyme activity, followed by efficient transfer of metabolites and subsequent accumulation of these metabolites in the grains, which increased the number, size and weight of individual grain which finally increased the grain and straw yield. Our results are in close proximity to the findings of Govindan and Thirumurugan [23] in mungbean and Beg *et al.* [14] in black gram.

Interaction effect between irrigation regimes and foliar potassium application on yield (grain and straw) of mungbean was found to be non significant.

Effect of irrigation regimes and foliar potassium application on the nutrient content of mungbean

The data pertaining to nitrogen content in mungbean grains and straw is presented in Table 8 and 9.

Irrigation regimes: In general, the nitrogen and phosphorus content was higher in mungbean grains than in straw. Potassium content was higher in mungbean straw as compared to grains. The nitrogen content (3.92 and 0.74 %), phosphorus content (0.296 and 0.210 %) and potassium content (0.53 and 1.26 %) in grains and straw, respectively were recorded significantly higher under 0.6 IW/CPE ratio irrigation schedule than 0.4 IW/CPE ratio. This increase might be due to the sufficient moisture in the soil eased the plants to absorb greater amount of water and nutrients, which in turn increased the nutrient content in grains and straw and also yielded more crop biomass. As a result, the nutrient uptake (N, P and K) was also found to be more under 0.6 IW/CPE ratio irrigation schedule. Our results are in close proximity with Arya and Sharma [31] in mungbean and Lakshmi *et al.* [28] in urdbean.

Foliar potassium application: The highest nitrogen content (3.92 and 0.74 %) and phosphorous content (0.298 and 0.209 %) in grains and straw, respectively was recorded with the foliar spray of 1%K through KNO_3 at flowering and pod development stage. The minimum nitrogen and phosphorous content in grains and straw was recorded under control treatment, though the foliar application of potassium increased the nitrogen content in grains and straw of mungbean but failed to bring any significant difference among them. Significantly higher potassium content in grains and straw (0.54 and 1.24 %, respectively) was recorded under treatment with 1%K as KNO_3 sprayed at flowering and pod development stage followed by %K as KCl sprayed at flowering and pod development stage over rest of the treatments. This increase in nutrient content in mungbean was might be due to the favorable influence of potassium on plant metabolism, biochemistry, physiology and biological activity, stimulating effect on photosynthesis, water relationship, protein synthesis and requirement for K in at least 60 different enzyme systems in the plant. Higher nutrient content and grain yield resulted into higher N, P and K uptake. Our results are in close conformity with the findings of Yadav and Choudhary [32] in cowpea and Goud *et al.* [24] in chickpea. Kurhade *et al.* [33] also reported that “N, P and K content in grains and straw were higher with the foliar application of 1.5% KCl at flowering and 15 days after the first spray along with RDF than with control”.

Interaction effect between irrigation regimes and foliar potassium application on nutrient content of mungbean was found to be non significant.

Conclusion

From the above results, it can be concluded that irrigating the mungbean crop at 0.6 IW/CPE ratio produced significantly higher growth, yield and nutrient content in grain and straw as compared to 0.4 IW/CPE. Foliar application of 1%K as KNO_3/KCl sprayed at flowering and pod development stage recorded significantly higher growth parameters and yield as compared to other treatments. However, nutrient content increased with dual spray of 1%K as KNO_3/KCl sprayed at flowering and pod development stage as compared to other treatments but did not influence significantly. Hence, irrigating the mungbean crop at 0.6 IW/CPE ratio with the foliar application of 1% K through KCl/KNO_3 at flowering and pod development produced significantly higher growth parameters and yield and marginal increase in nutrient content than other treatments.

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Table 1: Effect of irrigation schedules and foliar potassium management on plant population and mortality percentage of mungbean

Treatments		Initial plant Population ('000/ha)			Final plant population ('000/ha)			Mortality (%)		
		IW/CPE ratio			IW/CPE ratio			IW/CPE ratio		
		I_1	I_2	Mean	I_1	I_2	Mean	I_1	I_2	Mean
Foliar potassium management	T_1	330.8	329.2	**330.0**	289.1	280.5	**284.8**	12.6	14.8	**13.7**
	T_2	330.3	330.1	**330.2**	294.6	287.5	**291.1**	10.8	12.9	**11.8**
	T_3	329.7	329.5	**329.6**	295.7	289.0	**292.4**	10.3	12.3	**11.3**
	T_4	328.8	328.9	**328.8**	297.0	291.4	**294.2**	9.8	11.7	**10.7**
	T_5	328.3	330.3	**329.3**	299.8	293.7	**296.8**	8.8	10.7	**9.8**
	T_6	329.3	330.0	**329.7**	301.1	296.3	**298.7**	8.3	10.3	**9.3**
	Mean	**329.5**	**329.7**		**296.2**	**289.7**		**10.1**	**12.1**	
			S.Em. (±)	C.D. (P=0.05)		S.Em. (±)	C.D. (P=0.05)		S.Em. (±)	C.D. (P=0.05)
Irrigation			1.03	NS		0.99	6.40		0.23	1.49
Foliar potassium management			4.7	NS		7.54	NS		1.20	NS
Interaction (I x T)			6.67	NS		10.66	NS		1.70	NS

Table 2: Effect of irrigation schedules and foliar potassium management on plant height (cm) of mungbean

Treatments		Plant height (cm)								
		25 DAS IW/CPE ratio			50 DAS IW/CPE ratio			At harvest IW/CPE ratio		
		I_1	**I_2**	**Mean**	**I_1**	**I_2**	**Mean**	**I_1**	**I_2**	**Mean**
Foliar potassium management	**T_1**	19.8	16.7	**18.3**	41.7	35.9	**38.8**	47.9	41.0	**44.4**
	T_2	20.3	16.9	**18.6**	46.6	41.6	**44.1**	53.9	46.9	**50.4**
	T_3	19.2	15.7	**17.5**	47.5	43.0	**45.3**	55.5	47.7	**51.6**
	T_4	20.1	17.3	**18.7**	47.9	43.4	**45.7**	55.7	48.2	**52.0**
	T_5	19.4	15.9	**17.7**	46.8	41.9	**44.4**	57.7	50.1	**53.9**
	T_6	19.6	16.7	**18.2**	47.3	42.8	**45.1**	59.9	52.1	**56.0**
	Mean	**19.7**	**16.5**		**46.3**	**41.4**		**55.1**	**47.7**	
			S.Em. (±)	C.D. (P=0.05)		S.Em. (±)	C.D. (P=0.05)		S.Em. (±)	C.D. (P=0.05)
Irrigation			0.4	2.4		0.6	3.8		0.71	4.7
Foliar potassium management			0.9	NS		1.1	3.2		1.34	4.0
Interaction (I x T)			1.2	NS		1.5	NS		1.9	NS

Table 3: Effect of irrigation schedules and foliar potassium management on plant spread (cm) of mungbean

Treatments		Plant spread (cm)								
		25 DAS			50 DAS			At harvest		
		IW/CPE ratio			IW/CPE ratio			IW/CPE ratio		
		I_1	**I_2**	**Mean**	**I_1**	**I_2**	**Mean**	**I_1**	**I_2**	**Mean**
Foliar potassium management	**T_1**	15.9	13.8	**14.9**	32.0	26.1	**29.0**	28.2	23.8	**26.1**
	T_2	16.3	12.9	**14.6**	36.3	30.4	**33.4**	32.5	26.3	**29.4**
	T_3	16.5	15.1	**15.8**	37.2	32.2	**34.7**	33.5	27.0	**30.2**
	T_4	15.7	14.7	**15.2**	38.8	33.1	**36.0**	34.3	28.5	**31.4**
	T_5	16.7	14.4	**15.6**	37.9	30.3	**34.1**	35.0	29.1	**32.1**
	T_6	15.8	12.7	**14.2**	38.4	32.4	**35.4**	35.6	29.8	**32.7**
	Mean	**16.1**	**13.9**		**36.8**	**30.8**		**33.2**	**27.4**	
			S.Em. (±)	C.D. (P=0.05)		S.Em. (±)	C.D. (P=0.05)		S.Em. (±)	C.D. (P=0.05)
Irrigation			0.3	1.9		0.8	5.3		0.7	4.5
Foliar potassium management			0.6	NS		0.9	2.7		0.9	2.6
Interaction (I x T)			0.76	NS		1.3	NS		1.2	NS

Table 4: Effect of irrigation schedules and foliar potassium management on number of physiologically active trifoliate leaves per plant of mungbean

Treatments		Number of physiologically active trifoliate leaves per plant								
		25 DAS			**50 DAS**			**At harvest**		
		IW/CPE ratio			**IW/CPE ratio**			**IW/CPE ratio**		
		I_1	**I_2**	**Mean**	**I_1**	**I_2**	**Mean**	**I_1**	**I_2**	**Mean**
Foliar potassium management	**T_1**	3.93	2.94	**3.45**	6.27	5.60	**5.93**	4.46	3.62	**4.05**
	T_2	3.80	2.86	**3.33**	7.69	6.18	**6.95**	5.24	4.30	**4.77**
	T_3	3.90	3.08	**3.50**	8.28	6.77	**7.53**	5.34	4.39	**4.87**
	T_4	3.97	3.15	**3.57**	8.38	6.91	**7.63**	5.43	4.49	**4.95**
	T_5	3.71	2.62	**3.17**	7.73	6.56	**7.17**	5.77	4.74	**5.27**
	T_6	3.60	2.53	**3.07**	8.18	6.70	**7.43**	5.87	4.84	**5.37**
	Mean	**3.82**	**2.88**		**7.75**	**6.47**		**5.36**	**4.40**	
			S.Em. (±)	C.D. (P=0.05)		S.Em. (±)	C.D. (P=0.05)		S.Em. (±)	C.D. (P=0.05)
Irrigation			0.08	0.53		0.20	1.32		0.15	0.95
Foliar potassium management			0.13	NS		0.21	0.63		0.16	0.47
Interaction (I x T)			0.18	NS		0.30	NS		0.23	NS

Table 5: Effect of irrigation schedules and foliar potassium management on leaf area index (LAI) of mungbean

Treatments		Leaf Area Index (LAI)								
		25 DAS			**50 DAS**			**At harvest**		
		IW/CPE ratio			**IW/CPE ratio**			**IW/CPE ratio**		
		I_1	**I_2**	**Mean**	**I_1**	**I_2**	**Mean**	**I_1**	**I_2**	**Mean**
Foliar potassium management	**T_1**	3.15	2.13	**2.64**	3.88	3.12	**3.50**	3.42	2.69	**3.05**
	T_2	3.06	2.21	**2.63**	4.18	3.28	**3.73**	3.72	2.82	**3.28**
	T_3	3.23	1.95	**2.59**	4.36	3.30	**3.83**	3.79	2.84	**3.30**
	T_4	3.00	2.04	**2.52**	4.42	3.49	**3.95**	3.81	2.90	**3.35**
	T_5	2.93	2.29	**2.61**	4.23	3.30	**3.76**	3.94	3.10	**3.52**
	T_6	3.30	2.36	**2.83**	4.38	3.45	**3.91**	3.98	3.14	**3.55**
	Mean	**3.11**	**2.16**		**4.24**	**3.32**		**3.77**	**2.91**	
			S.Em. (±)	C.D. (P=0.05)		S.Em. (±)	C.D. (P=0.05)		S.Em. (±)	C.D. (P=0.05)
Irrigation			0.07	0.47		0.10	0.63		0.08	0.49
Foliar potassium management			0.09	NS		0.08	0.23		0.06	0.19
Interaction (I x T)			0.13	NS		0.11	NS		0.10	NS

Table 6: Effect of irrigation schedules and foliar potassium management on dry matter accumulation (g/plant) of mungbean

Treatments		Dry matter accumulation (g/plant)								
		25 DAS			50 DAS			At harvest		
		IW/CPE ratio			IW/CPE ratio			IW/CPE ratio		
		I_1	**I_2**	**Mean**	**I_1**	**I_2**	**Mean**	**I_1**	**I_2**	**Mean**
Foliar potassium management	**T_1**	4.32	2.93	**3.6**	7.72	5.96	**6.9**	11.04	8.99	**10.0**
	T_2	4.50	3.40	**3.9**	8.77	7.03	**7.9**	12.12	10.12	**11.1**
	T_3	4.37	3.13	**3.8**	8.81	7.22	**8.0**	12.19	10.38	**11.3**
	T_4	4.27	3.17	**3.7**	8.91	7.16	**8.1**	12.27	10.75	**11.5**
	T_5	4.43	3.30	**3.9**	8.64	6.90	**7.8**	13.19	11.63	**12.4**
	T_6	4.03	3.03	**3.5**	8.88	7.05	**8.0**	13.56	11.82	**12.7**
	Mean	**4.3**	**3.2**		**8.6**	**6.9**		**12.4**	**10.6**	
			S.Em. (±)	C.D. (P=0.05)		S.Em. (±)	C.D. (P=0.05)		S.Em. (±)	C.D. (P=0.05)
Irrigation			0.09	0.58		0.19	1.16		0.25	1.65
Foliar potassium management			0.12	NS		0.23	0.69		0.35	1.03
Interaction (I x T)			0.17	NS		0.33	NS		0.49	NS

Table 7: Effect of irrigation schedules and foliar potassium management on grain and straw yield (kg/ha) of mungbean

Treatments		Grain yield (kg/ha) IW/CPE ratio			Straw yield (kg/ha) IW/CPE ratio		
		I_1	**I_2**	**Mean**	**I_1**	**I_2**	**Mean**
Foliar potassium management	**T_1**	923.3	686.7	**805.0**	2118.3	1714.9	**1916.6**
	T_2	1043.3	820.0	**931.7**	2327.8	2089.8	**2208.8**
	T_3	1063.3	850.0	**956.7**	2340.8	2150.9	**2245.8**
	T_4	1090.0	890.0	**990.0**	2531.1	2425.5	**2478.3**
	T_5	1206.7	990.0	**1098.3**	2615.4	2472.0	**2543.7**
	T_6	1273.3	1030.0	**1151.7**	2355.2	2243.4	**2299.3**
	Mean	**1100.0**	**877.8**		**2381.4**	**2182.8**	
			S.Em. (±)	C.D. (P=0.05)		S.Em. (±)	C.D. (P=0.05)
Irrigation			18.7	113.6		25.8	157.1
Foliar potassium management			34.7	102.4		51.4	151.7
Interaction (I x T)			49.1	NS		72.7	NS

Table 8: Effect of irrigation schedules and foliar potassium management on nitrogen, phosphorus and potassium content in mungbean grain

Treatments		**N content (%) IW/CPE ratio**			**P content (%) IW/CPE ratio**			**K content (%) IW/CPE ratio**		
		I_1	**I_2**	**Mean**	**I_1**	**I_2**	**Mean**	**I_1**	**I_2**	**Mean**
Foliar potassium management	**T_1**	3.76	3.60	**3.68**	0.272	0.234	**0.253**	0.49	0.44	**0.47**
	T_2	3.87	3.65	**3.76**	0.284	0.248	**0.266**	0.52	0.46	**0.49**
	T_3	3.90	3.68	**3.79**	0.288	0.251	**0.270**	0.53	0.47	**0.50**
	T_4	3.92	3.70	**3.81**	0.294	0.254	**0.274**	0.53	0.48	**0.51**
	T_5	4.00	3.74	**3.87**	0.314	0.266	**0.290**	0.54	0.52	**0.53**
	T_6	4.05	3.79	**3.92**	0.322	0.274	**0.298**	0.55	0.53	**0.54**
	Mean	**3.92**	**3.69**		**0.296**	**0.255**		**0.53**	**0.48**	
			S.Em. (±)	C.D. (P=0.05)		S.Em. (±)	C.D. (P=0.05)		S.Em. (±)	C.D. (P=0.05)
Irrigation			0.032	0.211		0.005	0.031		0.01	0.05
Foliar potassium management			0.05	NS		0.010	NS		0.014	0.04
Interaction (I x T)			0.074	NS		0.014	NS		0.020	NS

Table 9: Effect of irrigation schedules and foliar potassium management on nitrogen, phosphorus and potassium content in mungbean straw

		N content (%)			**P content (%)**			**K content (%)**		
Treatments		**IW/CPE ratio**			**IW/CPE ratio**			**IW/CPE ratio**		
		I_1	**I_2**	**Mean**	**I_1**	**I_2**	**Mean**	**I_1**	**I_2**	**Mean**
Foliar potassium management	**T_1**	0.61	0.43	**0.52**	0.197	0.170	**0.184**	1.19	1.11	**1.15**
	T_2	0.74	0.53	**0.63**	0.206	0.180	**0.193**	1.25	1.16	**1.20**
	T_3	0.71	0.55	**0.63**	0.209	0.183	**0.196**	1.26	1.17	**1.21**
	T_4	0.74	0.58	**0.66**	0.211	0.185	**0.198**	1.26	1.17	**1.22**
	T_5	0.80	0.64	**0.72**	0.216	0.193	**0.205**	1.29	1.19	**1.24**
	T_6	0.83	0.66	**0.74**	0.219	0.199	**0.209**	1.29	1.19	**1.24**
	Mean	**0.74**	**0.56**		**0.210**	**0.185**		**1.26**	**1.16**	
			S.Em. (±)	C.D. (P=0.05)		S.Em. (±)	C.D. (P=0.05)		S.Em. (±)	C.D. (P=0.05)
Irrigation			0.020	0.14		0.003	0.021		0.009	0.06
Foliar potassium management			0.049	NS		0.006	NS		0.019	0.055
Interaction (I x T)			0.069	NS		0.008	NS		0.026	NS